"COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING T SCAN: A FOLLOW UP STUDY"

By

REG.NO. II0221001

Dissertation

Submitted to

KAHER, Belagavi, Karnataka

In partial fulfilment of the requirements for the degree of

MASTERS OF DENTAL SURGERY

IN

ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

(BRANCH – V)

DEPARTMENT OF

ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

KLE VISHWANATH KATTI INSTITUTE OF DENTAL SCIENCES,

KAHER, BELAGAVI, KARNATAKA.

2021 – 2024

KAHER, BELAGAVI

Endorsement by the Head of the Department and Principal/Head of the Institution

This is to certify that the dissertation entitled **"COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING T SCAN: A FOLLOW UP STUDY"** is a bonafide research work done by **REG.NO. II0221001.**

Head of Department

Dr Rohan Hattarki M. D.S.
Professor & Head,
Department of Orthodontics and
Dentofacial Orthopaedics,
KLE Vishwanath Katti
Institute of Dental Sciences,
KAHER, Belagavi.

Date :
Place: Belagavi

Principal

Dr Alka Kale M. D.S.
Principal,
KLE Vishwanath Katti
Institute of Dental Sciences,
KAHER, Belagavi.

Date : 25/4/24
Place: Belagavi

UNDERTAKING

I, **REG.NO. II0221001** Post-Graduate student in the subject of Orthodontics and Dentofacial Orthopaedics, have completed research work on the topic **"COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING T SCAN: A FOLLOW UP STUDY",** in the year 2024.

I have been given to understand that any research work I undertake for dissertation, oral presentation or publication during my study course shall be the property of the KLE Academy Of Higher Education and Research, (KAHER) KLE V. K. Institute of Dental Sciences, Belagavi. Hence, I hereby declare that the name of the Department, Institute and University shall be mentioned in my publications. The authorship shall be according to the guideline informed to me.

REG.NO. II0221001

UNDERTAKING

I, **REG.NO. II0221001** hereby declare that the information and data mentioned in my thesis entitled **"COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING T SCAN: A FOLLOW UP STUDY"** belongs to me and is original.

I am aware of the definition of plagiarism as detailed below:

- An act or instance of using or closely imitating the language and thoughts of another author without authorization and the representation of that author's work as one's own, as by not crediting the original author.
- A piece of writing or other work reflecting such unauthorized use or imitation.
- The deliberate or reckless representation of another's words, thoughts or ideas as one's own without attribution in connection with the submission of academic work, whether graded or otherwise.

I hereby declare that the thesis prepared by me is an original one and does not involve plagiarism anywhere. In case at a later stage, it is found that I have indulged in plagiarism, then I am solely responsible for the same and the Institution is at liberty to take any disciplinary action against me including cancellation of dissertation or any other penalties imposed by the University.

Place:

Date: **REG.NO. II0221001**

ABSTRACT

Introduction: The phases of orthodontic treatment include Initial Leveling and Aligning, Space closure, Finishing Detailing and Settling and Retention. The phase of finishing and detailing in orthodontic treatment has a crucial role in refining the occlusion and ensuring long-term stability [(1)]

Occlusion of the patient affects the orofacial muscles, the health of the Temporomandibular joint, and the ligaments and nerves that surround it. The function of the masticatory system and post-orthodontic stability are all impacted by these elements. [(3)]

The study aims to assess the post-orthodontic occlusal characteristics in patients who have undergone meticulous finishing and detailing according to the given guidelines and those who do not meet the required standards, using T Scan. This study will guide the practitioners in refining their treatment protocol to enhance occlusal stability and long-term retention.

Materials and methods: The subjects were distributed into Group A and B after inspection of the casts and radiographs based on the inclusion criteria which is similar to the parameters set by the American Board of Orthodontics.

The T Scan was used to record the bite forces of 42 patients who had undergone debonding at three time intervals- T1, T2 and T3.

The occlusal parameters that were evaluated are-

1. Occlusion Time
2. Disclusion time

3. Total Antagonism (%)
4. % of Force Distribution between Right and Left occlusion
5. The Anterior- Posterior % occlusal force ratio in the anterior and the posterior aspect

After Clinical Examination and before recording the T Scan Data, every patients tooth dimensions and details regarding teeth present were entered into the T Scan software. The patient was then trained to bite in Centric occlusion and the sensitivity parameters were adjusted. The patient was asked to bite on the sensor plate and the occlusion was recorded in Maximum Intercuspation (MIP) holding the intercuspation into MIP. The scan was repeated 3 consecutive times and the average value was taken into consideration.

Results: In a comparative evaluation between Group A & B, it was seen that the OT, Force distribution between the right and left sides and the Antero-Posterior Force distribution in the anterior and the posterior aspect was higher in Group B as compared to A. The Total Antagonism was seen to be more in Group A as compared to B.

Conclusion: The results of our study indicated that in cases where finishing and detailing were conducted, the occlusal parameters (OT, A-P Force distribution, Total Antagonism, and Force distribution with respect to the Left and Right sides) showed near-ideal values as compared to the patients who had not met the goals of finishing and detailing. Digital analysis obtained using T Scan is essential during the process of Finishing and Detailing to obtain a stable and well-balanced occlusion by the end of the orthodontic treatment.

Key words: T Scan, Finishing and Detailing, occlusion time, Disclusion time, Force distribution, Anteroposterior force distribution, Total Antagonism, digital occlusal analyzer

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF ANNEXURES

INTRODUCTION

The phases of orthodontic treatment include Initial Leveling and Aligning, Space closure, Finishing Detailing and Settling and Retention. The phase of finishing and detailing in orthodontic treatment has a crucial role in refining the occlusion and ensuring long-term stability [(1)]

The phase of finishing, detailing, and settling is the final phase of orthodontic treatment and involves fine-tuning of the occlusion, correcting any discrepancies and ensuring adequate interdigitation in between the maxillary and mandibular teeth during static and dynamic occlusion [(2)] Detailing helps in achieving the final location of each tooth in all planes with adequate tip, torque, and individual in and out changes.

Several guidelines for Finishing and Detailing have been given by various authors over time. The earlier authors relied on natural bite force for achieving the final occlusion whereas the Edgewise appliance started with minor procedures of finishing and detailing with rectangular wires. Beggs emphasized on overcorrection of all malocclusions so that even after tissue rebound the teeth would settle in the desired position. Roth added the gnathologic goals of finishing as a part of the treatment. In 1972 Andrews formulated the six keys of occlusion and emphasized that the objective of any orthodontic treatment should be to attain the keys of occlusion. In the pre-adjusted edgewise appliance, the procedure of Finishing and detailing became easier as compared to the Conventional Beggs technique. [(1)]

Currently, the guidelines of Finishing and Detailing that is followed widely is the one given by the American Board of Orthodontics. The Objective Grading System was incorporated to examine the final occlusion using a quantitative method. Before that in 1987 the Peer Assessment Rating Index (PAR) was put forward for the assessment of post orthodontic occlusion.

Orthodontic treatment aims to achieve optimal occlusal relationships and dental alignment, not only for aesthetic purposes but also for functional harmony. However, the effectiveness of orthodontic treatment is not solely assessed by the alignment of teeth and jaws but also by achieving stable occlusion post-treatment. Occlusion of the patient affects the orofacial muscles, the health of the Temporomandibular joint, and the ligaments and nerves that surround it. The function of the masticatory system and post-orthodontic stability are all impacted by these elements. [(3)]

Despite the recognized importance of finishing and detailing the extent to which this phase contributes to occlusal stability is still questionable. Sufficient credible literature is not available to emphasize the effects of meticulous and proper finishing and detailing on the post orthodontic occlusal stability. Some clinicians advocate precise finishing and detailing for every case to avoid the risk of post-orthodontic relapse whereas other clinicians prioritize treatment efficiency and timing.

Traditionally post orthodontic evaluation would be done by visual observation of stone casts or by listening to the patient's "feel" feedback. Other traditional methods such as articulating paper, shim stock, silicone impression, and waxes have also been used over time, but such methods were neither accurate nor would they tell us about the force discrepancies in functional occlusion and lack of precision and objectivity. [(4)]

Digital occlusal analysis tools like T Scan, offer a more accurate and impartial way to assess the patient's occlusion and help prevent this. T Scan is utilized to record the distribution of occlusal forces and contact and enables real-time digital examination of occlusion in both static and dynamic mode. [5]

It is expected that by the end of orthodontic treatment, there should be simultaneous contact between the maxillary and mandibular teeth with equal distribution of occlusal forces at centric as well as excursive movements. Following orthodontic treatment, there should be a uniform distribution of masticatory force intensity during mandibular clenching. Any such variation in occlusal characteristics can aid as a contributory factor for Temporomandibular Joint disorders.

Previously very few studies have been conducted where the effects of proper finishing and detailing have been assessed in subjects who have undergone orthodontic treatment, using a digitized method where the distribution of occlusal contacts and forces are recorded in a graphical form.

The study aims to assess the post-orthodontic occlusal characteristics in patients who have undergone meticulous finishing and detailing according to the given guidelines and those who do not meet the required standards, using T Scan. This study will guide the practitioners in refining their treatment protocol to enhance occlusal stability and long-term retention.

This study also addresses an important aspect of orthodontic treatment by evaluating the influence of finishing and detailing on post-orthodontic occlusion using advanced diagnostic aids.

AIM AND OBJECTIVES

AIM

To compare the post orthodontic occlusion in patients who have completed finishing and detailing as to those who were debonded in the mid finishing stage, using T-Scan

OBJECTIVES:

- To evaluate the post orthodontic occlusion of patients who have completed the finishing and detailing stage
- To evaluate the post orthodontic occlusion of patients who have been debonded during the mid-finishing stage
- To compare the post orthodontic occlusion of patients who have completed finishing and detailing and those who have not.

REVIEW OF LITERATURE

1. **Noha Ezzat et al (2023)** studied the difference in occlusal parameters in orthodontically treated patients who have undergone premolar extraction and the result was compared with occlusion of non-orthodontic patients. The Force distribution between the right and the left side was assessed for the presence of frictional contacts and interferences.

It concluded that- The Force distribution between the two sides showed significant imbalances and prematurities in the patients who were treated with extraction as compared to the control group. These imbalanced forces could lead to instability and could affect retention post-orthodontically. [(3)]

2. **Robert B Kerstein, Svitlana Koval (2021)** conducted a study where they evaluated 49 patients of different Angle's malocclusion in individuals who were interested in undergoing orthodontic treatment

It was concluded that- When subjects with Class I, II and III were compared, it was seen that the an imbalance between forces on the right and left side in all three groups. It was seen that the highest anterior force % was seen in Class II subjects. The occlusal parameters such as Right-left force %, Disclusion time, and Antero-Posterior Force % were non ideal even in Class I occlusion suggesting that the visual method of assessing occlusion is not satisfactory [(6)]

3. **Dr Mona A. Abbassy and Dr Marcello Melis (2020)** conducted a study to evaluate the occlusal balance, lateral occlusal scheme, and occlusion time in various dental and skeletal malocclusions

It was concluded that – Patients who had Class I occlusion presented with a reduced occlusion time and increased frequency of canine-guided occlusion. Patients with Class III malocclusion had a longer OT than patients with Class II. The other parameters that were evaluated were the Occlusal balance and Lateral Occlusal scheme. The association between overjet and balanced occlusion was found significant. [(7)]

4. **Sumanth Ks and Prafulla Thumati (2019)** conducted a study to evaluate the occlusal force parameters of 5 orthodontically treated patients using T Scan and Bio EMG in post-orthodontic individuals. Patients were advised to bite down on the sensor, hold it for a few seconds, and then glide left or right to capture excursive forces and the corresponding muscle activity using Bio EMG III.

It was concluded that- The disclusion time was prolonged because of the frictional contacts between the posterior teeth following orthodontic treatment and this contributes to the increased muscle activity. Post-orthodontic disclusion time should be less than .5 sec to reduce muscle hyperactivity and the myofascial symptoms associated with it. [(8)]

5. **Raul Ayuso-Montero,Yumaysla Mariano-Hernandez (2019)** conducted a study to assess the reliability of T Scan and 3D intraoral scanning techniques for the assessment of occlusal contact area (OCA). T-scan recordings were used to assess the OCA at 50% and maximum force. A second method considered the occlusal contact at two interocclusal distances and evaluated the OCA between two virtual models intraorally using a 3D surface scan. The third method measured OCA by taking contact at the two interocclusal

distances and using occlusal registration at both the maximal and moderate occlusal force.

It was concluded that – T-scan is a reliable method for measuring the OCA, but the 3D surface scan is not. [9]

6. **Qadeer, Ahmed A Abbas (2016)** studied the disclusion time, excursive frictional contacts, and occlusal scheme of non-orthodontic and post-orthodontic participants using a T scan. A TMD questionnaire was filled by each participant to ascertain whether or not there are symptoms of Temporomandibular joint disorders (TMD).

It was concluded that- The disclusion time was increased in post-orthodontic individuals. The higher the disclusion time, the more frictional contacts in the posterior aspect were observed. The non-orthodontic group presented with increased frictional contacts on the working side as compared to the non-working side whereas post-orthodontic subjects had more evenly distributed occlusal contacts. With the increase of disclusion time, the patient had an increased tendency for TMD. [10]

7. **Qadeer and Yang (2016)** carried out a study where they compared occlusal force parameters in patients who were treated orthodontically and those who have not, using T Scan III

It was concluded that- In contrast to the participants with natural dentition, there was a notable occlusal force difference in the post-orthodontic subjects, with larger force percentages seen posteriorly and significantly lower percentage force anteriorly. In order to help the clinician decrease the severity of the occlusal force imbalance caused

by orthodontics, T-Scan® III digital occlusal analysis may be suggested for orthodontic case completion.[11]

8. **Seth V, Patil AK, Kidiyoor H, and Patil K (2016)** conducted a quantitative occlusal analysis using T Scan which was performed on 16 adult patients at the start of the finishing stage (T1) followed by a detailed finishing and settling phase of 2 months. Another scan was taken 1 month after debonding (T2).

It was concluded that – Two months of extensive detailing and finishing produced positive adjustments in occlusion and a noticeable improvement in the distribution of occlusal contacts, Mandibular position, and occlusal force on the right and left side. Because of this, the T Scan occlusion evaluation approach is novel and objective, highlighting the need for adequate finishing to provide functionally stable occlusion. [2]

9. **Sang Min Lee and Jin Woo Lee (2016)** carried out a study to assess the validity of T Scan III as an objective evaluation tool by comparing it with two occlusal indexes- PAR (Peer Assessment rating) and OGS (Objective Grading System).

It was concluded that- The OGS scores were correlated significantly with the T Scan measurements as compared to the PAR index. [12]

10. **Alvaro Carvajal-Flórez (2016)** evaluated the outcome of finishing protocols set by the Objective Grading System (OGS) of the Americal Board of Orthodontics (ABO) by evaluation of 34 casts and panoramic radiographs

It was concluded that- Implementation of the finishing and detailing protocols improved the outcomes of the orthodontic treatment. Significant emphasis should be given during the finishing and detailing phases to obtain a stable occlusion. (13)

11. **Morton and Pancherz (2007)** evaluated 115 patients who had undergone orthodontic treatment and assessed the post-orthodontic occlusion by assessing the anteroposterior and lateral interferences.

It was concluded that – After debonding, settling did not appear to improve the functional efficiency of the occlusion. Therefore, it was crucial to examine the occlusion and remove any undesired contacts before removing the appliance. (14)

12. **M.H. SULTANA, K YAMADA (2002)** conducted a study in patients who have undergone premolar extractions, to assess the changes in functional occlusion using pressure-sensitive sheets throughout the retention phase following active orthodontic treatment.

It was concluded that – There was an increase in the occlusal force and contact area in the molar and second molar region rather than in the anterior aspect, one year after removal of the retainers. The force distribution at the second molar region was significantly higher in the treatment group. (15)

13. **The Americal Board of Orthodontics Grading System for Dental Casts and Panoramic Radiographs (1999)** states that Alignment, Marginal Ridges, Buccolingual inclination, Occlusal contacts, occlusal relationship, overjet, Interproximal contacts and root angulation have to be assessed for precise finishing and detailing. If a case report has a reduction of more than 30 points then, it is considered a fail, and if it is less than 20, it is considered a pass (16)

14. **Richard P McLaughlin and John C. Bennett (2003)** in an article mentions that in addition to cephalometric and aesthetic considerations, finishing and detailing variables must take into account horizontal, vertical, and transverse dimensions. The proper tips of the anterior and posterior teeth are taken into account horizontally. All gaps must be sealed, and the incisors must maintain a sufficient torque. Contact points, marginal ridge relationships, and vertical crown lengths need to be changed. From a dynamic occlusion perspective, condyles should be in centric relation when teeth occlude, and functional movements should be established. In transverse relation, arch form and archwire coordination should be set up. [(17)]

15. **Young Kyu Ryu, Young-Joon Kim (1999)** in a review article mentioned the rationale and criteria for excellent finishing.

It concluded that- Patients should have Class I occlusion with all teeth aligned. Occlusal factors such as Alignment, Interproximal contact, Anterior and posterior inclination, overjet, overbite, and arch form were considered. In aesthetic factors- gingival form, crown form. Crown width and periodontal factors- root angulation and bone level were to be evaluated. [(18)]

MATERIAL AND METHODS

Study Design: Prospective study

Source of data/laboratory details: The study was done on patients who were undergoing fixed mechanotherapy treatment in the Department of Orthodontics and Dentofacial Orthopedics, KLE Academy of Higher Education and Research, KLE VK Institute of Dental Sciences, Belagavi.

Inclusion criteria:

- Patients in the age group of 18-46 years
- Patients who were undergoing active orthodontic treatment.
- Patients who were being treated with pre-adjusted edgewise appliances with an 0.022" slot MBT prescription with complete space closure achieved.
- Patients with no more than one missing tooth in each quadrant excluding 3rd molars.
- Both male and female patients.

GROUP A	GROUP B
• Patients who have met the goals of finishing and detailing stage-	• Patients who have not met the treatment goals of finishing and detailing stage
1) Alignment- If all teeth are aligned or < 1mm of deviation	Alignment- Deviation >1mm
2) Marginal ridge position- Adjacent marginal ridges at the same level or deviate from .5- 1mm	Marginal Ridge position- Deviation > 1mm
3) Occlusal contacts- All cusps are in interdigitation with the opposing arch or have a distance of <1mm	Occlusal contacts- Cusps are out of interdigitation with the opposing arch > 1mm
4) Occlusal Relationship- Maxillary Class 1 relationship- Mesio buccal cusps coincide with the buccal groves of mandibular molars or are within 2 mm of it.	Occlusal Relationship- Mesio buccal cusps deviate >2mm
5) Interproximal contacts- Mesiodistal surfaces are in contact or have a spacing of <1mm	Interproximal contacts- Spacing > 1mm is present.
6) Root parallelism-Maxillary and mandibular teeth are parallel to each other or have a slight mesiodistal angulation, not touching the adjacent teeth	Root parallelism- Maxillary and mandibular teeth have significant mesiodistal angulation and are touching each other.

Exclusion criteria:

- Patients with more than one missing tooth in each quadrant, excluding 3rd molars.
- Patients who have undergone orthognathic surgical treatment
- Patients with Cleft Lip and Palate
- Patients whose post orthodontic occlusion is not Angles Class I

Sample size estimation:

Sample size at 95 % Confidence Interval

Power= 80%

$$n = \frac{(z_{1-\alpha/2} + z_{1-\beta})^2 (SD_1^2 + SD_2^2)}{(x_1 - x_2)}$$

$$n = \frac{(1.96+0.85)^2 (4.45^2 + 10.68^2)}{(71.23-61.94)^2}$$

n= 21.2 (without attrition)

n= 23.3 (with 10% attrition)

For each group

where, $z_{1-\alpha/2} = 1.96$

$z_{1-\beta} = 0.85$

$x_1 = 51.92$

$x_2 = 48.08$

$SD_1 = 4.45$

$SD_2 = 4.45$

Materials and methodology with flowchart:

The materials required were-

- Patient's post-treatment records- Patient's post-treatment casts and radiographs were evaluated for categorizing the subjects into groups
- Vernier Caliper- Before the scan, the T Scan software was loaded with the patient's tooth measurements and dental information.
- T Scan Novus III- It is a chairside handpiece that helps in recording and reviewing scans by creating an accurate representation of the occlusion.**[Fig 1]**
- Tekscan version 10.0.40- It is the software that helps generate dynamic patient reports and convert them into MP4 movie files.**[Fig 2]**
- T Scan sensors – The sensors are wafer-thin sheets that can withstand 15-25 closures and provide with repeatable and high level of accuracy. They are reusable on a single patient after cold sterilization**. [Fig 3]**

Fig 1- T Scan Novus III Scannerv

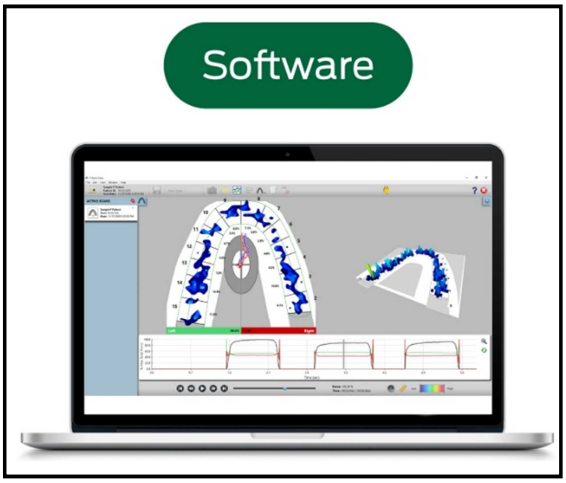


Fig 2- Tekscan version 10.0.40

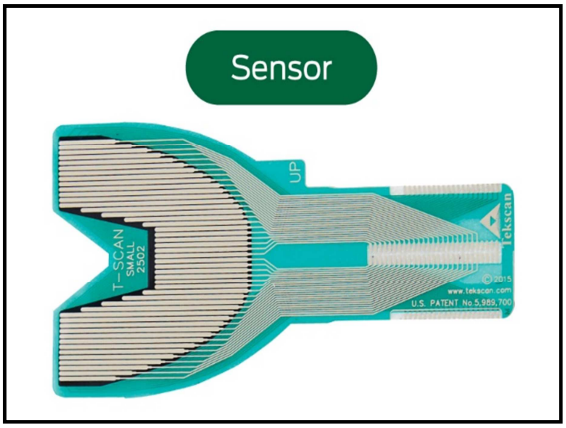


Fig 3- T Scan Sensors

Methodology

Patients post treatment records were collected and evaluated

Patients were divided into two groups on the basis of –

1) Alignment
2) Marginal ridge level
3) Occlusal contacts
4) Occlusal Relationship

Group A

Debonded Patients who have met the inclusion criteria of Group A

Group B-

Debonded patients who have met the inclusion criteria of Group B

Recordings were taken at –

T1- 30 minutes after Debonding

T2- 3 months after Debonding

T3- 6 months after Debonding

Patient's post-treatment casts were used to calculate the dental Arch dimensions and Tooth Dimensions using Vernier Caliper.

The following data was entered into the T Scan software-1) Personal Details 2) Dental arch dimensions 3) Tooth Dimensions 4) Intraoral Examination details

The patient was asked to be seated upright in the dental chair (Frankfort Horizontal{FH} Plane is parallel to the floor) and the patient was instructed to practice occluding in Maximum Intercuspation (MIP) several times with a portable mirror

An appropriate sensor was placed on the occlusal surface of the maxillary arch and the sensor's sensitivity was adjusted by limiting only the first three pink high force columns.

For multi bite recording, the patient was instructed to occlude into the recording sensor three times in succession using Maximum Bite Force.

Force distributions were recorded as percentages. The MIP was used to measure the relative occlusal force, the data of which is shown in 2D, 3D images.

All patients were analysed at –
T1- 30 mins after debonding
T2- 3months after debonding
T3- 6 months after debonding

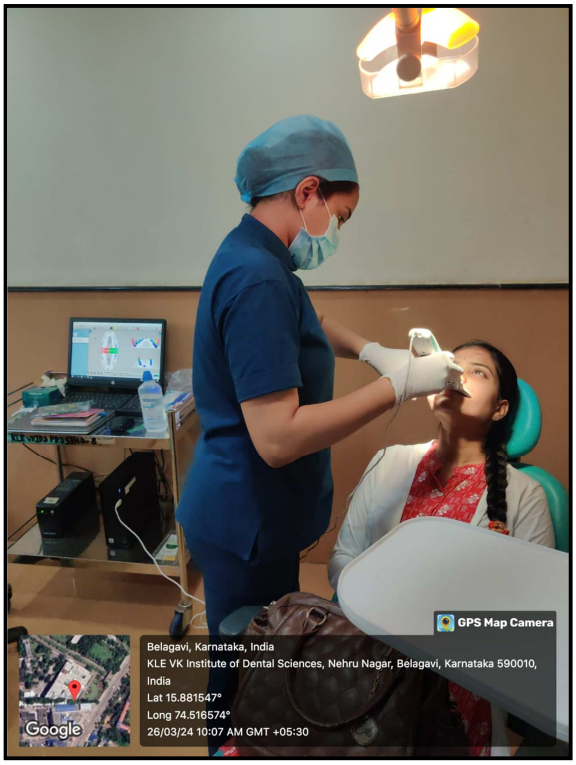


Fig 4: Recording of patient's occlusal parameters using T Scan.

Details of the procedures conducted during the research

The subjects were distributed into Group A and B after inspection of the casts and radiographs based on the inclusion criteria which is similar to the parameters set by the American Board of Orthodontics.

The T Scan 10 digital occlusal system is a complete digital occlusal analyzer that helps practitioners identify interferences, high forces and interocclusal relationships. The T Scan Novus handpiece is plugged into the USB port and a size-appropriate sensor is placed into the holder. The sensors used were wafer-thin.The T Scan v10 software was used to examine the data.

The T Scan was used to record the bite forces of 42 patients who had undergone debonding at three time intervals- T1, T2 and T3. [Fig 4.]

The occlusal parameters that were evaluated are-

1. **Occlusion Time**
2. **Disclusion time**
3. **Total Antagonism (%)**
4. **% of Force Distribution between Right and Left occlusion**
5. **The Anterior- Posterior % occlusal force ratio in the anterior and the posterior aspect**

After Clinical Examination and before recording the T Scan Data, every patient's tooth dimensions and details regarding teeth present were entered into the T Scan software. The patient was then trained to bite in Centric occlusion and the sensitivity parameters were adjusted. The patient was asked to bite on the sensor plate and the occlusion was recorded in Maximum Intercuspation (MIP) holding the intercuspation into MIP. The scan was repeated 3 consecutive times and the average value was taken into consideration.

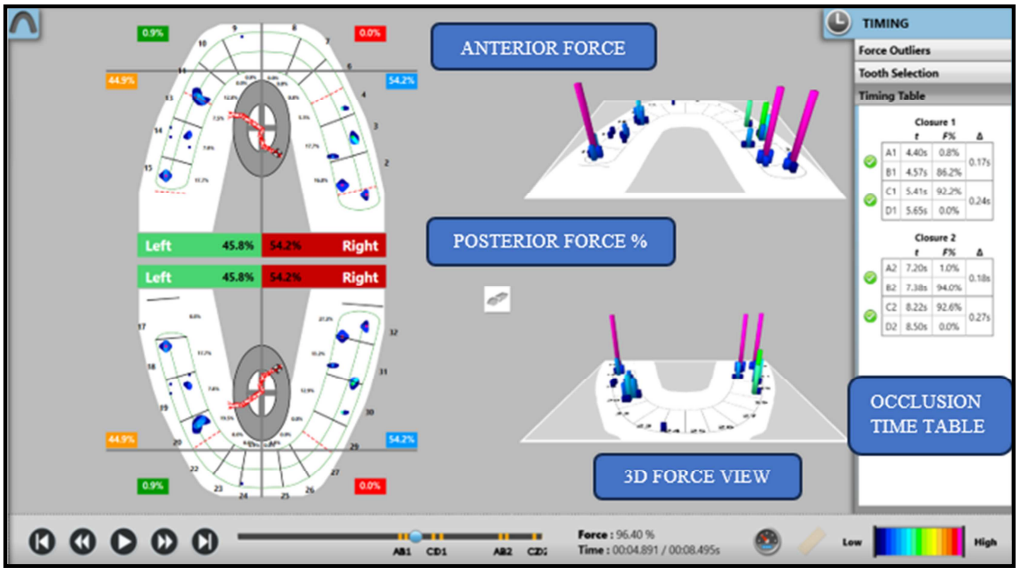


Fig 5: T Scan Recording

A Line denotes the 1st tooth contact

B Line- All teeth complete intercuspation in MIP

A-B Time Duration- Occlusion Time

B-C Time Duration- When all teeth are held at maximum intercuspation

C Line- Starting of an excursive movement when teeth start disarticulating

D Line- When all teeth have disarticulated

C-D time duration- Time required to disocclude all the posterior teeth

Using the T Scan system five occlusal parameters were evaluated-

1) **Occlusion time (OT)-** OT should ideally be less than 0.2 seconds, with larger OT times indicating a patient who closes slowly, which is frequently associated by muscle weakness. When a patient closes, there are a lot of closure interferences and early contacts present (OT>.2sec).

2) **Disclusion time (DT**)- DT has to be less than 0.4 seconds, preferably. More occlusal surface frictional contacts are indicated by longer DT durations, which increase masticatory muscle activity and frequently result in occlusal-activated muscular Temporomandibular joint disorder (TMD) symptoms.

3) **Total Antagonism (%)** – percentage of teeth in contact compared to all teeth. Maxillary dental arch teeth arranged antagonistically at each person's maximum intercuspation degree

4) **% Force Distribution between Right and Left occlusion-** The occlusal forces applied by the teeth on that side of the arch are represented by this. It provides us with the relative distribution of occlusal forces on the dental arch on both the sides.

5) **The Anterior- Posterior Force % (A-P Force %) - occlusal force ratio in the anterior and the posterior aspect-** The force distribution in the anterior and posterior aspect.

RESULTS

Method of statistical analysis –

1. Data obtained was entered and sorted in Microsoft Excel (v.2013).
2. Statistical analysis was performed using Statistical package for social sciences (SPSS) software (IBM Corp) (v.21.0).
3. Descriptive statistics were performed for all the different parameters assessed in the study.
4. Comparisons between different time intervals T1, T2, and T3 for all different landmarks were performed using Repeated measures ANOVA test to assess significant differences.
5. Comparisons between the two Groups- A & B were performed using the MANN WHITNEY U Test.
6. All statistical tests were performed at 95% confidence intervals.
7. A p-value of less than 0.05 was considered as statistically significant in the study.
8. The study was done to assess and compare the occlusal parameters in post-orthodontic patients who have undergone finishing and detailing and those who have not, using a T-scan
9. A total of 42 subjects who had undergone orthodontic treatment were evaluated over a period of 6 months at T1=after debonding, T2 = 3 months after debonding, and T3= 6 months after debonding.

DESCRIPTIVE STATISTICS

Table 1- Descriptive statistics of the T Scan parameters in patients who have met the treatment goals of finishing and detailing

	MINIMUM	**MAXIMUM**	**MEAN**	**STANDARD DEVIATION**
GROUP A: Patients who have met the treatment goals of finishing and detailing stage				
OCCLUSION TIME (T1)	0.06	0.62	0.26	0.14
OCCLUSION TIME (T2)	0.14	0.64	0.31	0.14
OCCLUSION TIME (T3)	0.12	0.74	0.37	0.16
DISCLUSION TIME (T1)	0.07	1.60	0.35	0.30
DISCLUSION TIME (T2)	0.22	1.60	0.38	0.29
DISCLUSION TIME (T3)	0.08	3.70	0.59	0.73
FORCE DISTRIBUTION: DIFFERENCE (T1)	5.60	50.50	22.16	14.24
FORCE DISTRIBUTION: DIFFERENCE (T2)	3.20	50.30	19.38	14.41
FORCE DISTRIBUTION: DIFFERENCE (T3)	2.20	56.00	18.42	15.42
TOTAL ANTAGONISM (T1)	84.00	100.00	95.28	5.22
TOTAL ANTAGONISM (T2)	74.20	99.00	92.50	6.54
TOTAL ANTAGONISM (T3)	67.01	99.91	95.14	6.76
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T1)	0.80	34.50	7.26	7.90
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T2)	2.20	33.20	7.53	6.92

ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T3)	0.90	28.60	6.02	6.57
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T1)	15.40	49.20	42.72	7.91
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T2)	16.80	52.30	42.59	7.56
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T3)	21.40	49.70	43.61	6.91

The mean values with a standard deviation of occlusal parameters recorded by using T Scan, such as Occlusion time, Disclusion time, Total Antagonism, Force distribution between the right and left side and Antero-posterior force distribution in patients who have undergone finishing and detailing has been depicted in Table 1

Table 2- Descriptive statistics of the T Scan parameters in patients who have not met the treatment goals of finishing and detailing

GROUP B: Patients who have not met the treatment goals of finishing and detailing stage				
OCCLUSION TIME (T1)	0.14	1.40	0.41	0.29
OCCLUSION TIME (T2)	0.26	1.60	0.45	0.27
OCCLUSION TIME (T3)	0.29	2.80	0.59	0.52
DISCLUSION TIME (T1)	0.07	1.22	0.36	0.31
DISCLUSION TIME (T2)	0.32	0.72	0.48	0.12
DISCLUSION TIME (T3)	0.31	0.72	0.47	0.11
FORCE DISTRIBUTION: DIFFERENCE (T1)	7.00	46.00	26.08	13.83
FORCE DISTRIBUTION: DIFFERENCE (T2)	4.00	54.00	28.47	12.86
FORCE DISTRIBUTION: DIFFERENCE (T3)	3.00	44.00	30.46	12.03
TOTAL ANTAGONISM (T1)	73.50	100.00	91.38	9.36
TOTAL ANTAGONISM (T2)	71.20	98.00	88.18	9.20
TOTAL ANTAGONISM (T3)	69.40	98.20	87.36	9.37
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T1)	1.20	28.60	12.31	8.18
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T2)	2.70	26.30	12.64	7.22
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T3)	3.40	29.40	15.76	7.48

ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T1)	3.05	48.80	34.82	13.27
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T2)	23.70	47.30	37.35	7.22
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T3)	20.60	46.60	34.23	7.48

The mean values with a standard deviation of occlusal parameters recorded by using T Scan, such as Occlusion time, Disclusion time, Total Antagonism, Force distribution between the right and left side and Antero-posterior force distribution in patients who have not undergone finishing and detailing has been depicted in **Table 2**.

TABLE 3: Comparison of different parameters across three time periods for each group using REPEATED MEASURES ANOVA test in patients who have met the goals of Finishing and Detailing

Table 3 – Follow up of patients who have achieved the treatment goals of finishing and detailing at T1- 30 minutes after debonding, T2- After 3 months and T3- After 6 months

	MEAN	**STANDARD DEVIATION**	**WILKS-LAMBDA VALUE**	**p-VALUE**
GROUP A: Patients who have met the treatment goals of finishing and detailing stage				
OCCLUSION TIME (T1)	0.26	0.14	0.468	0.001*
OCCLUSION TIME (T2)	0.31	0.14		
OCCLUSION TIME (T3)	0.37	0.16		
DISCLUSION TIME (T1)	0.35	0.30	0.770	0.084
DISCLUSION TIME (T2)	0.38	0.29		
DISCLUSION TIME (T3)	0.59	0.73		
FORCE DISTRIBUTION: DIFFERENCE (T1)	22.16	14.24	0.918	0.445
FORCE DISTRIBUTION: DIFFERENCE (T2)	19.38	14.41		
FORCE DISTRIBUTION: DIFFERENCE (T3)	18.42	15.42		
TOTAL ANTAGONISM (T1)	95.28	5.22	0.648	0.016*
TOTAL ANTAGONISM (T2)	92.50	6.54		

TOTAL ANTAGONISM (T3)	95.14	6.76		
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T1)	7.26	7.90	0.682	0.026*
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T2)	7.53	6.92		
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T3)	6.02	6.57		
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T1)	42.72	7.91	0.819	0.151
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T2)	42.59	7.56		
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T3)	43.61	6.91		

*p value <0.05 statistically significant

The comparison between the occlusal parameters over period T1, T2 and T3 in patients who have achieved the treatment goals of finishing and detailing was done using **Repeated measure ANOVA** test and the results have been depicted in **Table 3.**

A statistically significant difference was noted for OT (p=0.001) Total antagonism (p = 0.016), and Antero-posterior force distribution in the anterior (p = 0.026). A statistically significant difference was not found concerning Disclusion time, Difference in Force % between the right and left side and Antero-posterior distribution with respect to the posterior aspect.

- There was an increase in Mean Occlusion Time (OT) from Mean OT at T1 (Mean =0.26) to T3 (Mean = 0.37).
- The total antagonism reduced from T1 (Mean = 95.28)- T2 (Mean = 92.50) followed by an increase from T2 (Mean = 92.50) -T3 (Mean = 95.14)
- The Antero-posterior Force Distribution in the anterior aspect showed a reduction over time from T1 (Mean =7.26) -T3 (Mean = 6.02)

TABLE 4: Comparison of different parameters across three time periods for each group using REPEATED MEASURES ANOVA test in patients who have not met the goals of Finishing and Detailing

GROUP B: Patients who have not met the treatment goals of finishing and detailing stage				
OCCLUSION TIME (T1)	0.41	0.63	0.65	0.019*
OCCLUSION TIME (T2)	0.54	0.59		
OCCLUSION TIME (T3)	0.59	0.11		
DISCLUSION TIME (T1)	0.36	0.31	0.807	0.130
DISCLUSION TIME (T2)	0.48	0.12		
DISCLUSION TIME (T3)	0.47	0.11		
FORCE DISTRIBUTION: DIFFERENCE (T1)	26.08	13.83	0.810	0.135
FORCE DISTRIBUTION: DIFFERENCE (T2)	28.47	12.86		
FORCE DISTRIBUTION: DIFFERENCE (T3)	30.46	12.03		
TOTAL ANTAGONISM (T1)	91.38	9.36	0.761	0.075
TOTAL ANTAGONISM (T2)	88.18	9.20		
TOTAL ANTAGONISM (T3)	87.36	9.37		
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T1)	12.31	8.18	0.308	0.000*

ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T2)	12.64	7.22		
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T3)	15.76	7.48		
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T1)	34.82	13.27	0.298	0.000*
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T2)	37.35	7.22		
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T3)	34.23	7.48		

*p value <0.05 statistically significant

The comparison between the occlusal parameters over periods T1, T2, and T3 in patients who have not achieved the treatment goals of finishing and detailing was done using the Repeated measure ANOVA test and the results are depicted in **Table 4**. A statistically significant difference was noted for Occlusion time (p=0.019) and Antero-posterior force distribution in the anterior and posterior (p=0.000) aspect. There was an increase in Mean Occlusion Time (OT) from Mean OT at T1 (Mean =0.41) to T3 (Mean = 0.59). Disclusion time, Total Antagonism, Force distribution difference between the left and right sides, and Antero-posterior distribution concerning the posterior aspect did not show a statistically significant difference.

- The Antero-Posterior Force distribution with respect to the anterior aspect increased from T1 (Mean =12.64) to T3 (Mean = 15.76). A large increase in force % was seen in between T2-T3 whereas the increase from T1-T2 was not as much.
- The Antero-Posterior Force distribution with respect to the posterior aspect increased from T1 (Mean = 0.34.82) to T2 (Mean = 37.35), whereas there was a decrease in force % from T2 (Mean = 37.35) to T3 (Mean = 34.23). The value at T3 was similar to the value at T1.

TABLE 5: Comparison of different parameters between group A & group B using MANN-WHITNEY U test

	MANN-WHITNEY U VALUE	**Z-VALUE**	**p-VALUE**
OCCLUSION TIME (T1)	128.000	-2.332	0.020*
OCCLUSION TIME (T2)	118.000	-2.585	0.010*
OCCLUSION TIME (T3)	131.500	-2.243	0.025*
DISCLUSION TIME (T1)	211.000	-0.240	0.811
DISCLUSION TIME (T2)	93.500	-3.207	0.001*
DISCLUSION TIME (T3)	197.000	-0.592	0.554
FORCE DISTRIBUTION: DIFFERENCE (T1)	175.000	-1.146	0.252
FORCE DISTRIBUTION: DIFFERENCE (T2)	137.500	-2.090	0.037*
FORCE DISTRIBUTION: DIFFERENCE (T3)	110.000	-2.781	0.005*
TOTAL ANTAGONISM (T1)	192.000	-0.718	0.473
TOTAL ANTAGONISM (T2)	157.000	-1.600	0.110

TOTAL ANTAGONISM (T3)	85.000	-3.413	0.001*
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T1)	115.000	-2.657	0.008*
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T2)	116.000	-2.631	0.009*
ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR (T3)	59.000	-4.068	0.000*
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T1)	113.000	-2.707	0.007*
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T2)	121.000	-2.505	0.012*
ANTERO-POSTERIOR FORCE DISTRIBUTION: POSTERIOR (T3)	68.000	-3.840	0.000*

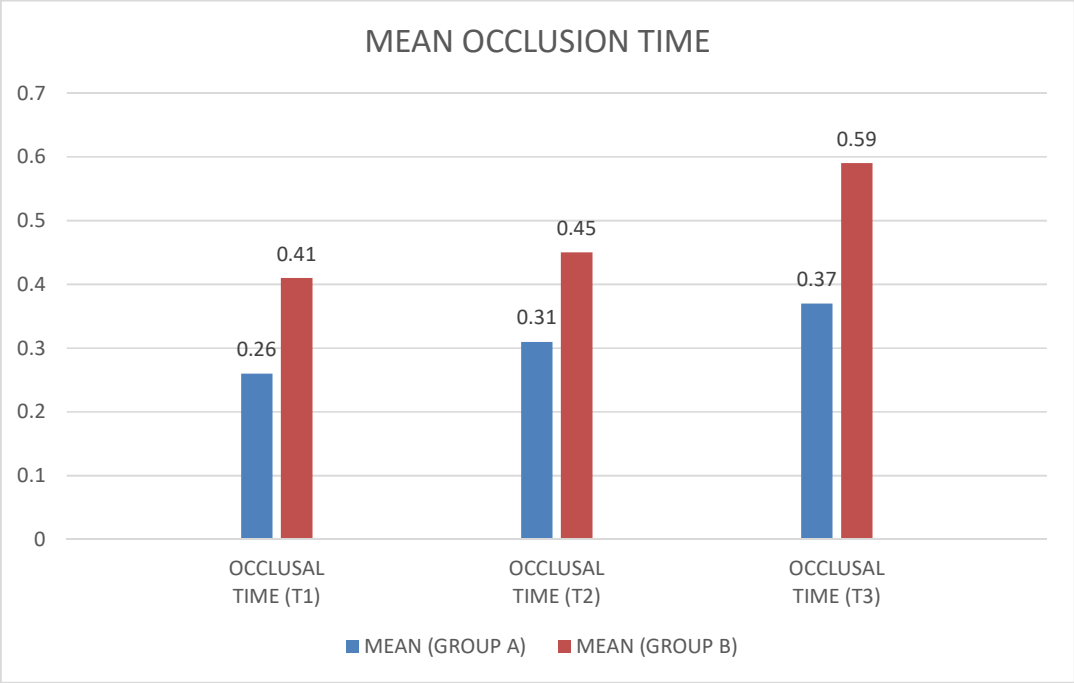
*p value <0.05 statistically significant

The comparison within the various occlusal parameters between the two groups which was done using the MANN-WHITNEY U TEST has been depicted in **Table 5.**

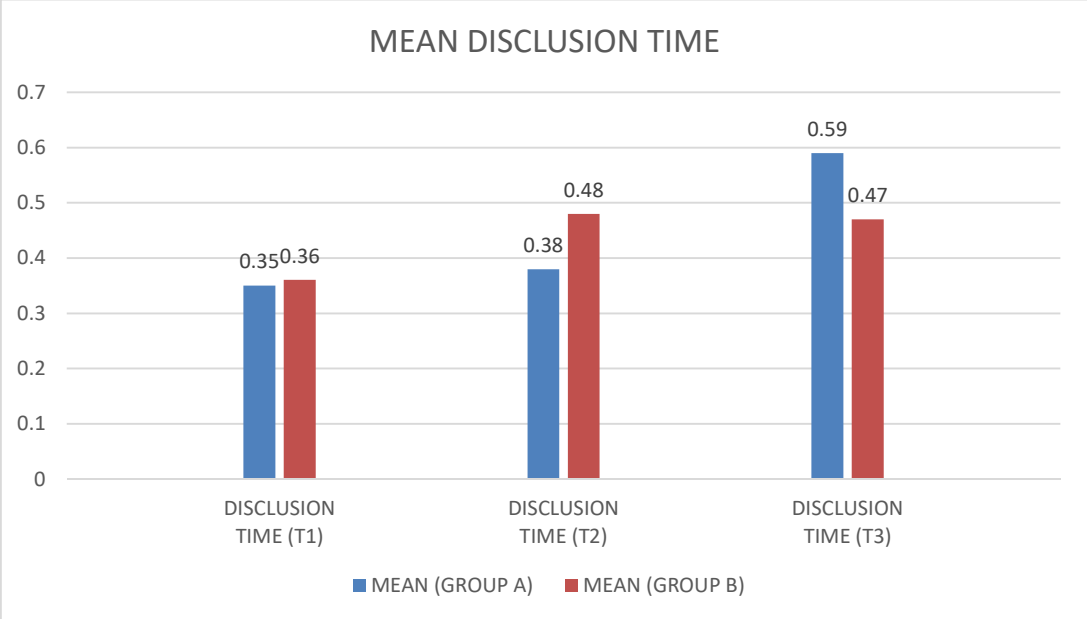
A statistically significant difference between Group A and B was seen with respect to the Occlusion time at T1 (p=.020) , T2 (p=.010) and T3 (p=.025), Disclusion time at T2 (p=.001) , Force Distribution at T2 (p= .037) and T3 (p= .005), Total Antagonism at T3 (p= .001) and Antero-posterior force distribution in the anterior aspect at T1(p=.008), T2(p=.009) and T3 (p=.000) and in the posterior aspect at T1 (p=.007), T2 (p=.012) and T3 (p=.000)

- At T1, T2, and T3, the occlusion period in Group B was substantially longer than in Group A.
- At T2, Group B had a considerably longer disclusion time than Group A.
- The Force distribution between the Right and the Left side was significantly higher in Group B at time intervals T2 and T3
- Total Antagonism was seen to be significantly higher in Group A at T3
- At all time intervals (T1, T2, and T3), Group B was observed to have a considerably higher anteroposterior force distribution with the anterior aspect.
- At all time intervals (T1, T2, and T3), Group B was observed to have a considerably larger anteroposterior force distribution with the posterior aspect.

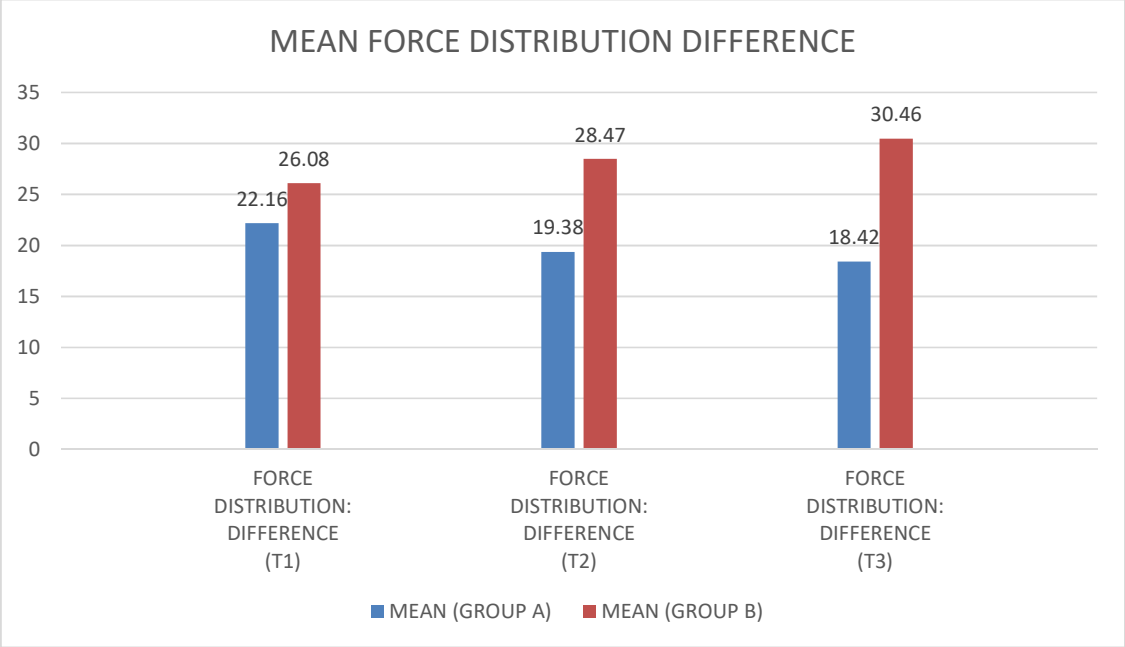
GRAPHS



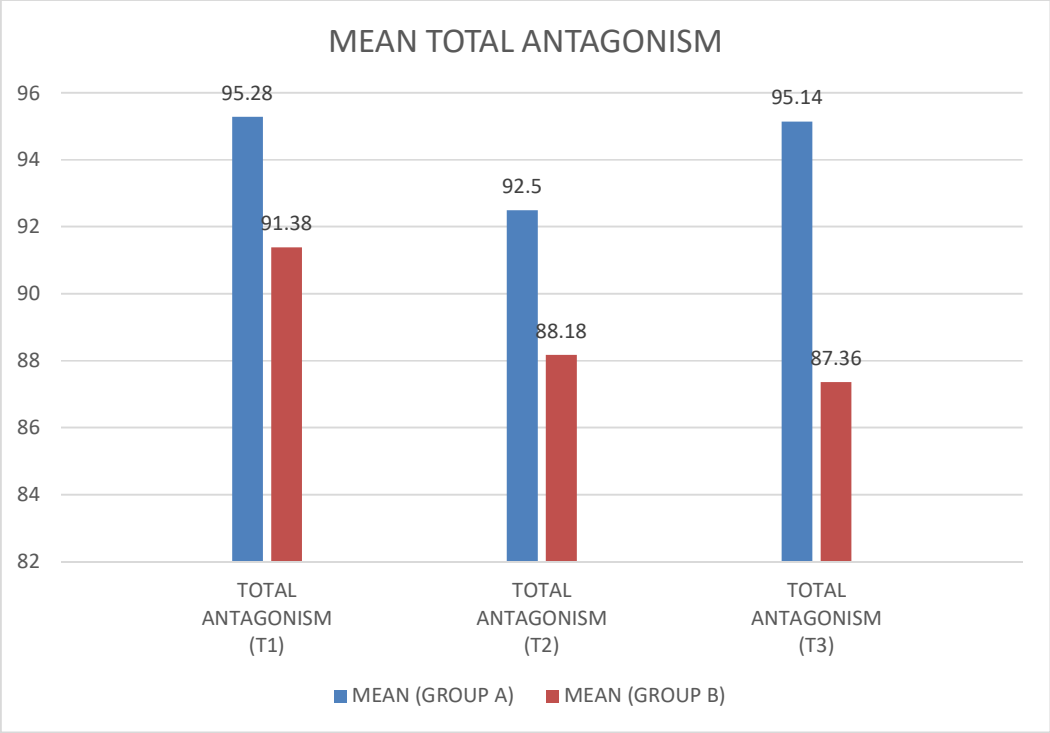
Graph 1- Comparison of mean occlusion time between Group A and B



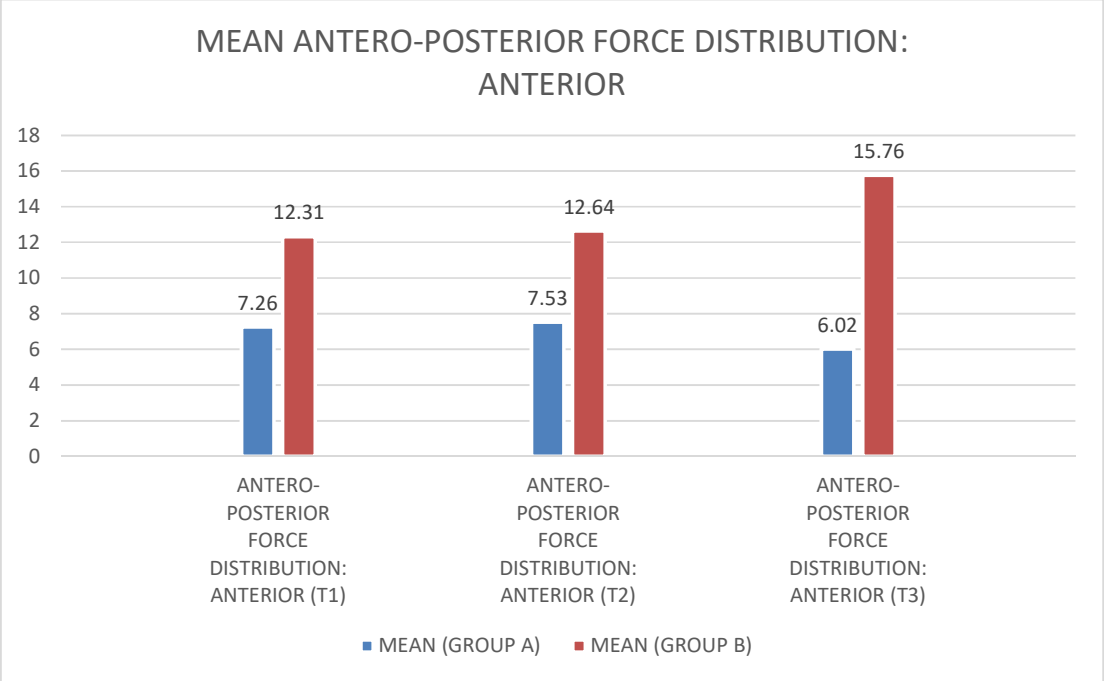
Graph 2:Comparison of mean Disclusion time between Group A and B



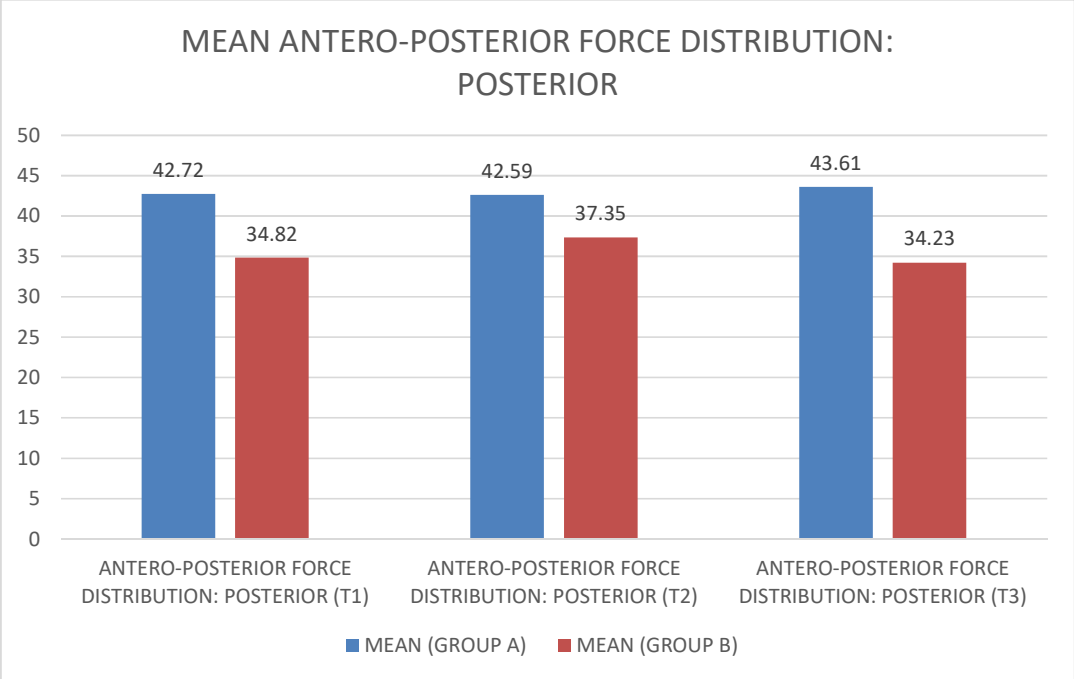
Graph 3: Comparison of mean Force distribution between the Right and Left side in Groups A and B



Graph 4 - Comparison of Total Antagonism in Group A and B



Graph 5 : Comparison of Antero-Posterior Force Distribution in the anterior aspect in Group A and B



Graph 6 - Comparison of Antero-Posterior Force Distribution in the posterior aspect in Group A and B

DISCUSSION

Finishing and detailing is the end phase of orthodontic treatment and it has been a continuous challenge for the orthodontist to achieve the treatment goals given by various authors. Finishing procedures should be considered from the initial phase of the treatment and require good diagnosis and treatment planning. This phase is carried out at the end of the orthodontic treatment process after the primary objectives such as leveling aligning and space closure have been achieved.

The major tooth movements like intrusion and retraction are referred to as macro mechanics whereas the minor tooth movements which are essential to achieve optimal occlusion are carried out during the finishing and detailing phase.[1]

Finishing refers to a more general goal of producing optimal tooth positions for the complete stomatognathic system which in turn provides stability and improved functional efficiency and best possible esthetics. Detailing is a part of the Finishing phase which emphasizes the individual placement of each tooth in all three orders of movement including tip, torque and rotation.[19]

Since ages, significant emphasis has been placed on proper finishing and detailing and its co-relation to stability. The phase of finishing and detailing usually takes 4-7 months post-space closure and by the end of the treatment, the minor discrepancies in occlusion should be corrected. [17]

Due to the increased time duration and repeated appointments, a significant group of patients want to get their braces removed after the macro movements have taken place. Though emphasis has been given to finishing and detailing, because of time

constraints, it is not always possible for the orthodontist to meet the goals of finishing and detailing.

The importance of finishing and detailing on the post-orthodontic static occlusion using a digital occlusal analyzer has not been studied before.

In this study, we aim to check the occlusal parameters in patients who have undergone proper finishing and detailing and met the treatment goals and those who have not, at 3 time intervals- T1,T2 and T3.

A digital occlusal analyzer called the T scan (T Scan III system) developed by Tekscan, which provides a real-time dynamic occlusal analysis including both quantitative and qualitative occlusal analysis to be carried out with great precision. T-scan was used to record the post-orthodontic occlusion. It provided an objective digital occlusal analysis rather than a subjective occlusal analysis based on "feel" feedback. [(4)]

It helps us assess the First tooth contact, Force distribution, Frictional contacts present and its impact on the temporomandibular joint and the orofacial musculature in patients.

INTRA GROUP COMPARISON

Comparison was conducted between the two groups (Group A & B). Group A includes patients who met the treatment goals of finishing and detailing and Group B includes patients who have not met the treatment goals of finishing and detailing.

The following occlusal parameters that have been assessed are-

1. **Occlusion Time (OT)**
2. **Disclusion Time (DT)**
3. **Total Antagonism (TA)**
4. **Force distribution between the Right and Left side (%)**
5. **Antero-posterior force distribution (%) (A-P Force%)**

GROUP A

When the occlusal parameters were compared over a period of 6 months in patients who had undergone finishing and detailing, a significant difference was seen in the Occlusion time (p=.001), Total Antagonism (p=.016), Antero-posterior force distribution in the anterior aspect (p=0.026).

OCCLUSION TIME

The lengthier the OT, the more unstable the occlusion is. OT is the measure of time from the initial tooth contact to maximal intercuspation. An occlusion is deemed steady when the OT is less than 0.3 seconds. [(6)]

In the current study, there was an increase (0.26-0.37) in the mean occlusion time from Mean OT at T1= 0.26 to T3= 0.37. Though a significant increase (p=0.001) in OT was seen over time but, the OT at T3 (0.37) was in close range to the ideal OT (0.3).

The occlusion time in Group A patients was in accordance to a study by Sang-Min Lee[(20)] where a comparison between PAR (Peer Assessment Rating Index) and the American Board of Orthodontics (ABO-OGS) and T Scan analysis was done.[(20)]

TOTAL ANTAGONISM

In the current study, there was a significant increase (p= 0.016) in TA with time from 95.28± 5.22 at T1 to 95.14± 6.76 at T3. This suggests that the tooth intercuspation improved over time giving rise to a more stable and functionally efficient static occlusion.

ANTERO-POSTERIOR FORCE DISTRIBUTION: ANTERIOR

In Anteroposterior force distribution, the force % in the anterior aspect decreased (7.26-6.02) over time significantly (p=0.026) from 7.26 at T1 to 6.02 at T2.

This finding is in accordance with the study done by Cohen-Levy[21] who saw that on the day of the appliance removal, only posterior teeth were in contact, whereas the contact between the cuspids was minimal.[21]

GROUP B

Patients who had not met the goals of finishing and detailing were categorized in Group B.

In Group B when the occlusal parameters were compared it was seen that there was a statistically significant difference in the Occlusion time (p=.019) and Antero-posterior force distribution both in the anterior and posterior aspect (p=.000)

OCCLUSION TIME

It was seen that there was a significant increase (p=0.019) in OT over time with the mean of .41 at T1 to .59 at T3. The OT at T3 was much higher in this group as compared to the ideal occlusion time which is .3 sec.

OT is dependent on tooth morphology and anterior guidance. OT increases when the "opening angles" of the slopes of cusps increase and when the "furrow angle of aperture" between the cusps decreases. [7]

ANTERO-POSTERIOR FORCE DISTRIBUTION

Antero-posterior force distribution both in the anterior (p=0.000) and the posterior aspect (p=0.000) increased significantly.

In the anterior aspect the mean value increased (12.31-15.76) over time, the force % at T1 being 12.31 to T3 being 15.76

In the posterior aspect it was seen that there was an increase from T1 (34.82) - T2 (37.35) whereas there was a reduction from T2 (37.35) -T3 (34.23).

COMPARISON BETWEEN GROUP A & B [INTERGROUP]

A Mann-Whitney U test was done in between the various occlusal parameters of the two groups and a significant difference was seen in The Occlusion time at T1(p=0.020), T2 (p=0.010) and T3(p=0.025), Disclusion time at T2 (p= 0.001), The Force distribution between the right and the left side at T2 (p=0.037) and T3 (p= 0.005) ,Total Antagonism at T3 (p= 0.001) and Antero-posterior force distribution in the Anterior aspect at T1 (p= 0.008) ,T2 (p= 0.009) and T3 (p= 0.000) and the Posterior aspect at T1 (p= 0.007) ,T2 (p= 0.012) and T3 (p= 0.000)

OCCLUSION TIME

The OT in patients who had undergone proper finishing and detailing (T1-.26, T2-.31, T3-.37) was lesser than those who had not met the goals of finishing and detailing (T1-.41, T2-.54, T3-.59) at all time intervals suggesting that doing a proper finishing helps in improving the occlusal stability significantly.

Although it was observed that Group A showed near-ideal OT, Group B had increased OT which was similar to a study done by Baldini et al[(22)] which showed that increased OT was associated with increased myofascial pain, joint dysfunction, and speed of mouth opening was also affected. [(22)]

A short OT is indicative of adequate dental occlusion without any major interference or imbalances

DISCLUSION TIME

The disclusion time (DT) was significantly more in Group B (Mean=0.48) as compared to Group A (Mean =0.38) at T2.

In our study it was observed that Group B had increased DT compared to Group A

The result of our study was not in accordance to a study by Qadeer et al [10] as the DT in post-orthodontic patients had increased as compared to the non-orthodontic group.[10]

In a study by Haralur et al[(23)] in 2013, it was observed that patients having temporomandibular joint disorders had prolonged OT and DT.[(23)]

FORCE DISTRIBUTION BETWEEN RIGHT AND LEFT SIDE (%)

The difference in force distribution between the right and left side was more in Group B as compared to Group A at T2 (p=0.037) and T3 (p=0.005). In Group A the difference in force % at T2 (19.38) and at T3 (18.42) which is lesser than Group B at T2 (28.47) and T3 (30.46).

This suggests that the occlusal equilibrium between the right and left side was better in patients who had undergone a proper finishing and detailing.

This was in accordance to the study done by Vidushi Seth and Anand K Patil[(2)] which suggested that after an extensive finishing and detailing phase for a duration of 2 months, the occlusal contacts were almost equal bilaterally. [(2)]

The study done by Qadeer et al[(10)] had opposing results as it stated that both orthodontically treated and non-orthodontic subjects did not have a significant difference between the right and left side.[(10)]

TOTAL ANTAGONISM

There was a significant increase in the total antagonism in Group A (95.14) as compared to Group B (87.36).

An increase in total antagonism suggests an increase in occlusal contact area suggesting that the intercuspation between the maxillary and the mandibular arches is better in Group A as compared to B.

ANTERO-POSTERIOR FORCE DISTRIBUTION

Antero-posterior force imbalance both in the anterior as well as the posterior aspect was more common in patients who had not undergone proper finishing and detailing as compared to patients who had undergone proper finishing and detailing.

The anteroposterior force in the anterior aspect in Group A at T1 (7.26), T2 (7.53), and T3 (6.02) was significantly lesser than Group B at T1 (12.32), T2 (12.64) and T3 (15.76) respectively.

The anteroposterior force in the posterior aspect in Group A at T1 (42.72), T2 (42.59) and T3 (43.61) was significantly lesser than Group B at T1 (34.82), T2 (37.35) and T3 (34.23) respectively.

In a study by Robert Kerstein and Svitlana[24], they concluded the anterior force was high in Class II subjects as compared to Class I. This was attributed to the restriction of the mandible with heavy forces from the canine. [24]

In a study conducted by Titirat et al(6) which showed that there was a tendency for the force distribution to be more in the posterior region, the highest force being at the molar region(61-67%) and then at the premolar region(24-28%) and the least in the anterior region (6)

Having excessive heavy forces in the posterior region mostly in the molar and the premolar region can also cause detrimental effects on the periodontal ligaments of the posterior teeth so the aim of any orthodontic treatment should be to shorten the occlusion and disclusion time. (7)

At present, not too much literature is available on the importance of finishing and detailing and the effect it has on the static and dynamic occlusion of the patient post-debonding.

The occlusal parameters recorded in our study were found to be closer to ideal in Group A as compared to Group B in relation to OT, Antero-posterior force distribution, Total Antagonism and the Force distribution between the right and left side. It has been seen that attaining a class I occlusion does not necessarily contribute to balanced force distribution and efficient functional occlusion at the end of orthodontic treatment. So, from the present study, we could conclude that it is very important to ensure that proper finishing and detailing should be carried out and evaluated for the distribution of contacts and forces along the arches during both static and dynamic occlusion, using T Scan.

As an orthodontist, it is important to consider the larger picture by not just settling the teeth but also digitally analyzing the occlusal parameters, which ensures long-term stability, a balanced masticatory apparatus, and a healthy temporomandibular joint.

LIMITATIONS OF THE STUDY

- Selection of finished cases can be done according to the ABO guidelines.
- The type of malocclusion before orthodontic treatment was not taken into consideration during the evaluation of the post-orthodontic occlusion.
- The type of mechanics, whether the patient has undergone extraction or not has not been taken into consideration.
- Muscle activity associated with the post orthodontic occlusion and its effect on the temporomandibular joint was not studied.

SCOPE OF THE STUDY

- A larger and more homogenous sample size can be considered
- The pre-treatment malocclusion can be taken into consideration while evaluating the post-treatment occlusion.
- Intraoral scans can be superimposed on the T Scans taken to assess the occlusal contact points.
- The T Scan evaluation can be co-related to the various indices used for the evaluation of post-orthodontic occlusion.
- Muscle activity associated with the post-orthodontic occlusion and its effect on the temporomandibular joint can be observed using Bio EMG along with T Scan

CONCLUSION

- Assessment of post-orthodontic occlusion just by visual inspection is not sufficient as we cannot assess the contact area and the distribution of forces in the arches.

- The study indicates that T Scan is an important tool for the evaluation of post-orthodontic occlusion as it helps in evaluating the occlusal imbalances which otherwise cannot be detected by visual evaluation.

- The results of our study indicated that in cases where finishing and detailing were conducted, the occlusal parameters (OT, A-P Force distribution, Total Antagonism, and Force distribution with respect to Left and Right side) showed near to ideal values as compared to the patients who had not met the goals of finishing and detailing.

- Digital analysis obtained using T Scan is essential during the process of finishing and detailing to obtain a stable and well-balanced occlusion by the end of the orthodontic treatment.

SUMMARY

- The study aimed to evaluate and compare the occlusal parameters such as Occlusion Time, Disclusion time, Total Antagonism, Force Distribution %, and Antero-posterior force distribution in Patients who have undergone finishing and detailing according to the inclusion criteria, as compared to those who have not used T Scan.
- Patients who had been orthodontically treated and had just undergone debonding were considered in the sample size. They were categorized into Group A and B based on the Inclusion criteria set by us based on Alignment, Marginal ridge position, Occlusal contacts, Occlusal relationship, Interproximal contacts, and Root parallelism.
- T scan which is a digital occlusal analyzer was used for recording the occlusion of the patient at an time interval of T1= 30 minutes after debonding, T2= 3 month after debonding and T3=6 months after debonding.
- It was seen that the occlusal parameters were deranged in Group B that is patients who had undergone finishing and detailing as compared to Group A.
- This study helped us understand the importance of proper finishing and detailing and the effect it has on static and dynamic occlusion of the patient undergoing orthodontic treatment. Though Finishing and detailing is a time-consuming process, still to establish a balanced occlusion with bilateral symmetry and proper frictional contacts, it is important to attain a properly finished occlusion by the end of orthodontic treatment, hence creating a bias in the obtained results.

BIBLIOGRAPHY

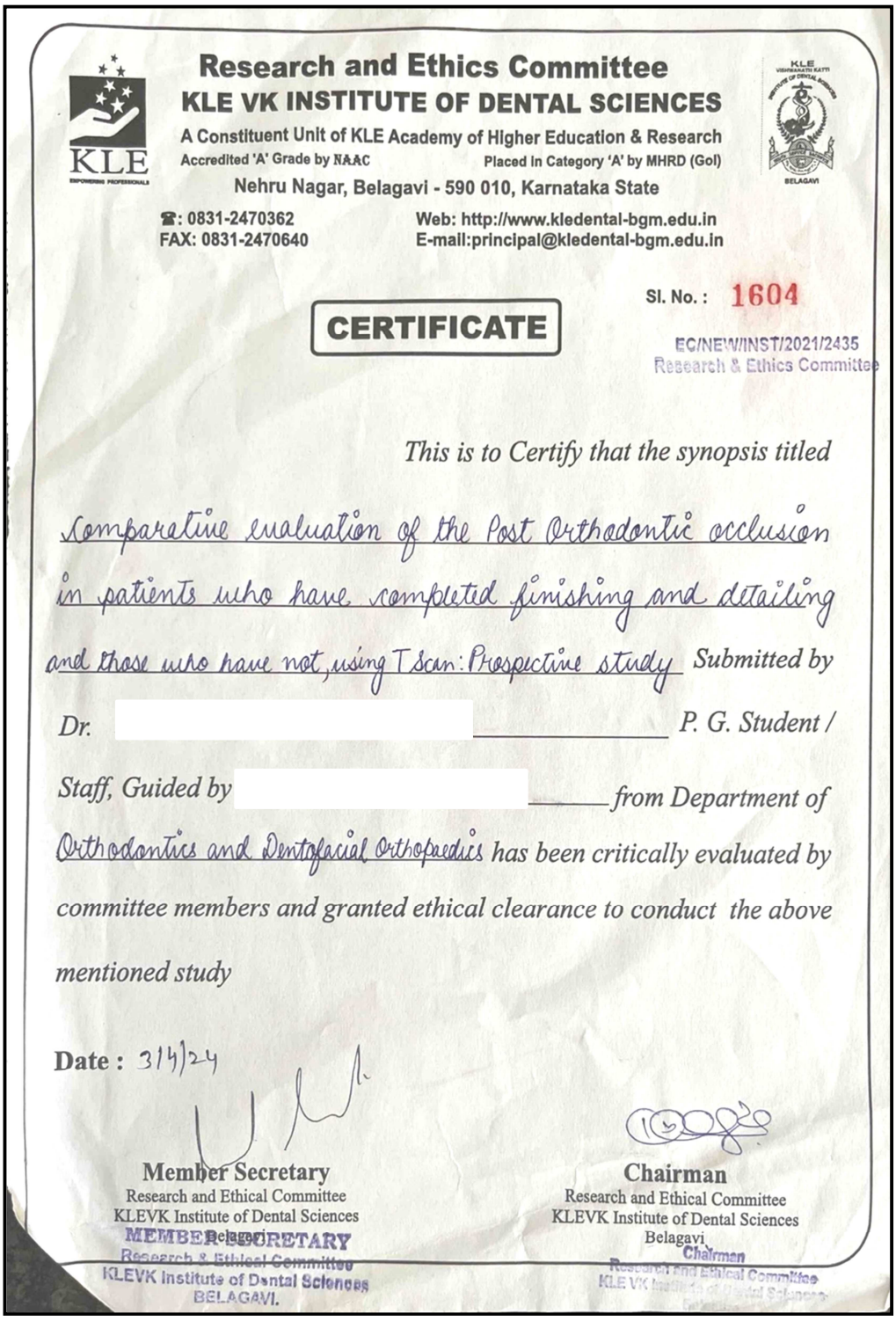
1. Nayak RS, Pasha D, Author C. Finishing and Detailing in Orthodontics: A Short Review. IOSR Journal of Dental and Medical Sciences 2019;18:7–12.
2. Seth V, Patil AK, Kidiyoor H, Patil K. T Scan – An aid in achieving stable occlusion during finishing stages of orthodontic treatment. Int J Stomatol Occlusion Med. 2016 Sep;8(S1):30–6.
3. Thabet, N., Elghoul, D., Abbas, N., Muhammed, A. T-Scan III Post-orthodontic Treatment Occlusal Analysis in Extraction Cases. Egyptian Dental Journal, 2023; 69(1): 45-50.
4. Bathiya A, Pisulkar SK. Digital occlusal analysis using T scan: Its role, mechanism, accuracy and application. Medical Science. 2020;24(105):2826-34.
5. Koval S, Kerstein R, Radke J. Characteristics of static and excursive occlusal parameters in subjects seeking orthodontic treatment using t-scan 9 digital occlusal analysis. Advanced Dental Technologies & Techniques. 2021 Jan 28: 87-99.
6. Chutchalermpan T, Pumklin J, Piyapattamin T. Evaluation of Disclusion Time in Various Angle's Malocclusions by T-Scan III System. Eur J Dent. 2019;13(4):510–3.
7. Alkayyal MA, Turkistani KA, Al-Dharrab AA, Abbassy MA, Melis M, Zawawi KH. Occlusion time, occlusal balance and lateral occlusal scheme in subjects with various dental and skeletal characteristics: A prospective clinical study. J Oral Rehabil. 2020 Dec 1;47(12):1503–10.
8. K.S S, Thumati P, Poovani S. Digital Analysis of Occlusion in Adult Post Orthodontic Subjects Using T-Scan III and BioEMG III - a Pilot Study. Adv Dent Tech 2019 Mar 13:22-8.

9. Ayuso-Montero R, Mariano-Hernandez Y, Khoury-Ribas L, Rovira-Lastra B, Willaert E, Martinez-Gomis J. Reliability and Validity of T-scan and 3D Intraoral Scanning for Measuring the Occlusal Contact Area. J Prosthodont. 2020;29(1):19-25
10. Qadeer S, Abbas AA, Sarinnaphakorn L, Kerstein RB. Comparison of excursive occlusal force parameters in post-orthodontic and non-orthodontic subjects using T-Scan® III. Cranio - Journal of Craniomandibular Practice. 2018 Jan 2;36(1):11–8.
11. Qadeer S, Yang L, Sarinnaphakorn L, Kerstein RB. Comparison of closure occlusal force parameters in post-orthodontic and non-orthodontic subjects using T-Scan® III DMD occlusal analysis. Cranio. 2016 Nov 1;34(6):395–401.
12. Lee SM, Lee JW. Computerized occlusal analysis: Correlation with occlusal indexes to assess the outcome of orthodontic treatment or the severity of malocculusion. Korean J Orthod. 2016 Jan 1;46(1):27–35.
13. Carvajal-Flórez A, Barbosa-Lis DM, Zapata-Noreña OA, Marín-Velásquez JA, Afanador-Bayona SA. Orthodontic treatment outcomes obtained by application of a finishing protocol. Dental Press J Orthod. 2016 Mar 1;21(2):88–94.
14. Morton S, Pancherz H. Changes in functional occlusion during the postorthodontic retention period: a prospective longitudinal clinical study. Am J Orthod Dentofacial Orthop. 2009;135(3):310-315.
15. Sultana MH, Yamada K, Hanada K. Changes in occlusal force and occlusal contact area after active orthodontic treatment: a pilot study using pressure-sensitive sheets. J Oral Rehabil. 2002;29(5):484-491.
16. The American Board of Orthodontics Grading System for Dental Casts and Panoramic Radiographs. 2012.

17. McLaughlin RP, Bennett JC. Finishing with the preadjusted orthodontic appliance. Seminars in orthodontics 2003,9(3),165-183
18. Poling R. A method of finishing the occlusion. Am J Orthod Dentofacial Orthop. 1999 May 1;115(5):476-87.
19. Srinivasan SR, Sundareswaran S. Finishing and detailing in Orthodontics-The guidelines, methods and philosophies-A comprehensive review. IOSR Journal of Dental and Medical Sciences. 2021;20:56–60.
20. Wang M, Liu L, Ma X, Jin X, Zhang Z, Jia X, et al. Computerized dynamic occlusal analysis and its correlation with static characters in post-orthodontic patients using the T-Scan system and the ABO objective grading system. BMC Oral Health. 2023 Dec 1;23(1).
21. Cohen-Lévy J, Cohen N. Computerized occlusal analysis in Dentofacial orthopedics: indications and clinical use the T-scan III system.J Dentofacial Anom Orthod 2012;15(2):203.
22. Baldini A, Nota A, Cozza P. The association between Occlusion Time and Temporomandibular Disorders. J Electromyogr Kinesiol. 2015;25(1):151-154.
23. Haralur SB. Digital Evaluation of Functional Occlusion Parameters and their Association with Temporomandibular Disorders. J Clin Diagn Res. 2013;7(8):1772-1775.

ANNEXURE – I

ETHICAL CLEARANCE



Research and Ethics Committee
KLE VK INSTITUTE OF DENTAL SCIENCES
A Constituent Unit of KLE Academy of Higher Education & Research
Accredited 'A' Grade by NAAC — Placed in Category 'A' by MHRD (GoI)
Nehru Nagar, Belagavi - 590 010, Karnataka State
☎: 0831-2470362 FAX: 0831-2470640
Web: http://www.kledental-bgm.edu.in
E-mail:principal@kledental-bgm.edu.in

Sl. No. : 1604

CERTIFICATE

EC/NEW/INST/2021/2435
Research & Ethics Committee

This is to Certify that the synopsis titled

Comparative evaluation of the Post Orthodontic occlusion in patients who have completed finishing and detailing and those who have not, using T Scan: Prospective study *Submitted by*

Dr. _____ *P. G. Student / Staff, Guided by* _____ *from Department of* Orthodontics and Dentofacial Orthopaedics *has been critically evaluated by committee members and granted ethical clearance to conduct the above mentioned study*

Date : 3/4/24

Member Secretary
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

MEMBER SECRETARY
Research & Ethical Committee
KLEVK Institute of Dental Sciences
BELAGAVI.

Chairman
Research and Ethical Committee
KLEVK Institute of Dental Sciences
Belagavi

Chairman
Research and Ethical Committee
KLE VK Institute of Dental Sciences

ANNEXURE – II

PLAGIARISM CHECK REPORT

Scientific Correspondence and Review Committee

KLE VK Institute of Dental Sciences
A Constituent Unit of KLE Academy of Higher Education and Research
(Deemed-to-be-University u/s 3 of the UGC Act, 1956)
Nehru Nagar, Belagavi - 590 010, Karnataka State
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
☎: 0831-2470362 Web: http://www.kledental-bgm.edu.in
FAX: 0831-2470640 E-mail:principal@kledental-bgm.edu.in

Date : 23.4.24 Serial No. : 200

PLAGIARISM CHECK REPORT

Name of the Applicant :
UG / PG / Ph.D / Staff : POST GRADUATE
Batch & Year : 2021 - 2024
Department : ORTHODONTICS

The soft copy of Research Work / Manuscript by entitled

"COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING TSCAN: A PROSPECTIVE STUDY."

under the guidance of .....has been submitted for Anti-Plagiarism check to the Scientific Correspondence & Review Committee of KLE VK Institute of Dental Sciences using "Turn-it-in" software.

The scan has been carried out and the scanned output reveals a Similarity Index of .....8.....%, which is **within / not within** the acceptable limits of 10% as per the UGC guidelines.

23/04/2024

Member Secretary
Scientific Correspondence and Review Committee
KLEVK Institute of Dental Sciences
KAHER-Belagavi

Chairman
Scientific Correspondence and Review Committee
KLEVK Institute of Dental Sciences
KAHER - Belagavi

ANNEXURE – III

BIOSTATISTICS CLEARANCE CERTIFICATE

KLE V.K. Institute of Dental Sciences
(A Constituent unit of KLE Academy of Higher Education & Research
Deemed-to-be-University u/s 3 of the UGC Act, 1956)
Nehru Nagar, Belagavi-590 010 INDIA
Re-Accredited 'A' grade by NAAC (2nd Cycle) & Placed in Category 'A' by MHRD (GoI)
0831-2470362
FAX: 0831-2470640
Web: http://www.kledental-bgm.edu.in
E-mail: principal@kledental-bgm.edu.in

Biostatistics Clearance Certificate

This is to certify that the Biostatistics aspect of the Dissertation / Research work of] **Post Graduate Student**, under the guidance of , **Professor, Department of Orthodontics and Dentofacial Orthopaedics**, entitled **"COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING T SCAN: A FOLLOW UP STUDY"** has been done under my guidance and considered satisfactory.

Dr. Abhra Roy Choudhury
Name & Signature of Biostatistician

Place: Belagavi
Date:

ANNEXURE- IV

CONSENT FORMS

KLE VK INSTITUTE OF DENTAL SCIENCES,

BELAGAVI –590010

CONSENT FORM

TITLE: " COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING T SCAN: PROSPECTIVE STUDY"

OPERATOR: DR.

Purpose of the study: You are invited to take part in a clinical study, but before you accept, I would like to help you understand the study and what participation you will be involved in. I am conducting a comparative study of the post orthodontic occlusion in patients who have completed Finishing and Detailing and those who have been debonded before that.

I, _____ aged _____

have been informed about my involvement in the study:

- I agree to give my personal details like name, age, sex, address, and the details required for the study to the best of my knowledge.

- I am informed about the procedure and also that I will be undergoing the procedure. I agree and give my consent to the orthodontist for the procedure.
- I permit the dentist to utilize the information given by me and the results obtained from this study for presentation and publication purposes.
- I will not claim any returns for my cooperation in the study, even if it is being sponsored by any agency. I am participating with my own will and wish.
- I will follow the instructions given by the doctor.
- During the study, if I wish to resign from the study, I am free to do so and my treatment will still be completed in the department.
- In my full consciousness and presence of mind, after understanding all the procedures in my vernacular language, I am willing and give my consent to participate in this study.
- Date:
- Place:
- Signature of witness Signature

ANNEXURE- V

PATIENT INFORMATION SHEET

TITLE: COMPARATIVE EVALUATION OF THE POST ORTHODONTIC OCCLUSION IN PATIENTS WHO HAVE COMPLETED FINISHING AND DETAILING AND THOSE WHO HAVE NOT, USING T SCAN: PROSPECTIVE STUDY"

OPERATOR: DR.

Purpose of the study: You are invited to take part in a clinical study, but before you accept I would like to help you understand the study and what participation you will be involved in. I am conducting a comparative study of the post orthodontic occlusion in patients who have completed Finishing and Detailing and those who have not.

Procedure of the study: If you wish to participate, you will be told to bite on a sensor right after removing your braces, 3 months and 6 months after, during which we will be recording your bite force.

ANNEXURE- VI

MASTER CHART

GROUP B

SL NO	NAME	OCCLUSION TIME			DISCLUSION TIME			FORCE DISTRIBUTION %			TOTAL ANTAGONISM %			ANTERO-POSTERIOR FORCE DISTRIBUTION					
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1		T2		T3	
														Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
1	GOWRI	0.37	0.42	0.46	0.16	0.43	0.46	46	36	44	99.41	98	96	16.9	3.05	17.4	32.6	23.2	26.8
2	TASBIHA	0.14	0.34	0.32	1.22	0.67	0.72	18	24	29	100	96.4	98.2	28.6	21.4	26.3	23.7	29.4	20.6
3	ANWESHA	0.34	0.43	0.54	0.26	0.46	0.31	15	24	28	99.2	86.2	84.3	13.15	36.85	16.3	33.7	15.2	34.8
4	MARYA	0.34	0.46	0.44	0.34	0.54	0.46	46	34	39	73.5	71.2	69.4	24.2	25.8	20.7	29.3	22.3	27.7
5	SWATI alloted	0.23	0.56	0.72	0.46	0.42	0.45	24	26	32	89.4	72.1	73.4	6.5	43.5	4.3	45.7	6.6	43.4
6	SHUBHAM	0.72	0.46	0.4	0.16	0.33	0.54	7	4	3	99.5	92.6	94.8	8.35	41.65	10.2	39.8	14.7	35.3
7	MRIDULA	0.18	0.26	0.67	0.07	0.32	0.43	45	54	36	86.2	90.1	88.5	1.2	48.8	2.7	47.3	3.4	46.6
8	ASHWINI	0.45	0.32	0.35	0.23	0.46	0.54	23	35	43.2	76.4	87.4	88.9	12.5	37.5	14.6	35.4	18.4	31.6
9	KAVERI	0.65	0.45	0.52	0.46	0.54	0.42	22.3	26	34.2	94.3	87.2	82.3	6.4	43.6	8.7	41.3	14.6	35.4
10	siddhi	0.24	0.32	0.46	0.45	0.72	0.36	24	32	26.4	92.3	97.6	93.4	7.3	42.7	6.5	43.5	10.4	39.6
11	Shreyas	0.37	0.42	0.59	0.16	0.43	0.46	46	36	44	99.41	98	96	16.9	3.05	17.4	32.6	23.2	26.8
12	Akshata	0.14	0.34	0.32	1.22	0.67	0.72	18	24	29	100	96.4	98.2	28.6	21.4	26.3	23.7	29.4	20.6
13	Triveni	0.34	0.43	0.67	0.26	0.46	0.31	15	24	28	99.2	86.2	84.3	13.15	36.85	16.3	33.7	15.2	34.8
14	Harini	0.34	0.46	0.44	0.34	0.54	0.46	46	34	39	73.5	71.2	69.4	24.2	25.8	20.7	29.3	22.3	27.7
15	Reema	0.23	0.56	0.72	0.46	0.42	0.45	24	26	32	89.4	72.1	73.4	6.5	43.5	4.3	45.7	6.6	43.4
16	Maheshwari	0.72	0.46	0.4	0.16	0.33	0.54	7	4	3	99.5	92.6	94.8	8.35	41.65	10.2	39.8	14.7	35.3
17	Sridhar	0.18	0.26	0.29	0.07	0.32	0.43	45	54	36	86.2	90.1	88.5	1.2	48.8	2.7	47.3	3.4	46.6
18	Namrata	0.45	0.32	0.35	0.23	0.46	0.54	23	35	43.2	76.4	87.4	88.9	12.5	37.5	14.6	35.4	18.4	31.6
19	Ankit	0.65	0.45	0.52	0.46	0.54	0.42	22.3	26	34.2	94.3	87.2	82.3	6.4	43.6	8.7	41.3	14.6	35.4
20	Ankush	0.24	0.32	0.46	0.45	0.72	0.36	24	32	26.4	92.3	97.6	93.4	7.3	42.7	6.5	43.5	10.4	39.6
21	Noor	1.4	1.6	2.8	0.1	0.33	0.67	7.2	8	10.2	98.67	94.34	96.21	8.35	41.65	10.2	39.8	14.7	35.3

GROUP A

0

SL NO	NAME	OCCLUSION TIME			DISCLUSION TIME			ORCE DISTRIBUTION (differenc			TOTAL ANTAGONISM %			ANTERO-POSTERIOR FORCE DISTRIBUTION					
		T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1		T2		T3	
														Anterior	Posterio	Anterior	Posterio	Anterior	Posterior
1	ALLWYNA	0.22	0.24	0.33	0.21	0.22	0.27	36.6	25.4	22.1	99.92	98	94.2	2.35	47.65	3.67	48.2	3.2	49.7
2	SONI	0.24	0.22	0.25	0.2	0.23	0.52	25.8	10.2	2.2	98.07	92	99.91	7	43	4.6	42.9	2.1	47.9
3	SNEHA	0.17	0.34	0.27	0.3	0.24	0.46	14.8	13.2	5.2	100	94	96.4	15	35	7.5	36.4	5	35.4
4	SUMA	0.32	0.34	0.47	0.26	0.27	0.34	27.8	22.4	18	98.06	96	97.32	1.55	48.45	2.4	52.3	3.2	46.4
5	NEHA	0.18	0.24	0.2	0.27	0.24	0.47	7	6	7	96.4	98	92	0.8	49.2	7.6	42.4	0.9	49.1
6	ARZOO	0.18	0.22	0.59	0.22	0.34	0.77	11.2	7	6.2	100	94	97.85	3.6	46.4	2.9	47.1	2.35	47.65
7	PRAFUL	0.17	0.14	0.18	0.44	0.46	0.48	50.5	23.6	36.7	99.68	96	97.85	15.8	34.2	13.2	36.8	14.9	35.1
8	VACHANA	0.23	0.17	0.33	0.24	0.34	0.42	14.6	13.2	4.2	96.4	92.1	94.3	6.3	43.7	7.4	42.6	5.4	44.6
9	SANDHYA	0.33	0.39	0.38	0.35	0.42	0.15	12.8	9	27.8	99	94	97.4	34.5	15.4	33.2	16.8	28.6	21.4
10	TENZIN	0.16	0.25	0.22	0.34	0.45	0.33	45	42.2	35.2	97	94	93	1.55	48.45	2.4	52.3	3.2	46.4
11	VENKATESH	0.52	0.57	0.74	0.46	0.24	0.23	25.6	10.2	8	86	84.3	97.6	7.2	42.8	5.3	44.7	5.6	44.4
12	PRIYA	0.16	0.33	0.35	0.33	0.46	0.61	13.4	12.3	12.8	92	82	98.2	3.6	46.4	2.9	47.1	2.35	47.65
13	DEV	0.62	0.54	0.47	0.23	0.24	0.08	10	34.2	48.6	84	74.2	67.01	14.85	35.2	16.2	33.8	15.7	34.3
14	SWATI	0.24	0.22	0.45	0.29	0.32	0.72	6.7	4.6	7.8	96.4	92.1	96.4	3.6	46.4	2.9	47.1	2.35	47.65
15	AASTHA	0.18	0.24	0.33	0.07	1.6	3.7	42.4	50.3	22.4	87.3	82	98.6	0.8	49.2	7.6	42.4	0.9	49.1
16	Abhishek	0.33	0.64	0.46	0.46	0.33	0.72	5.6	3.2	3	99.4	97	98.2	1.4	48.6	2.2	47.8	3.2	46.8
17	Mamata	0.36	0.45	0.32	0.29	0.25	0.27	23.2	26.7	25	98.89	99	97.67	12.25	37.75	10.6	39.4	9.8	40.2
18	Pavitra	0.06	0.14	0.12	0.36	0.32	0.39	6	7.2	8.7	98.2	99	96.4	6.3	43.7	7.4	42.6	5.4	44.6
19	Arpita	0.56	0.46	0.72	1.6	0.54	0.77	36.4	33	23	86	92.3	96	6.2	43.8	5.4	44.6	5.9	44.1
20	Mansi	0.22	0.27	0.46	0.17	0.35	0.26	37	45.2	56	92	94.3	98.3	0.8	49.2	7.6	42.4	0.9	49.1
21	Anurag	0.13	0.26	0.33	0.35	0.26	0.45	13	8	7	96.3	98.2	93.4	7.2	42.8	5.3	44.7	5.6	44.4