

Clinical measurement of the height of the interproximal contact area in maxillary anterior teeth

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Abstract

Objectives: To clinically quantify the apico-incisal height of interproximal areas directly in patients' mouths.

Methodology: Thirty participants (11 females and 9 males, mean age=26±1.5 years) were recruited into this study. Measurement of interproximal contact areas was carried out directly in patients' mouths using digital caliper (TERENSA, USA) with measuring accuracy of 0.01mm. The interproximal contact areas that were measured are: central incisor to central incisor, central incisor to lateral incisor, lateral incisor to canine, and canine to first premolar on both sides of the jaw. Statistical significance was based on probability values less than 0.05 (p<0.05).

Results: The largest contact point was the one present between central incisors and it ranged from 2.9 to 6.5 mm. On the other hand, the contact point between canine and first premolar was the smallest on both sides of the arch and ranged from 0.6 to 2.5 mm. The dimensions of the contact points declined as we move from anterior area backwards. Statistical analysis using t-test showed that there were significant differences between the measurements of interproximal points of each tooth (P<0.05).

Conclusions: the apicogingival dimension of the contact point decreased as we moved from anterior to posterior teeth. The contact area between the central incisors was largest and the one between canine and premolar was the smallest. This study is the first to report direct intra-oral clinical measurement of contact points. Clinical evaluation of contact point dimensions using digital caliper is a viable, quick and accurate method to use.

Keywords: Contact point, Interproximal contact, anterior teeth, dental aesthetics

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Introduction

Most smile aesthetic components have received enormous attention by dental professionals and researchers. However, the literature lacks adequate evidence based scientific research regarding the ideal dimensions of maxillary incisal edge embrasure space and inter-proximal contact area. The interproximal contact area (ICA) is defined as the zone in which two adjacent teeth appear to meet.⁽¹⁾

The spaces that are formed coronal to the ICA are called spillway spaces or embrasures. They serve two main purposes: make a spillway for the escape of food during mastication, which reduces forces brought to bear upon the teeth; and prevent food from being forced through the contact area.⁽²⁾ The spaces that are formed apical to the ICA are called interproximal spaces, they are usually filled with the interdental papilla.

The design of the contact area, interproximal space and embrasures varies with the form and alignment of teeth, while both sections of the arch show similarity of this design.⁽²⁾ The gingival embrasure, the height of interdental papilla and the incisal embrasure are all defined by contact area.^(3,4) The contact area of the maxillary teeth are relevant for ensuring optimal 'pink aesthetics' for patients with a high smile line (or visible cervical margins). The iconic study by Tarnow *et al.*,⁽⁵⁾ which produced the 'mm rule', stated that when the distance from the contact point to the interproximal osseous crest is 5mm or less, there would be a complete fill of the gingival embrasures with interdental papilla. The chance of complete fill is progressively reduced by 50% for each millimeter increase above the 5mm distance.

Therefore, during planning for anterior restoration; attention should be paid for the height of the interproximal contact area due to its importance in the final aesthetic result. Short contact area might result in black triangles, while high proximal contact area might impinge on the gum and cause unpleasant appearance.⁽⁵⁾

The location of the ICA has been studied by Suilkowski⁽⁶⁾ who stated that the ICA lies between the incisal and gingival embrasures. Stappert *et al.*⁽⁷⁾ measured the proximal contact area on master cast from the apical point of the contact area, corresponding to the peak of the interdental papilla, to the incisal point of the contact area equivalent to the initiation of the incisal embrasure. He concluded that proximal contact area decreased anteroposteriorly

between maxillary central incisors to first premolars bilaterally, from 4 to 3 and 2 to 1.5 mm, respectively. Tarnow *et al.*⁽⁵⁾ and Martegani *et al.*⁽³⁾ measured the distance between the bone crest and facial aspect of the apical contact area by sounding the soft tissue. Martegani *et al.*⁽³⁾ reevaluated the results by periapical radiographs. The most apical portion of the contact area was identified using a copper line fixed within the interdental embrasure.

There are currently no studies that have measured the height of the interproximal contact area clinically. Therefore, the purpose of this study was to clinically quantify the apico-incisal height of interproximal areas directly in patients' mouths.

Methods

Thirty participants (11 females and 9 males, age range= 25-30 years, mean age=26±1.6 years) were recruited into this study.

The study was approved by Deanship of Scientific Research, Al-Jouf University, Saudi Arabia. Patients' informed consent was obtained before being recruited into the study.

To be included, participants should have good systemic health, adequately aligned maxillary teeth, no incisal attrition, no missing teeth and no fixed partial dentures or any other restorations. Before taking any measurement; each participant was thoroughly examined by the investigator to guarantee the above inclusion criteria.

Measurement of interproximal contact areas was carried out directly in patients' mouths using digital caliper (TERENSA, USA) with a light-emitting diode display (Figure 1). The digital caliper accuracy was up to 0.01 mm.

The following inter proximal contact areas were measured: central incisor to central incisor, central incisor to lateral incisor, lateral incisor to canine, and canine to first premolar on both sides of the jaw. The patients were instructed to brush and floss their teeth before carrying out the measurements. Each interproximal area was dried with a gentle air stream before the start of the measurement.

The tips of the measuring ends of the digital caliper were fabricated by the manufacturer much tapered to a slim wedge-shape with a pen-point tip and thus allowed easy access of the tips to the upper and lower borders of the inter proximal contact area (Figure 1). The measuring points on the proximal area were the visible touching areas of adjacent teeth both from occlusal side and gingival side. The tips of the

caliber were moved till they touch both boundaries (occlusal and gingival) of the contact area between the adjacent teeth (gingivo-occlusal dimension of the contact area) (Figure 2). Each contact point was measured three

times and the average measurement was calculated.

The intra-examiner reliability was checked by doing the measurements for 3 patients at two different occasions. No differences were found between the measurements on both occasions.

Figure 1: The digital caliber (TERENSA, USA) used for the measurement of interproximal contact areas in this study.



Figure 2: Measurement of the interproximal contact area between upper central incisors directly in the patient's mouth using the digital caliber.



Statistical Analysis:

The data were analyzed using the Statistical Package for Social Sciences software (SPSS, Version 16.0, Chicago, IL, USA). Simple frequency tables processed and analyzed by means of paired sample t tests to identify any significant relations between different contact areas. Statistical significance was based on probability values less than 0.05 ($p < 0.05$).

Results

The largest contact point was the one present between central incisors and it ranged from 2.9 to 6.5 mm. On the other hand, the contact point between canine and first premolar

was the smallest on both sides of the arch and ranged from 0.6 to 2.5 mm.

Table 1 presents the minimum and maximum interproximal contact point distances as well as the means and standard deviation among the measured teeth.

Statistical analysis using t-test showed that there were significant differences between the measurements of interproximal points of each tooth ($P < 0.05$) (Table 2).

Figure 3 shows the declination of the dimensions of the contact points as we move from anterior area backwards. The dimensions of the contact point decreased as we move from the contact between central incisors to the contact between canine and first premolar.

Table 1: The means, SD, minimum and maximum interproximal contact point distances among the measured teeth.

Interproximal Contact Areas	Mean	Std. Deviation	Minimum	Maximum
CI & CI	4.5933	.83992	2.90	6.50
CI & LI (R)	2.7967	.60713	1.80	4.10
LI & C (R)	2.2867	.80761	1.40	5.80
C & FP (R)	1.6133	.59870	.60	2.50
CI & LI (L)	2.8033	.79589	1.60	5.80
LI & C (L)	2.2100	.45285	1.40	3.00
C & FP (L)	1.6400	.57870	.70	2.40

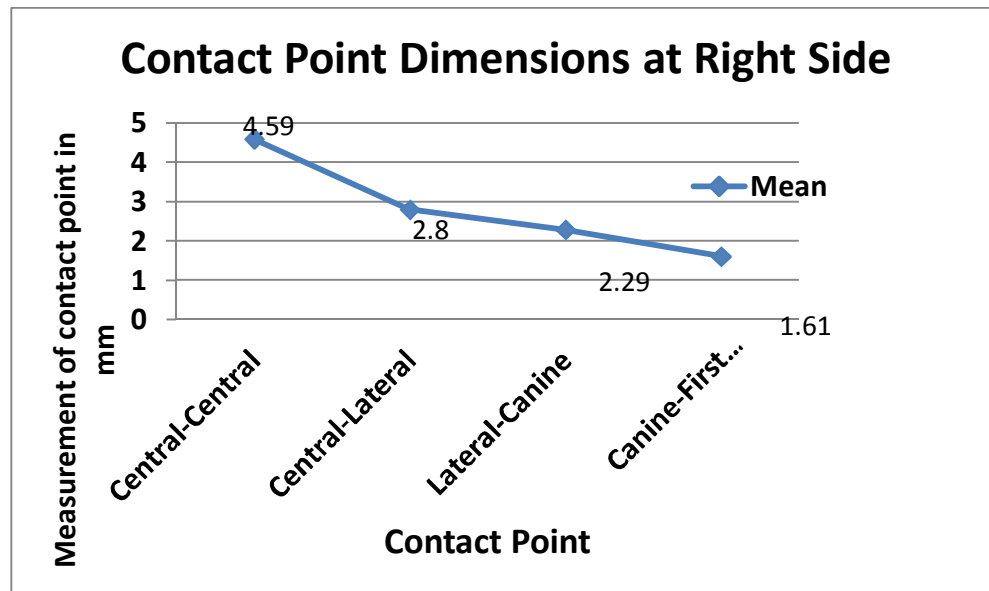
CI: central incisor, LI: lateral incisor, C: canine, FP: first premolar, (R): right side, (L): left side.

Table 2: Statistical analysis of the differences between the measurements of inter-proximal contacts of measured teeth.

Contacts*		Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
			Lower	Upper			
Pair 1	CIs & CI -LI (R)	.19127	1.40547	2.18787	9.393	29	.000
Pair 2	CI-LI (R) & LI-C (R)	.20725	.08614	.93386	2.461	29	.020
Pair 3	LI-C (R) & C-FP (R)	.18961	.28553	1.06113	3.551	29	.001
Pair 4	CIs & LI-CI (L)	.17448	1.43314	2.14686	10.259	29	.000
Pair 5	CI-LI & LI-C (L)	.17032	.24498	.94168	3.484	29	.002
Pair 6	LI-C & C-FP (L)	.11950	.32560	.81440	4.770	29	.000

* CIs: Central incisors, LI: Lateral Incisor, C: Canine, FP: First premolar, L: Left, R: Right

Figure 3: The trend of declination of the dimensions of the contact points from anterior area backwards at the right side of upper jaw (in mm).



Discussion

Although many researchers^(3, 7, 9-12) investigated smile aesthetics and addressed the importance of interproximal contact area in restoring anterior teeth; none of them have directly measured the height of the interproximal contact area clinically. Stappert *et al.*⁽⁷⁾ quantified the proximal contact area on stone models in an apicoincisal direction from the apical point of the contact area, corresponding to the peak of the interdental papilla, to the incisal point of the contact area, corresponding to the start of the incisal embrasure.

In addition, Tarnow *et al.*⁽⁵⁾ and Martegani *et al.*⁽³⁾ evaluated the distance between the bone crest and facial aspect of the apical contact area by sounding the soft tissue. Martegani *et al.*⁽³⁾ reevaluated the results by periapical radiographs. Although the interdental papilla corresponds to the apical point of the contact area; using the above methods might not provide the most accurate quantification of the contact area. This could be due to forcing the papilla apically during taking the impression, expansion of stone models, and problems related to using radiographs for measurement such as overlap of adjacent structures, distortion, and difficulty in getting ideal parallelism during taking the radiographs.

In this study and to overcome the above pitfalls, the apicoincisal height of the

interproximal contact area was directly measured inside the patient mouths using a digital caliper. Analysis of the height of the interproximal contact area showed high significant changes between all the teeth, it also demonstrated that the height of the contact area was decreasing antero-posteriorly. These findings concur the results of previous studies.^(2, 5, 7, 13)

Teeth are arranged with tectonic spacing that involves arrangement of teeth considering both functional and aesthetic dimensions.⁽⁸⁾ For example soon following the alignment of the teeth in both arches, appositional contact relation occurs mesially and distally between a tooth and adjacent teeth. This contact relation will keep food from packing between teeth, and it helps to stabilize the dental arch by the combined anchorage of all teeth. Also, the proper contact gives good aesthetics by avoiding the formation of black triangles. Consequently, extra efforts should be given to the height of the proximal contact area.

Clinical evaluation of contact point dimensions using digital caliber is a viable and quick method to use. Adequate handling of the contact points is mandatory for the success of aesthetic restorations and prevention of black triangles.

No attempts were made to compare the obtained measurements in this study to

measures obtained from casts or radiographs. This is an area of future research where the intraoral clinical measurement of contact points could be validated against measuring casts or radiographs.

Another potential area of study is checking the validity and applicability of this method to posterior teeth although it is expected to be difficult to apply this technique for the measurement of posterior contacts due to the difficult access to posterior area.

Future studies are also required to intraorally measure contact points among larger samples and different populations to generalize the results on different populations and see the difference between different populations in this regard.

Conclusions

The apicogingival dimension of the interproximal contact area decreased as we moved from anterior to posterior teeth. The contact area between the central incisors was the largest while the contact area between canine and premolar was the smallest. Clinical evaluation of contact point dimensions using digital caliber is a viable and quick method to use.

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Competing interests

The authors declare that they have no competing interests.

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