Journal of Advanced Zoology

ISSN: 0253-7214

*Volume **45** Issue **3 Year 2024** Page **239-251***

Evaluation Of Peri Implant Tissue Displacement Around Single Piece Implants Using 3 Different Displacement Methods - A Clinical Study

Dr. Neha Love Kumar[1], Dr. V. Vidyashree Nandini[2]*

[1]MDS, Prosthodontist Department of Prosthodontics and Implantology SRM Kattankulathur Dental College and Hospital SRMIST, Chengalpattu Dist, orchid ID 0000-0002-4439-7957

*[2]*MDS, DNB, Professor and Head Department of Prosthodontics and Implantology SRM Kattankulathur Dental College and Hospital SRMIST, Chengalpattu Dist, orchid ID 0000-0002-4439-7957*

***Corresponding Author:**Dr. V. Vidyashree Nandini,*
**MDS, DNB, Professor and Head Department of Prosthodontics and Implantology SRM Kattankulathur Dental College and Hospital SRMIST. Kattankulathur campus SRMIST, Chengalpattu Dist*
Email:vidyashv@srmist.edu.in, orchid ID 0000-0002-4439-7957

Abstract

PURPOSE: To compare and evaluate vertical displacement, lateral displacement and pressure during peri implant tissue displacement using 3 different displacement methods.

MATERIALS AND METHODS: Ten single piece implants were placed and provisional crowns were given. After a period of six months, primary impressions were made and casts were poured. Over these casts, custom trays were fabricated (n=40). A Pre displacement impression was followed by Mechanical (G cuff), Chemical (astringent retraction paste) and Chemico-mechanical (knitted retraction cord) displacement in a gap of seven days. Pressure measurements were made using customized pressure sensitive periodontal probe. Impressions were made and the forty die stone casts obtained were scanned and analysed to measure the vertical and lateral displacement. The statistical analysis was done using Kruskal Wallis test followed by Post Hoc analysis - Scheffe's method.

RESULTS: The highest vertical displacement was seen in Chemico-mechanical (knitted retraction cord) followed by Mechanical (G-cuff) and Chemical (astringent retraction paste). The highest lateral displacement was seen in Mechanical (G cuff) followed by Chemico-mechanical (knitted retraction cord) and Chemical (astringent retraction paste). Least pressure was seen with chemical (astringent retraction paste) method followed by mechanical (G cuff) and chemico – mechanical (knitted retraction cord) method.

CONCLUSION: Lateral peri implant displacement is more predictable than vertical peri implant displacement. All the methods tested showed pressure within acceptable limits during displacement procedures. Chemical (Astringent retraction paste) method produced desirable displacement with least pressure to the surrounding tissues.

Keywords: peri implant displacement; mechanical displacement; chemical displacement; chemico - mechanical displacement; pressure.

INTRODUCTION

Implant supported restorations are a routine treatment option to replace missing teeth owing to their high success rate; it is a reasonably safe surgical modality.[1] Tissues that occur around the Osseo-integrated dental implants, the peri-implant tissue, are divided into hard and soft tissue components. The purpose of peri-implant tissue is two-fold, due to its anatomy/ histological features; firstly the underlying bone is protected by the mucosa and secondly the implant is supported by the bone. Nonetheless there is an anatomical difference between the soft tissue around the natural teeth and around an end osseous dental implant. Proper care and hygiene is of utmost importance for success, otherwise it will lead to deterioration of peri-implant barrier, ultimately leading to peri-implant disease or complication of the implant.

There are two types of restorative techniques used in implant dentistry, to retain restorations on the implants viz., screw retained implant restorations and cement retained restorations with both techniques having their merits and demerits. The screw retained restoration produces a screw joint between the implant abutment and the restoration. While the cement retained method uses cement for retaining the restoration. Cement retained restoration technique has been believed by investigators to act as a shock absorber and it complements the transfer of load between the bone and the implant and is favoured for various reasons by both clinician and patients.[2,3]Screw retained restorations are also used extensively but the screw access channel may exit in the aesthetic zone when the implant is not restoration driven. Since there is a joint between the implant abutment and the restoration with a screw there are chances of screw loosening, breakage of the screw and these demerits can be avoided by the cement retained restorations. Various impression techniques are being widely used in implant dentistry which may require peri implant displacement for making impressions. For screw retained restorations clinicians use mechanical component while for cement-retained prostheses, direct or indirect closed tray impressions are made.

Ever since the introduction of dental implants by Per-Ingvar Branemark in the late 1970s, implant dentistry has made rapid progress with respect to the surfaces, design of the thread, protocol for placement, loading, types of restorations, components etc. Single piece implant is a modification over two piece implants which require two stage surgical procedures. In two piece implants micro movement of the prosthetic abutment and micro leakage may occur leading to localized inflammation of the soft tissue around the implant.[4]Single piece implants were basically developed to overcome the structural weakness in the design of two piece implants. The one piece implant reduces the micro gap between the prosthetic abutment and the implant at the level of the bone crest and has other characteristic features like strong unibody built, lesser interfaces or joints, single stage surgery with or without flap process and a simple prosthetic technique.

One of the factors for the success of fixed prostheses is an accurate capture of the hard and soft tissue components during impression making to ensure precise fit of the restoration. The choice of peri implant displacement material available from contemporary dental practice are very few and hence a good displacement is the key to providing accurate, aesthetic and functional implant supported prosthesis. Various studies have shown the effectiveness of gingival retraction in fixed partial denture but there is very little evidence relating to peri-implant tissue displacement techniques for implants. Few studies have compared the accuracy of peri implant displacement techniques during impression making for single piece implant supported prosthesis. The study was also designed to check the pressure exerted while different displacement methods were used. The study was started with a null hypothesis that there is no difference in the amount of vertical and lateral displacement of the peri implant tissue while using three different displacement systems - Mechanical (G cuff), Chemical (astringent retraction paste) and Chemico-mechanical (knitted retraction cord) and that the pressure experienced in the peri implant tissue while the three methods were used was the same. The aim of this study was to compare and evaluate the vertical displacement, lateral displacement and pressure experienced by the peri implant tissue using 3 different displacement methods during single piece implant impression making.

MATERIALS AND METHODS

Ethical clearance was obtained from the ethics committee of SRM Institute of Science and Technology (Ethics clearance no. 1253/IEC/2017) prior to the start of the study. The participants of study were those reporting to the outpatient department of Prosthodontics and Implantology with missing teeth and requiring replacement.

The present study was explained thoroughly through patient information sheet and those patients who were willing to participate in the study were given an informed consent form.
The edentulous site was examined, and a detailed case history was taken for these patients including a clinical examination (Fig.1A). Patients were advised an orthopantomograph (Acteon Satelac, France) and radiovisiography (Acteon Satelac X Mind, France) for the corresponding edentulous site. Bone caliper measurements were made. After evaluating the patient's blood investigations, radiographs and bone caliper measurements the patients indicated for single piece implants were discussed with a treatment plan. The implant size was determined based on the available mesiodistal and buccolingual bone. The upper and lower diagnostic impressions were made with the help of an irreversible hydrocolloid (Zelgan plus, Dentsply, India) and casts were poured with type III dental stone (Gold stone, Asian chemicals, Rajkot, India).
The patient was appropriately prepared for the implant placement. The extraoral site was prepared aseptically with Povidone Iodine Solution IP 5% (Pividine, Glide Chem pvt ltd, India) Under local anaesthesia (Lignocaine and Adrenaline 1:80000 IP, LIGNOX 2% A, India) a full thickness flap was raised with a periosteal elevator (GDC, India). Once the flaps were elevated, a series of drills were used to prepare the osteotomy site precisely and incrementally. The Single piece implant used (Indian Dental Education Academy, India) was a root form implant with a standard diameter of 3.75 mm and a length of 16 mm which included 10.5 mm of implant length and 5.5 mm of abutment height. The single piece implants (Indian Dental Education Academy, India) were inserted with an implant mount (Indian Dental Education Academy, India) and torqued with a torque wrench (Adin, Israel) along the line of the osteotomy site(Fig.1B) This was followed by a confirmatory radiovisiography (Acteon Satelac X Mind, Acteon group, France) of the implant site(Fig.1C). Simple interrupted resorbable sutures (4-0 absorable surgical suture, Ethicon, India) were placed to approximate the flap. For the provisional crown fabrication, an irreversible hydrocolloid impression (Zelgan plus, Dentsply, India) was made and the casts were poured with type III dental stone (Gold stone, Asian chemicals, Rajkot, India). The provisional crowns which were made of Bis-acryl composite resin material (Luxatemp, DMG, USA) were fabricated by an indirect technique. The provisional crowns were kept out of occlusion and they were polished (Nexus Medodent, India) and was luted with non eugenol based temporary cement (Provicol, Voco, USA). The implant was then allowed to osseointegrate for a period of 6 months.
After a waiting period of 6 months, an upper and lower impression was made with the help of an irreversible hydrocolloid (Zelgan plus, Dentsply, India). The primary casts were poured with type III dental stone (Gold stone, Asian chemicals, Rajkot, India). The custom trays were fabricated on these casts with the help of light cure acrylic material (Triad VLC custom tray material, Dentsply, India).

CUSTOMISED PRESSURE SENSITIVE PERIODONTAL PROBE

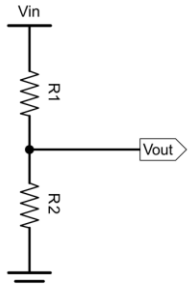
A novel customized setup provided measurement of the pressure during peri implant displacement before impression making.

Fundamental Concept

Sensor is a module that is used for detecting an event /changes in its environment and sends its information either as a digital/electrical/mechanical signal. In this study, a specific type of sensor named "Flex sensor" was used for measuring the amount of bend or angular deflection. This sensor measures the amount of bend or deflection by varying its resistance value measured in Ohm (Ω). Usually, the sensor is stuck to the surface, and the resistance of the sensor element is varied by bending the surface.

Flex Sensor Circuit

A simple change in resistance from initial to final value can be calculated using an electrical circuit principle called "Voltage Divider". A voltage divider is a circuit that converts an input voltage to a fraction of output voltage using two resistors connected in series. As the flex sensor provides resistance or varies its resistance with the change of deflection, we can assume one of the two resistors to be a flex sensor. Another resistor is a reference for completing the circuit which is a fixed value (~say 10kΩ) (fig.2A).



- Resistor [R1] will be the flex sensor
- Resistor [R2] will be the fixed value resistor of ~10kΩ
- Input voltage [Vin] provided to the flex sensor.
- By solving the circuit using the Kirchoff's voltage law the output voltage can be deduced to the following expression. The change in output voltage is directly proportional to change in the resistor value, so by varying the angular deflection/bend, the output voltage is varied.

The final setup was arranged to render the angular deflection/amount of bend from the sensor. The flex sensor consisted of two pins, a power source to the sensor and a ground pin for the reference with respect to its measurement. The power supply pin is connected in series with a 10kΩ resistor to create a voltage divider circuit (as mentioned earlier) and another end of the resistor is connected to the 5V supply pin provided by Arduino*. In order to measure the change in deflection, the test pin A0 is connected between terminals of Flex sensor and fixed resistor [Corresponds to V out as shown in the voltage divider circuit]. A0 pin will read the measured analogue voltage between the terminals. The data value obtained from the sensor is calibrated in terms of Force value from 0.1 Newton to 10 Newton and is displayed on the monitor (fig.2B)

PERI IMPLANT DISPLACEMENT PROCEDURE

The peri implant displacement was done with the following three materials in the following order Mechanical (G cuff, Stomatotech Inc, Canada), Chemical (Astringent retraction paste, 3M ESPE, Germany) and Chemico-mechanical (Knitted retraction cord ,Ultrapak, Ultradent products, USA)(fig.3) with an interval of 7 days between each displacement and impression.

On day 0, the peri implant tissue displacement was done with the help of G CUFF (Stomatotech Inc, Canada) implant retraction material. In the G CUFF kit the size of the plastic collar was determined and was then packed in to the apical end of the abutment. During this procedure the pressure which was experienced while packing the G cuff plastic collar into the peri implant sulcus was determined with the help of the customized pressure sensitive periodontal probe designed for this study (fig.4A). The measurements were made at sixteen different points around the peri implant sulcus and the values were noted. After leaving the G cuff plastic collar for about 3 minutes into the sulcus, the final impression was made with the help of a custom tray to which a tray adhesive (Poly Vinylsiloxane tray adhesive, 3M ESPE, Germany) was applied ten minutes prior to the procedure. Following this an impression was made using monophase polyvinyl siloxane impression material (Aquasil Monophase, Dentsply, Germany) (fig.5) and type IV die stone (Ultrarock, Kalabhai karson, Germany) casts (fig.6) were poured. After this the provisional crowns (Luxatemp, DMG, USA) was luted. On day 7, the peri implant tissue displacement was done with the help of Astringent retraction paste material (3M ESPE, Germany). The astringent retraction capsule was loaded on to a composite dispenser and the material is injected into the peri implant sulcus. The pressure with which the material was being pushed into the sulcus was measured with the help of a customized pressure sensitive periodontal probe (fig.4B).The measurements were made at sixteen different points around the peri implant sulcus and the values were noted. The material was left in the peri implant sulcus for a period of 2 minutes and the material was washed off with water from a 3 way syringe. The peri implant sulcus area was then dried and impression was made with custom stock tray. The impressions were made using monophase polyvinyl siloxane impression material (Aquasil Monophase, Dentsply, Germany) (fig.5) and type IV die stone (Ultrarock, Kalabhai karson, Germany) casts (fig.6) were

fabricated. Provisional crown (Luxatemp, DMG, USA) was luted on to the implant abutment. On day 14, the peri implant tissue displacement was done with the help of plain knitted type 000 size (Ultrapak, Ultradent products, USA) gingival retraction material which was soaked in 20% ferric sulphate solution (Viscostat, Ultradent, USA). While packing the cord the pressure with which it was packed in to the peri implant sulcus was measured with the help of a customized pressure sensitive periodontal probe (fig.4C). The measurements were made at sixteen different points around the peri implant sulcus and the values were noted. Impression making (fig.5), cast fabrication (fig.6) and provisional crown luting was done the same way as before. The same procedure was followed in all the ten single piece implants.
Following this the participants were given cement retained porcelain fused to metal crown and was luted with type I glass ionomer cement (Golden label, GC, Japan) following proper isolation technique.

MEASUREMENT OF THE VERTICAL AND LATERAL DISPLACEMENT

The type IV die stone (Ultrarock, Kalabhai karson, Germany) models which were obtained after peri implant displacement were scanned and digitized with the help of CAD-CAM blue LED scanner (D 900 Zentotech, Weiland, Germany) . The D 900 blue LED scanner has four cameras of five megapixels each to accurately capture the 3D visuals of the given model. All the four models - pre displacement casts and the casts obtained after the various peri implant retraction systems- G cuff, Astringent retraction paste and knitted retraction cord were scanned. The 3D model images were projected on the monitor for designing in the CAD CAM software (3 Shape dental system 2018, TRIOS, Denmark). In the CAD-CAM software (3 Shape dental system 2018, TRIOS, Denmark) on the control cast, a cross section was made bucccolingually dividing the implant abutment into two equal halves. Further, on the cross sectioned model displayed the deepest point on the peri implant sulcus was selected and was marked as point A(fig.7).From point A, a vertical line was drawn to the topmost point of the implant abutment and the values were noted for the control cast (pre displacement cast- A). The values for the scanned impressions of the three displacement systems were marked as A'. The difference between the control (pre displacement- A) and each displacement technique (A') provided the actual vertical peri implant displacement (A'-A) for that particular technique. The values were obtained numerically with an accuracy of 15µ.
For the lateral displacement measurement, in the cross-sectioned control (pre displacement) implant abutment model, the highest point on the crest of the peri implant tissue was marked as point B (fig.8). From this point B, a perpendicular line was drawn to intersect with the vertical axis of the implant abutment. The values were noted for the control cast (pre displacement- B). The values for the scanned impressions of the three displacement systems were marked as B'. The difference between the control (pre displacement- B) and each displacement technique (B') provided the actual lateral displacement (B'-B) for that particular technique. The values were obtained numerically with an accuracy of 15µ. The data obtained for vertical displacement, lateral displacement and pressure during displacement procedures using the three different displacement materials were analyzed using the SPSS (IBM SPSS Statistics for Windows, Version 19.0, IBM Corporation). The significance level was fixed as 5% ($\alpha = 0.05$).

RESULTS

Table I reveals the highest vertical displacement with a mean of 0.40 mm ± 0.45 in chemico-mechanical (knitted retraction cord) followed by 0.38 mm ± 0.72 in mechanical (G cuff) and 0.37 mm ± 0.36 in chemical (astringent retraction paste). The highest lateral displacement in Table II has a mean of 0.75 mm ± 0.59 was seen in mechanical (G cuff) followed by 0.56 mm ± 0.67 in chemico - mechanical (knitted retraction cord) and 0.51 mm ± 0.70 in chemical (astringent retraction paste). The highest pressure during peri implant displacement was recorded in Table III was with a mean of 0.23 N ± 0.02 in chemico - mechanical (knitted retraction cord) followed by 0.15 N ± 0.00 in mechanical (G cuff) and 0.07 N ± 0.02 in chemical (astringent retraction paste).
Table IV shows the Kruskal-Wallis test which was used to compare the vertical displacement, lateral displacement and pressure. The p value was 0.758 ($p < 0.05$- significant) for the vertical displacement which was statistically not significant. The p value was 0.077 ($p < 0.05$- significant) for the lateral displacement which was not statistically significant. The p value for the pressure during peri implant displacement was 0.0001 ($p < 0.05$- significant) which was statistically significant. Table V shows the multiple pairwise comparison of peri implant vertical displacement done by Post Hoc analysis- Scheffe's method revealed no statistical difference. Table VI shows the multiple pairwise comparison of peri implant lateral displacement by Post Hoc analysis- Scheffe's method revealed no statistical significance. Table VII shows the multiple pairwise

comparison of pressure during peri implant displacement reveals a statistically significant value of 0.0001 in mechanical (G cuff) and chemical (astringent retraction paste), 0.0001 in mechanical (G cuff) and chemico mechanical (knitted retraction cord) and 0.0001 in chemical (astringent retraction paste) and chemico-mechanical (knitted retraction cord).

DISCUSSION

Marginal adaptation plays an important role in the long term success of an indirect restoration and failure to achieve the same can result in poorly fitting crowns, marginal leakage and periodontal tissue inflammation. Restoration which has poor marginal adaptation always tend to breakdown the abutment and the supporting peri implant structures. Clinical parameters such as location of the finish line, peri implant health and sulcular bleeding directly influence the quality of impression making. At present there are various methods of tissue management such as mechanical (retraction cords), chemico-mechanical (chemicals embedded in cords), chemicals (pastes) and surgical methods (lasers, electrosurgery, rotary curettage). The importance of peri implant soft tissue and their role in the overall longevity of implant treatment has received greater attention in the recent years.

Success of an implant restoration is a fine balance between the implant, crown and the surrounding soft tissue contour, emergence profile, response of peri implant tissue to displacement materials and implant maintenance play a crucial role in successful restorations. The peri implant tissue surrounding the implants differs from the periodontal tissue. Peri-implant mucosa lacks keratinized epithelium at the base of the sulcus, which forms the junctional epithelium and has a hemi-desmosomal attachment and internal basal lamina in the lower regions of the interface. It adheres poorly to implant surfaces, is more permeable and has a lower capacity for proliferation and regeneration than the junctional epithelium around teeth. Peri-implant mucosa consists of circumferentially running fiber bundles and fibers that run longitudinally to the implant surface.

The single piece implants used for the study have an advantage over the two piece implants as the implant and the fixture is one piece during the fabrication. Since both the abutment and the implant are a unified structure it eliminates the fixture abutment interphase and marginal leakage which tend to reduce the plaque accumulation. There is lesser chance for screw loosening or fracture of the abutment screw. The clinician can control the final crown margins, gingival contour and it allows for immediate temporization.

The null hypothesis was partially rejected for the pressure measurements as the results were statistically significant. For the vertical and lateral displacement, there was no statistical difference and the null hypothesis was partially accepted with reference to the vertical displacement and lateral displacement.

The vertical and lateral peri implant displacement values were not significant statistically and it could be concluded that there is no difference in the amount of peri implant displacement produced by any of the three displacement systems - Mechanical (G cuff), Chemical (astringent retraction paste) and Chemico-mechanical (knitted retraction cord) tested.

The peri implant tissue displacement can be divided into two components: vertical and lateral. Lateral displacement displaces the tissue so that an adequate bulk of impression material can occupy the space between implant and the peri implant tissue. Vertical displacement exposes the implant finish line. Benson et al[5] indicated only lateral displacement was necessary for an atraumatic retraction while some authors consider both the displacements. The displacement process enhances the depth of the peri implant sulcus for the flow of the impression material to copy the peri implant sulcus details. At least 0.2 mm sulcus width is essential to withstand tearing and distortion of the impression material. The management of the peri implant sulcus is of utmost importance in fabrication of implant prosthesis, particularly when an exact registration of the abutment and soft tissue is required.

In this study, the overall mean for the vertical displacement was 0.40 mm in chemico - mechanical (knitted retraction cord) followed by 0.38 mm in mechanical (G cuff) and 0.37 mm in chemical (astringent retraction paste). The lateral displacement achieved was 0.75 mm in mechanical (G cuff) followed by 0.56 mm in chemico – mechanical (knitted retraction cord) and 0.51 mm in chemical (astringent retraction paste). All the three groups showed displacement levels greater than the required 0.2 mm for sulcus registration during impression making. In this study, it was found that using these mechanical (G cuff), chemical (astringent retraction paste) and chemico-mechanical (knitted retraction cord) three displacement methods lateral displacement was possible in all situations but vertical displacement was not achievable in all situations. This further proves that lateral displacement alone was necessary is substantiated in this study.

Bennani et al[6] did not recommend the usage of retraction cords around implants as it leads to ulceration of the junctional epithelium. They recommend the usage of injectable gingival retraction material around as they

produce considerable retraction atraumatically. They even contraindicate the use of electro surgery and rotary curettage around implants. Zeena Raja et al[7] in their study compared knitted cords, braided cords, Expasyl paste and Epipak rings which showed distinctive difference with maximum retraction in knitted cords. The difference between the knitted cords and Expasyl paste was 0.2 mm. Suganda et al[8] concluded that all the retraction agents affected the peri implant mucosa and the healing occurred within a week. The time period suggested by these authors were followed for this study.

Studies on peri implant tissue pressure during displacement are very few. This objective was included in this study to identify the range of force during displacement procedures. A study by Van Der Velden and De vries[9] in 1978 has shown that the epithelial attachment sustains injury at a force of 1 N/mm² while it ruptures at 2.5 N/mm². The pressure applied by the retraction cord is between 5 to 10 N/mm². To avoid any damage to the epithelial attachment, gingival retraction should be accomplished under a pressure between 0.1 and 1 N/mm². According to our study, least of 0.07 N pressure was recorded in chemical (astringent retraction paste) followed by 0.15 N in mechanical (G cuff) and 0.23N in chemico-mechanical (knitted retraction cord). In our study the pressure applied during peri implant displacement was within the normal range for gingival retraction of 0.1 N to 0.23 N but there are no values specified at present for the pressure that can be taken by the peri implant tissue without any injury. This is an area of further research as the desirable pressure during the peri implant displacement is still a grey area with little literature to substantiate.

The mechanical displacement (G cuff) was an efficient means of lateral displacement according to the present study. However, the apparatus was not user friendly especially when used for peri implant displacement. There is scope for modifications of the existing design that can be utilized for peri implant tissue displacement as the vertical displacement achieved in 3 out of 10 single piece implants was lesser when compared to the pre displacement group. The chemical displacement (astringent retraction paste) was supplied in a single capsule which was compatible with composite dispensers. This system of peri implant retraction gave desirable amount of lateral displacement and was user friendly. The aluminium chloride paste produced good haemostasis. This can be a good atraumatic method of peri implant displacement if cases are chosen carefully. The chemico – mechanical (knitted retraction cord) is supplied in a plastic box with a clean cut design featuring high carbon steel blade in the cap and a thin plastic gate that prevents cord from falling in to the bottle upon cutting. It has a ruler printed on the label that provides easy cord measurement and provides displacement in 3 to 5 minutes. In the present study, the chemico -mechanical system (knitted retraction cord) produced better values for vertical displacement than the lateral displacement. The main disadvantage with this system is that it is contraindicated in thin gingival biotypes and it produces microscopic scratches on the implant collar which may lead to plaque accumulation due to trauma by the packing instrument. Ahmed et al[10] in his study reported 92% of dentists used gingival displacement cords , of which 61% were a braided cord, 20% were knitted cord and 18% were reported unknown.

The measurements were made digitally to avoid human errors for all the three objectives. A customization of the pressure sensitive periodontal probe was done to measure the exact amount pressure experienced by the peri implant tissue during the displacement procedure.

There is a need for further studies with larger sample size to investigate the peri implant displacement with different displacement systems; randomized control studies comparing different displacements systems can also be a future study. Limitations of the study could include the errors inherent during fabrication of the custom tray, impression making, cast fabrication and in digitizing the casts. The peri implant displacement was done within a gap of 7 days to achieve healing. Studies with modified time period can be done. The assessment of the vertical and lateral displacement can also be measured by different methods like SEM, Stereomicroscope etc., to compare the results of the present study. Other parameters like periodontal index, varied sulcular depth, distendability of the gingival tissue after peri implant displacement can be included to study various parameters in future studies.

CONCLUSION

Within the limitations of the study,

- The most vertical displacement was seen with chemico – mechanical (knitted retraction cord) followed by mechanical (G cuff) and chemical (astringent retraction paste) methods. Vertical displacement was not always possible in all situations. However, vertical displacement values between and within the different methods were not statistically significant.
- All the three methods of peri implant displacement showed lateral displacement in all the situations. Most lateral displacement was seen with mechanical (G cuff), chemico – mechanical (knitted retraction cord)

and chemical (astringent retraction paste). The lateral displacement values between and within the different methods were not statistically significant.

- The pressure on the peri implant tissues was different with the 3 methods tested. Least pressure was found with chemical (astringent retraction paste) method followed by mechanical (G cuff) and the most pressure was with chemico – mechanical (knitted retraction cord) method. The difference in pressure was significant between and within the 3 methods.
- Lateral peri implant displacement is more predictable than vertical peri implant displacement
- All the methods tested showed lateral displacement that was well within displacement required for impression material to flow into the sulcus
- G cuff a mechanical device for displacement, can produce reliable lateral displacement.
- All the methods tested showed pressure within acceptable limits during displacement procedures.
- Astringent retraction paste a chemical displacement method, produced desirable displacement with least pressure to the surrounding tissues.

LIST OF ABBREVIATIONS

mm- Millimeter
N- Newton
V- Volt
Ω- Ohm
kΩ- Kilo Ohm
µ- Micron

DECLARATIONS

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE- provided by Ethics committee of SRM Institute of Science and Technology (Ethics clearance no. 1253/IEC/2017)

CONSENT FOR PUBLICATION- provided with a cover letter

AVAILABILITY OF SUPPORTING DATA- included in the discussion and references section

FUNDING- Self

ACKNOWLEDGEMENTS-

Mr. Daniel Stephen (Assistant Professor, Department of Mechanical engineering, SRM Institute of Science and Technology)
Dr. Balaji (Assistant Professor, Department of Community Medicine, SRM Medical College and Hospital)

REFERENCES

1. S.G. Kim.Clinical complications of dental implants in Implant Dentistry—A Rapidly Evolving Practice. I. Turkyilmaz. 2011; 2 (20): 467–490.
2. Ferencz JL. Maintaining and enhancing gingival architecture infixed prosthodontics. J Prosthet Dent. 1991; 65: 650-7.
3. The glossary of prosthodontic terms: Ninth edition. J Prosthet Dent. 2017; 117(5S): 1-105.
4. Goldberg PV, Higginbottom FL, Wilson TG: Periodontal considerations in restorative and implant therapy. Periodontol. 2001; 25: 100-109.
5. Benson, T.J. Bomberg, R.A.Hatch, W.Hoffman. Tissue displacement methods in fixed Prosthodontics. J Prosthet Dent. 1986; 55(2): 175-181.
6. Bennani V, Schwass D, Chandler N. Gingival Retraction Techniques for Implants Versus Teeth-Current Status. J Am Dent Assoc. 2008;139(10):1354-1363.
7. Zeena Raja, Chandrasekharan Nair. A clinical study on gingival retraction. J Indian Prosthodont Soc. 2003; 3(3): 21-27.
8. Gupta S, Dhawan P, Madhukar P, Tandan P, Sachdeva A. Clinical evaluation of the effect of two gingival retraction systems, gingival cuff and gingival retraction paste, on peri-implant soft tissue. J Inter Dis Dent. 2017; 7: 53-9.

9. Ashish Jain, Nallaswamy D. Comparison of gingival retraction produced by retraction cord and expasyl retraction systems - An in vivo study. J Drug Inv. 2018; 10: 35-41.
10. Ahmed SN, Donovan TE. Gingival displacement: Survey results of dentists' practice procedures. J Prosthet Dent. 2015; 114(1):81-5.

LIST OF TABLES

Table I: Comparison of Peri Implant Vertical Displacement Between Mechanical (G Cuff), Chemical (Astringent Retraction Paste) And Chemico-Mechanical (Knitted Retraction Cord)

Sample Number	Mechanical (G Cuff)	Chemical (Astringent Retraction Paste)	Chemico-Mechanical (Knitted Retraction Cord)
1	0.866	0.122	0.166
2	0.544	0.532	0.331
3	0.464	0.104	0.157
4	1.476	0.292	0.503
5	0.458	0.28	0.327
6	0.744	0.14	0.184
7	0.925	0.923	1.365
8	0.631	0.592	0.565
9	0.668	0.435	0.335
10	0.845	0.813	0.778
Mean	0.38	0.37	0.4

Table II: Comparison of Peri Implant Lateral Displacement Of Mechanical (G Cuff), Chemical (Astringent Retraction Paste) And Chemico-Mechanical (Knitted Retraction Cord)

Sample Number	Mechanical (G Cuff)	Chemical (Astringent Retraction Paste)	Chemico-Mechanical (Knitted Retraction Cord)
1	0.839	0.097	0.583
2	0.315	0.819	0.553
3	0.893	0.172	0.859
4	0.557	0.066	0.236
5	2.404	2.389	2.334
6	0.852	0.229	0.271
7	0.604	0.415	0.213
8	0.571	0.271	0.081
9	0.535	0.53	0.43
10	0.12	0.086	0.084
Mean	0.75	0.51	0.56

Table III- Comparison of Pressure On The Peri Implant Tissue In Mechanical (G Cuff), Chemical (Astringent Retraction Paste) And Chemico- Mechanical (Knitted Retraction Cord)

Sample Number	Mechanical (G Cuff)	Chemical (Astringent Retraction Paste)	Chemico-Mechanical (Knitted Retraction Cord)
1	0.15	0.1	0.21
2	0.15	0.06	0.25
3	0.16	0.06	0.26
4	0.15	0.04	0.23
5	0.15	0.04	0.23
6	0.16	0.07	0.26
7	0.15	0.06	0.25
8	0.15	0.1	0.21
9	0.15	0.1	0.21
10	0.15	0.07	0.23
Mean	0.15	0.07	0.23

Table IV- Kruskal-Wallis Test To Compare Vertical Displacement, Lateral Displacement And Pressure During Peri Implant Retraction Between Mechanical (G Cuff), Chemical (Astringent Retraction Paste) And Chemico- Mechanical (Knitted Retraction Cord)

Test	**Kruskal-Wallis Test**	**P Value**
Vertical Displacement	0.555	0.758
Lateral Displacement	5.137	0.077
Pressure	27.454	0.0001

Table V– Post Hoc Analysis By Scheffe's Method To Compare The Vertical Displacement Between Mechanical (G Cuff) [1],Chemical (Astringent Retraction Paste) [2] And Chemico-Mechanical (Knitted Retraction Cord) [3]

Groups	Mean Difference	P Value
1 & 2	0.013	0.998
1 & 3	0.015	0.998
2 & 3	0.028	0.993

Table VI– Post Hoc Analysis By Scheffe's Method To Compare The Lateral Displacement Between Mechanical (G Cuff) [1], Chemical (Astringent Retraction Paste) [2] And Chemico-Mechanical (Knitted Retraction Cord) [3]

Groups	Mean Difference	P Value
1 & 2	0.244	0.699
1 & 3	0.187	0.810
2 & 3	0.057	0.981

Table VII – Post Hoc Analysis By Scheffe's Method To Compare The Pressure Between Mechanical (G Cuff) [1], Chemical (Astringent Retraction Paste) [2] And Chemico- Mechanical (Knitted Retraction Cord) [3]

Groups	Mean Difference	P Value
1 & 2	0.082	0.0001
1 & 3	0.082	0.0001
2 & 3	0.164	0.0001

LIST OF FIGURES

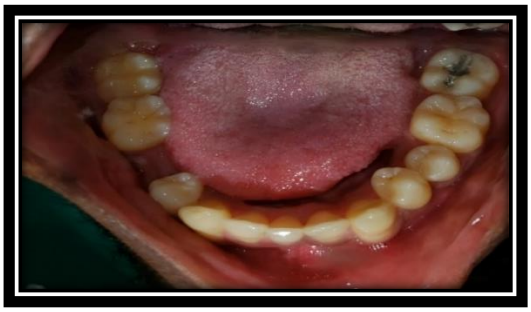
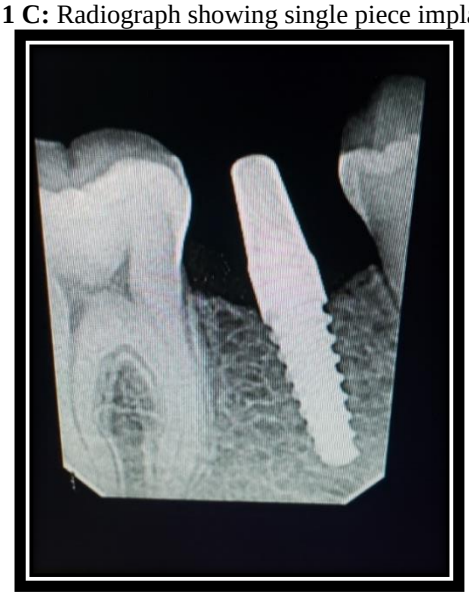


Fig 1 A: Pre Operative Photograph

Fig 1 B: Post Operative Photograph of a single piece implant in 45

Fig 1 C: Radiograph showing single piece implant placed in 45



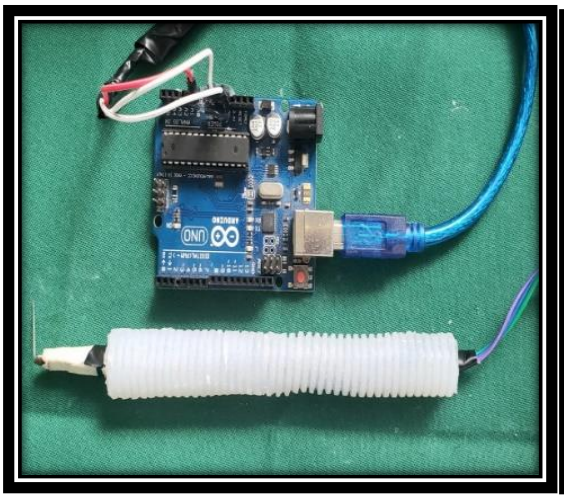


Fig 2 A: Customized Pressure Sensitive Periodontal Probe

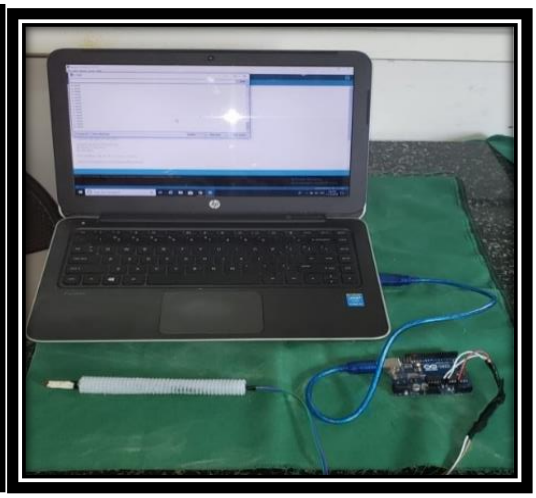


Fig 2 B: Customized pressure sensitive periodontal probe connected to laptop

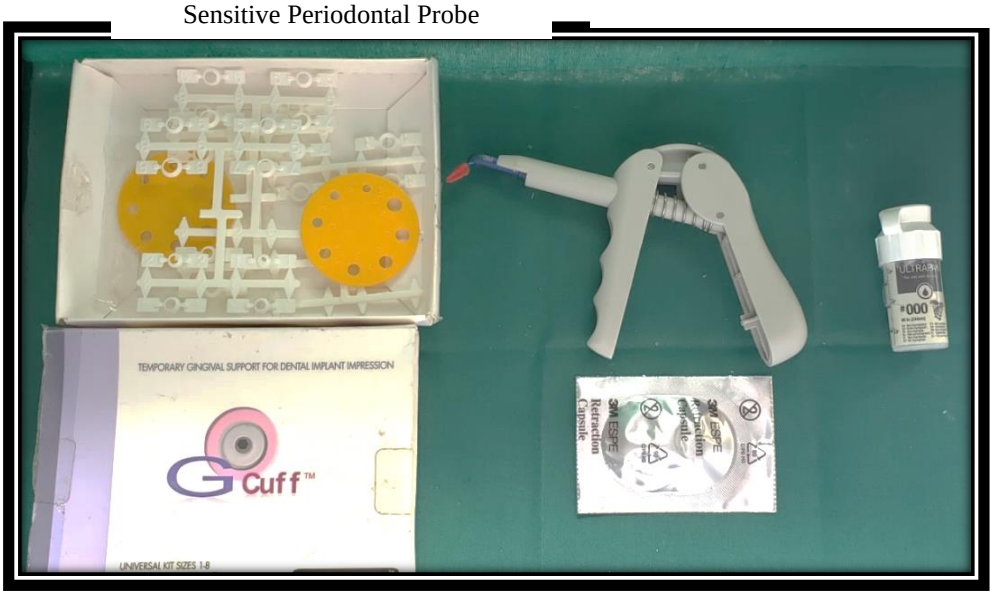


Fig 3: Peri Implant Displacement Materials- G Cuff Implant Impression,

Asti Cord

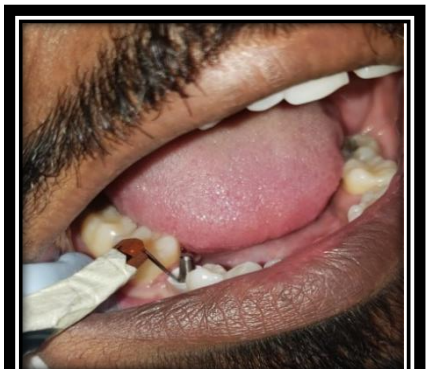


Fig 4 A: Pressure Measurement using G-Cuff

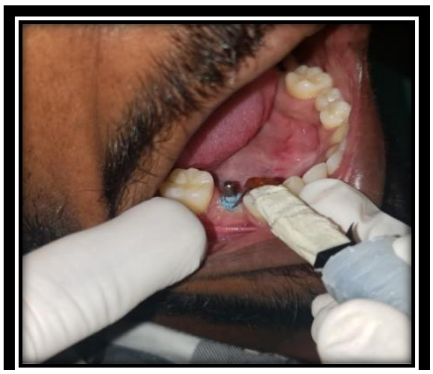


Fig 4 B: Pressure Measurement using Astringent Retraction Paste

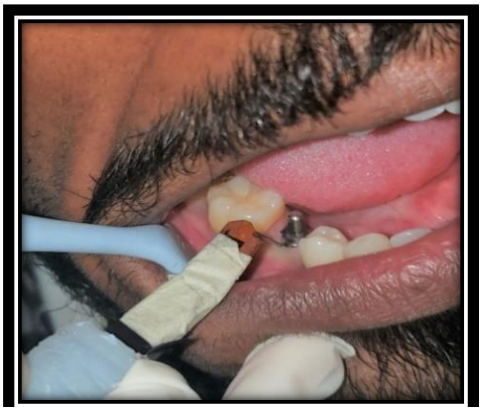


Fig 4 C: Pressure Measurement using Knitted Retraction Cord

Fig 5: Monophase Polyvinyl Siloxane Impressions
Mechanical(G Cuff), Chemical(Astringent Retraction Paste) and Chemico-mechanical(Knitted Retraction Cord)

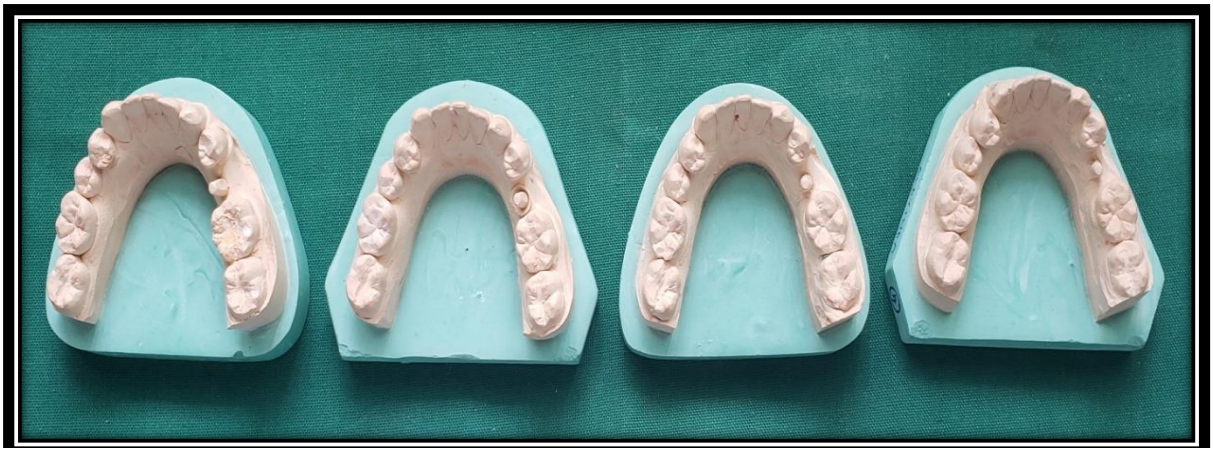


Fig 6: Die Stone Models-Pre-Displacement, Mechanical (G Cuff), Chemical (Astringent Retraction Paste) and Chemico-Mechanical (Knitted Retraction Cord)

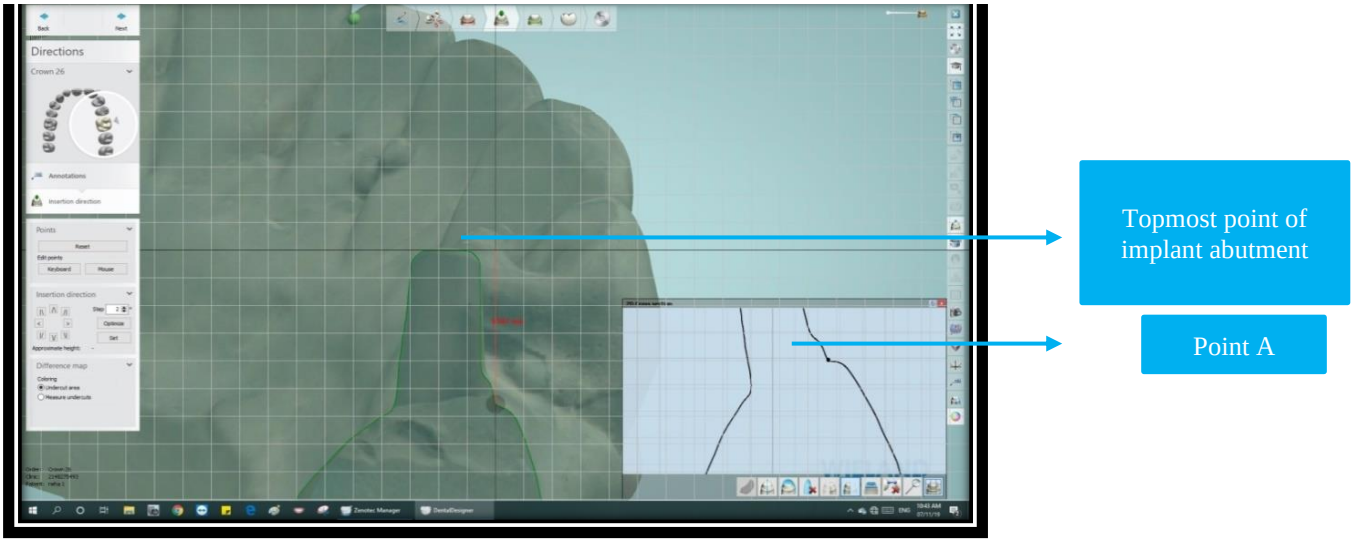


Fig 7: Vertical Displacement Measurement

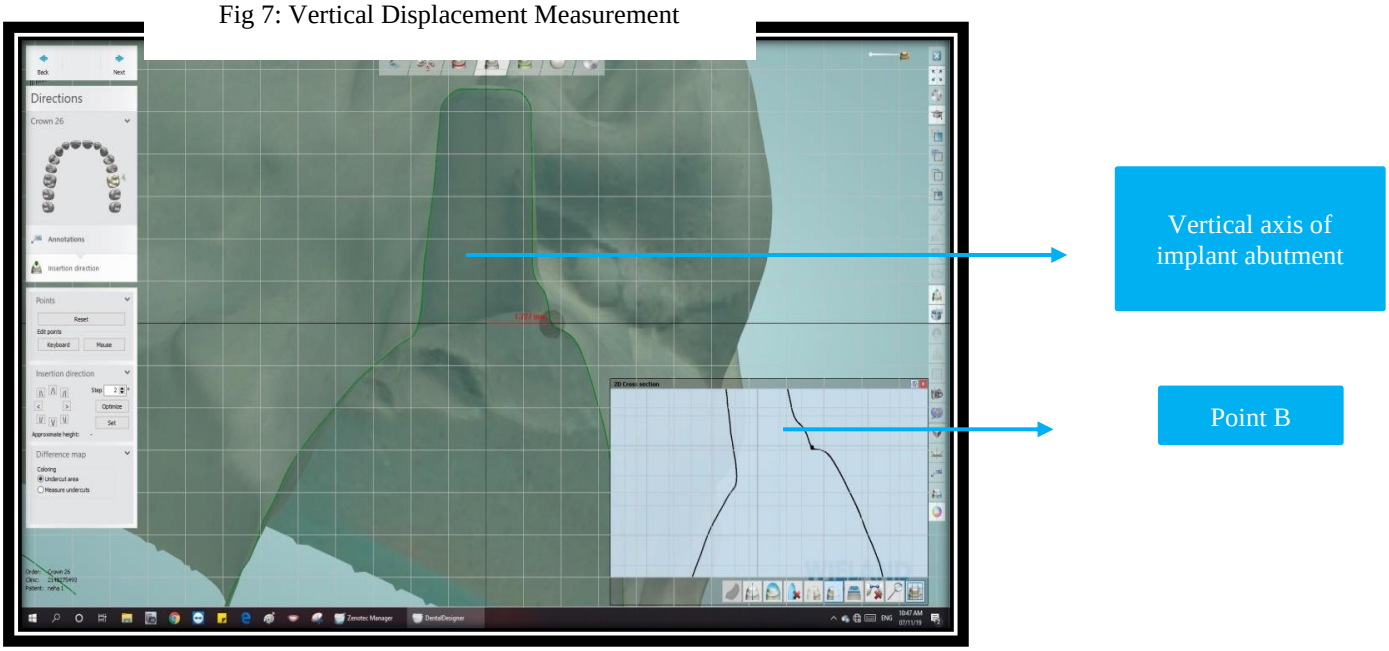


Fig 8: Lateral Displacement Measurement