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RESEARCH ARTICLE

EVALUATION OF THE PROXIMAL CONTACT TIGHTNESS BETWEEN FULL COVERAGE METAL CROWN AND ADJACENT NATURAL TEETH - AN IN VIVO STUDY

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Abstract

Context: The present study assesses the changes in the proximal contact tightness giving clinician a standardized method and a digital tool for evaluation of the proximal contact tightness. The results of this study also proves to be an educating tool for the patients in their maintenance of the prosthesis.

Aims: to evaluate the proximal contact tightness between single full coverage metal crown and adjacent natural teeth at cementation appointment and after 10 days at recall appointment and to compare the proximal contact tightness measured at both the appointments

Settings and Design: in vivo prospective study

Methods and Material:31 healthy subjects seeking treatment for fabrication of single full coverage metal crown were selected for this study. Conventionally fabricated single full coverage metal crowns were cemented and the proximal contact tightness was measured using a digital force gauge with hook attachment and a 0.05mm metal strip between the crown and adjacent natural teeth at mesial and distal contacts.

Statistical analysis used: The proximal contact tightness at cementation and at recall appointment after 10 days were analysed using a Paired 't' test.

Results: The mean value of proximal contact tightness at the mesial and distal contacts obtained at cementation appointment was 2.35 ± 0.486 N and 2.32 ± 0.475 N respectively. The mean value of proximal contact tightness at the mesial and distal contacts obtained at recall appointment was 1.03 ± 0.180 N and 1.65 ± 0.486 N respectively. There was a statistically significant difference between the proximal contact tightness obtained at cementation and at recall appointment after 10 days.

Conclusions: The results suggested that there is a significant reduction in the proximal contact tightness between full coverage metal crown and adjacent natural teeth after cementation. The method used in the study showed potential to be a more standard and quantitative method to assess the changes occurring in the proximal contact tightness.

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Introduction:-

A tooth must be looked upon as a harmonious part of the whole dentition and a successful restoration is achieved by diligent and prudent application of physiologic, mechanical and biologic factors.[1] Proximal contact is the area of a tooth that is in close association, connection or touch with an adjacent tooth in the same arch and is considered as an important parameter for a successful restoration. Proper proximal contact between two adjacent teeth plays a very significant role in maintaining the stability of the dental arch as well as a healthy periodontal tissue.[2] The proximal contacts are generally examined by a dental floss during tooth restoration but it is difficult to detect changes in the proximal contact tightness by this method because this is a very subjective method rather than qualitative.Various other methods for clinically evaluating the proximal contacts like using Mylar shim stock dental films, articulating films and thin metal strips have been documented.[3] A concept for measuring the proximal contact tightness using the frictional force generated when a thin metal strip is escaped from between the proximal contacts was given by Osborn in 1961.[4]Dörfer et al. described this maximum generated frictional force as the proximal contact strength.[5] Previous studies suggested that proximal contact tightness is not just a constant value but various other physiological factors such as chewing, postural changes, clenching and time of the day influence the proximal contact tightness.[5,6] Proximal contacts have been assessed between fixed prostheses and adjacent natural teeth using a dental floss, however, due to the limitations of the dental floss to measure changes in the proximal contacts and also due to the lack of literature the present study assesses the changes in the proximal contact tightness between single fixed tooth supported full coverage metal crown and adjacent natural teeth using a digital force gauge and a thin metal strip which gives clinician a standardised method and a digital tool for evaluation of the proximal contact tightness.

Subjects and Methods:-

A total of 31 subjects who reported to the Department of Prosthodontics and Crown & Bridge, Bapuji Dental College and Hospital, Davangere, Karnataka, seeking conventional single full metal crown were selected for this study.All of the study subjects were informed and explained in detail about the nature of the research procedure in understandable terms. To standardize the selection of the study subjects and to avoid bias in the study, well defined inclusion and exclusion criteria were set as follows:

Inclusion Criteria

- Patients within age group 18 – 47 years and receiving a full coverage metal crown.
- Adjacent natural teeth.
- Opposing natural teeth.
- Patients with healthy periodontium. (Bleeding on probing – absent and pocket depth < 3mm.)

Exclusion Criteria

- Adjacent teeth with mobility greater than Grade I.
- Opposing teeth with mobility greater than Grade I.
- Severe malocclusion.
- Diastema between posterior teeth.
- Plunger cusps.
- Signs and symptoms of TMJ dysfunction.
- Patients who are unable to or unwilling to return for follow up visits.

Diagnostic impressions of both maxillary and mandibular arches were made using irreversible hydrocolloid impression material. After retrieving the diagnostic casts, diagnostic mounting was done and maximum intercuspation was assessed on the diagnostic mounting. Following the principles of tooth preparation and guidelines for the preparation for a full metal crown, tooth preparation was done on the respective mandibular first molars (Figure 1). Gingival retraction was done using gingival retraction cord. After removal of the retraction cord, final impression was made with metallic perforated dentulous tray using polyvinyl siloxane impression material putty and light body consistency. Temporary crown made using temporary crown resin material (Protemp 4) was cemented using temporary luting cement after impression making (Figure 2).Final impressions were poured using Type IV die stone and pin holes were made using the Pindex system. After which the die pins were attached and the base of the cast were poured. After die preparation wax patterns were fabricated on the prepared tooth and then the metal crowns were fabricated in the dental laboratory.During the try in procedure occlusal interferences and proximal discrepancies were assessed and corrected.After final finishing and polishing the crowns were cemented using Type

I GIC luting cement (Figure 3).Proximal contact tightness were measured using the customised digital force gauge with a hook attachment and to which a 0.05mm metal strip was attached after final cementation of the crown (Figure 4). The 0.05mm metal strip was inserted between the prosthesis and the adjacent natural tooth (Figure 5). The frictional force generated while removing the metal strip slowly in the buccal direction was recorded on the screen of the customised digital force gauge. Since here a known thickness of metal strip was used the frictional force generated was considered equal to the proximal contact tightness and was recorded in Newton (N). Patients were recalled after 10 days and the proximal contact tightness were measured again in a similar way as measured at the cementation appointment (Figure 6).

Figure 1:- Prepared tooth and gingival retraction of mandibular first molar.

Figure 2:- Temporisation of mandibular first molar.

Figure 3:- Cementation of full coverage metal crown on mandibular first molar.

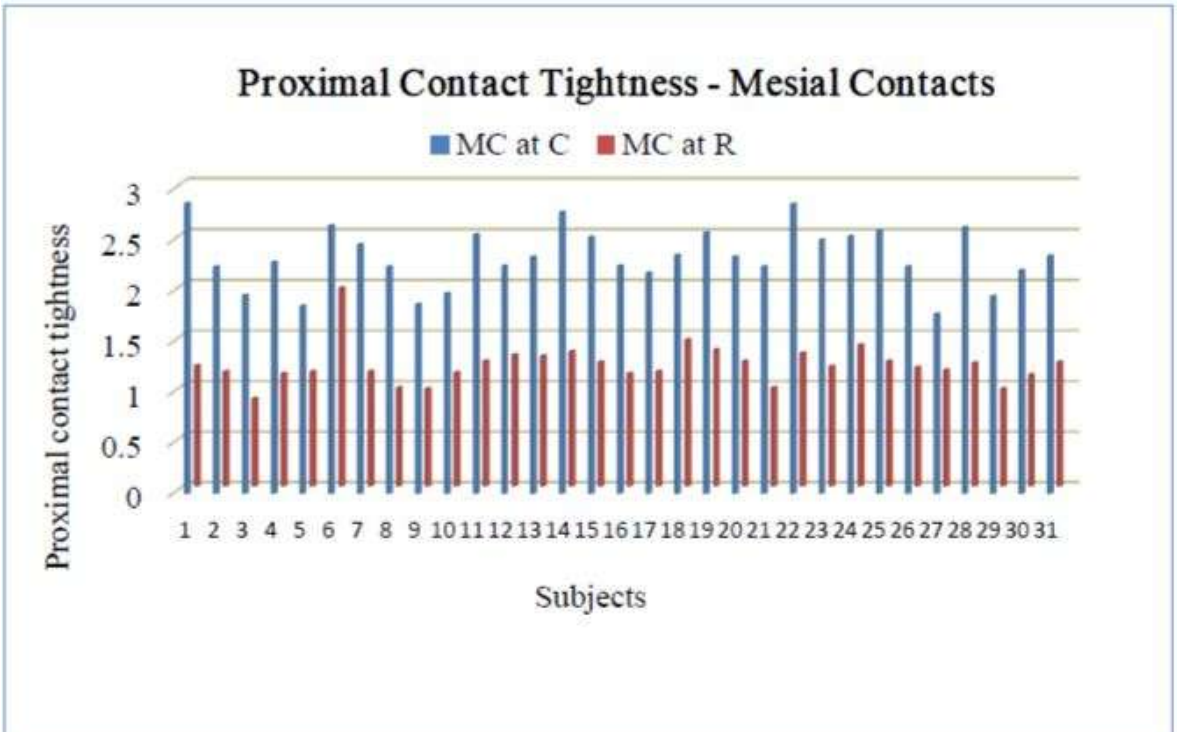
Figure 4:- Digital Force gauge with Hook attachment and 0.05mm metal strip.

Figure 5:- Evaluation of Proximal Contact Tightness using Digital Force Gaugeand 0.05mm metal strip at Cementation appointment.

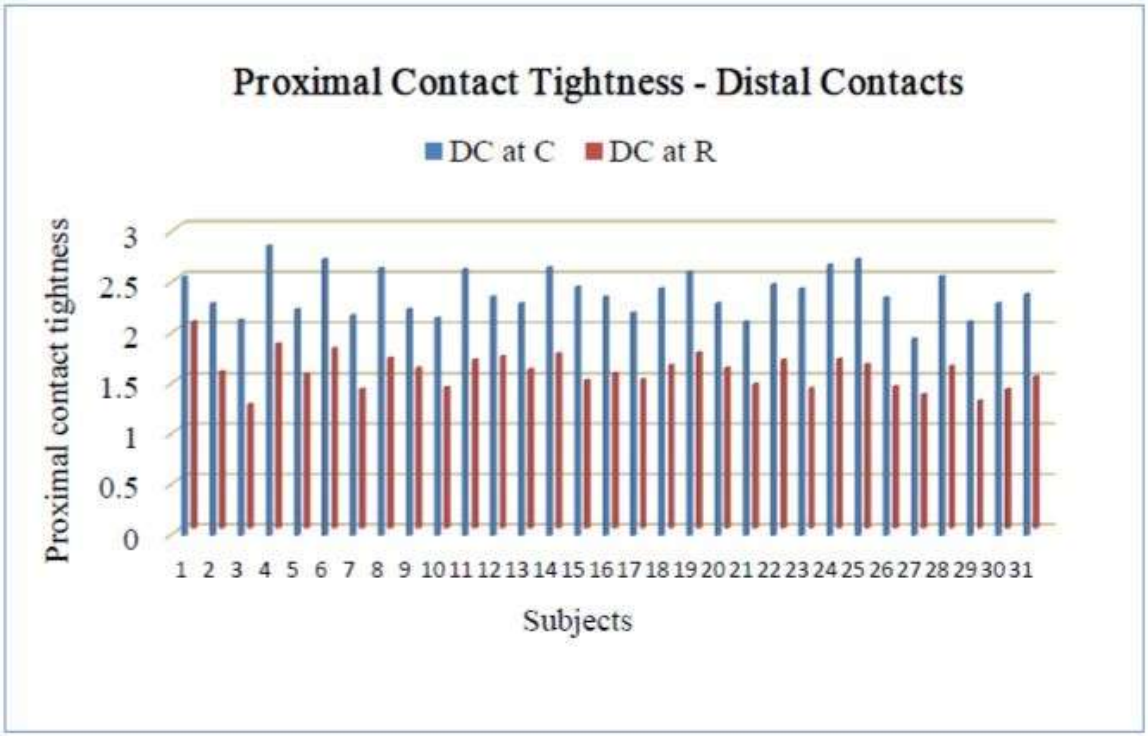
Figure 6:- Evaluation of Proximal Contact Tightness using Digital Force Gaugeand 0.05mm metal strip at Recall appointment.

Results:-

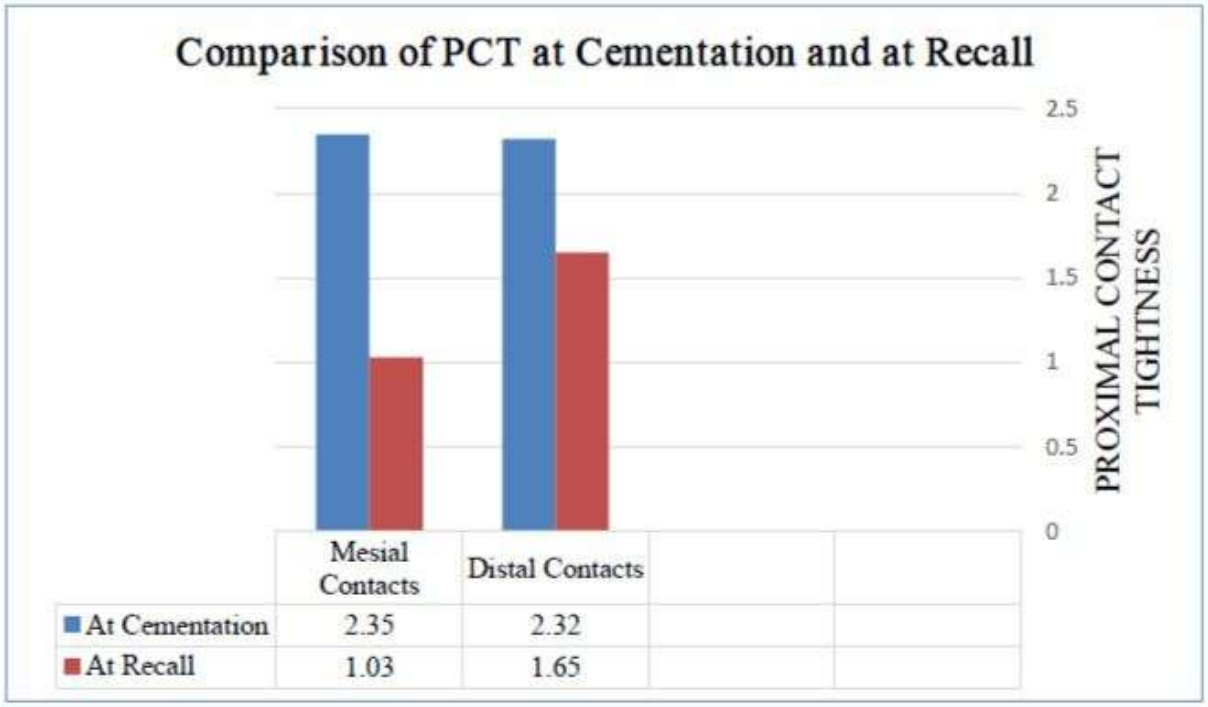
Graph 1 shows the values of proximal contact tightness obtained at the mesial contacts at both the appointments i.e. at cementation and at recall appointment after 10 days.Upon close observation at the Graph 1 and the values obtained, it can be observed that the highest value of proximal contact tightness obtained at the mesial contact at cementation appointment was 2.87 N and the lowest value obtained at the recall appointment was 0.87 N. Graph 2 separately shows the values of proximal contact tightness obtained at the distal contacts at both the appointments i.e. at cementation and at recall appointment after 10 days.Upon close observation at the Graph 2 and the values obtained, it can be observed that the highest value of proximal contact tightness obtained at the distal contact at cementation appointment was 2.87 N and the lowest value obtained at the recall appointment was 1.23 N. Table 1 and Graph 3 shows the proximal contact tightness obtained at cementation and after 10 days at recall appointment after subjecting the data to Paired 't' test.For mesial contacts the mean value for proximal contact tightness at cementation appointment obtained was 2.35 N and the standard deviation obtained was 0.486. The mean value for proximal contact tightness at recallappointment after 10 days obtained was 1.03 N and the standard deviation obtained was 0.180. The p value obtained was < 0.001.For distal contacts the mean value for proximal contact tightness at cementation appointment obtained was 2.32 N and the standard deviation obtained was 0.475. The mean value for proximal contact tightness at recall appointment after 10 days obtained was 1.65 N and the standard deviation obtained was 0.486. The p value obtained was < 0.001.The above results states that there was a statistically significant difference between the proximal contact tightness obtained at cementation and at recall appointment after 10 days ($p<0.001$).



Graph 1:- Proximal contact tightness at mesial contacts at different timeintervals i.e. at cementation and at recall appointment after 10 days.



Graph 2:- Proximal contact tightness at distal contacts at different timeintervals i.e. at cementation and at recall appointment after 10 days.



Graph 3:- Comparison of proximal contact tightness at different timeintervals i.e. at cementation and at recall after 10 days.

Table 1:- The mean proximal contact tightness obtained at cementation andafter 10 days at recall appointment after subjecting the data to Paired 't' test.

PCT (Newton)	**At Cementation**			**At Recall after 10 days**			**p value**
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	
Mesial Contact	31	2.35	0.486	31	1.03	0.180	<0.001*
Distal Contact	31	2.32	0.475	31	1.65	0.486	<0.001*

*significant difference observed at p<0.001

Discussion:-

The ideal proximal contacts in natural teeth and restorations are important factor for the health and longevity of the dentoalveolar complex. Interproximal contact tightness is affected by several factors including, the location of the teeth in the jaws, diurnal variations, patient position, occlusion, and para-functional habits.[7] Under physiological conditions, teeth are stabilized in the dental arch by making occlusal contacts with opposing teeth and proximal contacts with adjacent teeth. Alexander et al reported that the proximal contact is maintained by two conflictive theories known as the Compression theory and Resistance theory. The Compression theory states that the compression force occurs between proximal surfaces of the adjacent teeth and keeps an active proximal contact. The Resistance theory states that teeth touch each other passively when no forces are acting, but resisting any force which tries to separate them.[8]

Dentists note the proper contact in clinical treatment as the entry of floss with a snap. This method is simple but it is difficult to detect the detailed changes in the proximal contact tightness. The proximal contact tightness is considered to be too tight if the floss cannot pass through the contact area or tear out during entry, but too weak if the floss passes the contact area too easily. Although this method is simple and easy but it is inaccurate and very subjective and it is not possible to record or assess the changes that occur in the proximal contact tightness.[3]Osborn was the first who constructed a device based on the theory of frictional force to quantify the proximal contact tightness by inserting a thin metal strip interdentally which is pulled out with a spring balance in horizontal direction. When a strip is slipped between two adjacent teeth, each tooth is displaced and exerts a force against the

strip. The maximum frictional force (Ff) that resists withdrawal is a value for the proximal contact tightness. With a known coefficient of dynamic friction (μ) between tooth enamel of adjacent tooth and metal strip material, the proximal contact tightness is related to Ff by the following equation: Contact tightness = Ff/2μ (N).[4] Southard et al used a digital tension transducer to measure the frictional force occurred at pulling metal strip of 0.03 mm-thickness, whereas Oh et al constructed a device equipped with a digital strain gauge designed to convert the frictional force into compressive force using a hinge. Dorfer et al developed a device in which the metal strip of 0.05 mm-thickness was fixed in a special holder, which was prepared with strain gauges to register the bending action of the holder during removal of the strip. Proximal contact tightness was measured by various devices as stated above quantitatively but the data are not enough yet.[5, 6] According to the study conducted by Kim et al in 2008, the highest proximal contact tightness was observed at the mesial and distal contacts of the mandibular first molar region in natural teeth.[9] A digital force gauge along with a hook attachment was used in the present study to evaluate the proximal contact tightness which is in accordance with the study conducted by Ren et al and a thin metal strip of 0.05mm thickness was used to pass between the metal crown and adjacent natural tooth which was pulled out using the digital force gauge and the hook attachment which is in accordance with the study conducted by Dorfer et al. The instruments used in the present study helped in quantitatively evaluating and standardizing the proximal contact tightness.[5, 10].

Southard et al suggested that the anterior component of occlusal force progresses anteriorly through the proximal contacts and can sometimes cross the dental midline.[11] The anterior component of an occlusal force acting from the molars and the degree of irregularity in the anterior teeth are both related to the contact tightness of posterior teeth. Dorfer et al suggested that the proximal contact tightness is not a constant value but is a physiological entity and can be influenced by a variety of factors like chewing, postural changes, clenching and time of the day. A tooth may move under the influence of components of the masticatory force which might be a possible factor for the mesial drift of the teeth which may lead to changes in the proximal contact tightness.[5]According to Kim et al the most accurate evaluation of the proximal contact tightness was observed when the subject was initially seated upright in the dental chair and on the other hand, a restored contact which was considered appropriate after a long appointment with the patient in the supine position was excessively tight and could result in undesirable tooth movement.[3] Thus before evaluating the proximal contact tightness the subjects in the present study were made to sit in an upright position.

Other factor that could potentially influence the measurement of the proximal contact tightness as suggested by Dorfer et al is the initial distance between the teeth before the measurement.[5] The recoil force depends on the amount of dislocation of the teeth during insertion of the matrix band. The presence of a small space between adjacent teeth might result in a smaller dislocation and a reduced recoil force. To exclude this source of error, every proximal contact area was thoroughly examined clinically under optimal conditions before cementation using the same 0.05mm metal strip, which allowed the detection of any lack of proximal contact between adjacent teeth. From the results obtained it is quite evident that the proximal contact tightness had reduced when compared to that obtained at the cementation appointment. The difference between the mesial and distal proximal contact tightness at the recall appointment i.e. more amount of loss of proximal contact tightness at the mesial contact was observed when compared to the distal contact can be accounted to the work done by Southard et al who suggested that the anterior component of occlusal force progresses anteriorly through the proximal contacts and can sometimes cross the dental midline.[11] However, the forces acting on the teeth do not act in isolation. The alveolar bone especially that of the mandible, has been shown to deform under function. Clenching between posterior teeth on the working side seems to induce tooth movement on the balancing side. Thus results showing the changes in the proximal contact tightness confirms that it is a physiological entity and not a constant value as suggested by Dorfer et al.[5]

Conclusion:-

Within the limits of the present study, the following conclusions can be made:

1. The proximal contact tightness is a physiological entity which changes with time under the influence of multiple factors.
2. The proximal contact tightness reduces at the mesial and distal contacts over a period of time.
3. The changes in the proximal contact tightness at the mesial contact are more severe when compared to the changes occurring at the distal contact.

Clinical Implications:

1. The proximal contacts should be assessed well before final cementation and should be checked periodically at recall appointments for long term prognosis of the prostheses.
2. The digital force gauge along with the hook attachment and 0.05mm metal strip can be used as a standardised method to assess the proximal contact tightness which would enable the dentist to analyse it more qualitatively.
3. The method used in the present study can be used to motivate and educate the patients about the changes occurring with the prostheses in the arch and help them understand the importance of oral hygiene maintenance.

List of Abbreviations:

reviation	Definition
PCT	Proximal Contact Tightness
N	Newton
SD	Standard Deviation

References:-

1. Shillingberg HT. Fundamentals of fixed prosthodontics. 3rd ed. Chicago: Quintessenence, 1997.
2. Wheeler RC. An atlas of tooth form. 4th ed. Philadelphia: W. B. Saunders Co, 1969.
3. Kim HS, Na HJ, Kim HJ, Kang DW, Oh SH. Evaluation of proximal contact strength by postural changes. J Adv Prosthodont. 2009;1:118-123.
4. Osborn JW. An investigation into the interdental forces occurring between the teeth of the same arch during clenching the jaws. Arch Oral Biol. 1961;5:202-211.
5. Dörfer CE, von Bethlenfalvy ER, Staehle HJ, Pioch T. Factors influencing proximal dental contact strengths. Eur J Oral Sci 2000;108:368-377.
6. Southard TE, Southard KA, Tolley EA. Variation of approximal tooth contact tightness with postural change. J Dent Res. 1990 Nov;69(11):1776-1779.
7. Almalki AD, Rafee MA. Evaluation of presence of proximal contacts on recently inserted posterior crowns in different health sectors in Riyadh city, Saudi Arabia. J Family Med Prim Care. Nov 2019;8(11):3549-3553.
8. Vardimon AD, Matsaev E, Lieberman M, Brosh T. Tightness of dental contact points in spaced and non spaced permanent dentitions. Eur J Orthod. 2001;23:305-314.
9. Kim KH, Jung JH, Kim HJ, Chung CH, Oh SH. Evaluation of tightness of proximal tooth contact in permanent dentition. J Korean AcadProsthodont. 2008;46(6):553-559.
10. Ren S, Lin Y, Hu X, Wang Y. Changes in proximal contact tightness between fixed implant prostheses and adjacent teeth: A 1-year prospective study. J Prosthet Dent. Apr 2016;115(4):437-440.
11. Southard TE, Behrents RG, Tolley EA. The anterior component if occlusal force. Part 1: Measurement and Distribution. Am J OrthodDentofacOrthop. 1989 Dec;96(6):493-500.