EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 69, 697:704, JANUARY, 2023
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
FIXED PROSTHODONTICS AND DENTAL MATERIALS
Submit Date : 19-12-2022 • Accept Date : 14-01-2023 • Available online: 1-1-2023 • DOI : 10.21608/edj.2023.181304.2381

CLINICAL AND RADIOGRAPHIC EVALUATION OF CROWN MARGIN SHIFTING CONCEPT: A NEW TECHNIQUE FOR RE-ESTABLISHING THE BIOLOGICAL WIDTH

Hussein, Sarah Farouq* ; Aboelsaad, Nayer**;
Hussein, Nasser***; Ghanem, Lomaya*** *and* Fouad, Maha****;

ABSTRACT

Objective: To evaluate an innovative approach, Crown Margin Shifting (CMS), for its ability to re-establish the biological width (BW) or supracrestal tissue attachment.

Clinical considerations: Seven patients aged between 25-45 years old, presented with bilateral maxillary premolars with deep interproximal caries violating the BW were recruited for this study. Both study sites received monolithic zirconia crowns with heavy chamfer finish line. The heavy chamfer is thicker and with bevel on the deepest part of experiment site. Clinical parameters were evaluated at baseline, 6 and 12 months after. Radiographic evaluation using CBCT was done to measure marginal bone loss (MBL) and the established BW at the deep proximal finish line.

Results revealed significant improvement in Modified Plaque Index (MBI) and Gingival Index (GI) parameters in both sites at the end of the study. The Periodontal Probing Depth (PPD) increased significantly in the first 6 months only for both. The marginal bone loss (MBL) was present in control site throughout the 12 months, whereas in CMS site, it took place only in the first 6 months.

Conclusions: The results support that CMS approach had less radiographic marginal bone loss without a negative influence on the clinical parameters up to one year follow-up.

KEYWORDS: Biologic width; CAD/CAM monolithic zirconia; Crown lengthening; subgingival crown margin.

* Department of Oral Rehabilitation Sciences, Faculty of Dentistry, Beirut Arab University, Beirut, Lebanon
** Professor, Department of oral surgical Sciences, Faculty of Dentistry, Beirut Arab University, Beirut, Lebanon.
*** Associate Professor, Fixed prosthodontics, Conservative Dentistry Department, Faculty of Oral and Dental medicine. Modern University for Technology and Informations
**** Associate Professor Fixed Prosthodontics, Conservative dentistry, Misr International University (MIU)
***** Lecturer of Fixed Prosthodontics Department, Faculty of Dentistry, Galala University, Egypt

INTRODUCTION

Fixed prosthodontics obligate a thorough periodontal examination in order to establish the harmony between the restorations and the periodontium. The biologic width (BW), or recently called "supracrestal tissue attachment" (Ref) is described as the zone of the root surface coronal to the alveolar crest to which the junctional epithelium and connective tissue are attached. It was estimated to be 2.04 mm.[1] The proximal carious lesion often follows the line of the dentinal tubules, which may extend apically to impinge the zone of supracrestal attachment thus violating the BW. To prevent BW violation, a crown-lengthening (CL) [2] was usually performed to expose healthy tooth substance, with or without bone removal, for restorative purposes.[3] It has been demonstrated that placing restorative margins within the BW without CL may lead to gingival inflammation, loss of clinical attachment and bone loss[4] However, some researchers observed continued bone loss until re-formation of a BW. [5]

During surgical CL, removing supporting bone of the adjacent neighboring teeth sometimes could not be avoided. This has been a main drawback for the CL procedure, hence many clinicians have sought ways to avoid this procedure such as orthodontic force eruption.[6] Recently, platform-switching concept was introduced in implant field with an attempt to minimize implant crestal bone loss while preserving/increasing soft tissue volume.[7] Hence, a common question was raised, can platform-switching concept be applied in the natural dentition especially in the re-establishment of BW? Thus, Crown Margin Shifting (CMS) was proposed by us to preserve soft tissue volume and barrier length in order to re-establish BW. Conceptually, if a tooth has a deep proximal carious lesion, the prepared tooth finish line was left to be partially exposed to behave like the implant fixture platform and the restoration act like the implant abutment, this mimics the same junction of platform-switching in implants. Therefore, the aim of this study was to evaluate crown margin shifting (CMS) for its ability to re-establish and maintain the biological width.

MATERIALS AND METHODS

Sample selection and distribution

The study was approved by the IRB committee (H-0023-D-M-0083). Patients were selected from the outpatient clinic. A signed consent was obtained, after informing them about their rights and obligations.

Seven individuals who met inclusion and exclusion criteria, aged ranged between 25 to 45 years old, with endodonticaly treated maxillary bilateral 1st or 2nd carious premolars with a proximal deep lesion violating the biological width were enrolled in this study. Each patient represented both the control site (CS) and the experiment site (CMS). All selected abutments had a neighboring tooth showing normal contact condition. All remaining clinical crown surfaces provided minimal ferrule effect of 1.5mm[8] with crown/root ratio of the abutment teeth not less than 1:1.[9]

The CS abutments received monolithic zirconia crowns with a heavy chamfer margin designed on the whole finish line. The CMS group received similar tooth preparation with the newly tested CMS technique and monolithic zirconia crowns.

Pre-prosthetic procedures

Periapical radiographs for both bilateral abutments were done to include the tooth in which the BW was less than 2 mm.[1] A custom made radiographic bite block was made for each patient that corresponds to the used cone beam computerized tomography (CBCT) machine. The first CBCT using the bite block was made at baseline after caries removal. For each patient, the following measurements were done:

1. The vertical BW (VBW) was measured, for both sites, at the middle apical crestal bone, between the deepest level of the finish line and bone crest.
2. The horizontal BW (HBW) was calculated for the study site (SS) according to the following

equation: HBW = 2 mm – VBW. (Where 2 mm, is the size of a healthy biological width[1]). HBW measurements will be applied on the deep wide finish line and will be left exposed and not covered by the crown margin.

3. Further BW measurements were taken at the most buccal and the most palatal crestal bone in order to detect if any changes in the whole interdental bone level took place.

PROSTHETIC PROCEDURE

Fiber post and composite core build up was done, followed by a full crown preparation. For CS, both proximal, buccal and lingual walls were reduced with round ended tapered diamond bur producing heavy chamfer finish line, which was placed 0.5 mm subgingivally all around except for the proximal finish line with the deep carious lesion violating the BW which was placed at the level of the gingival floor of the cleaned deep carious lesion in a subgingival level. For CMS premolar, it was similar to CS, except for the proximal surface with the deep carious lesion that was cut with a large round shoulder end tapered diamond bur, the finish line margin was beveled with a flame diamond bur and then, the entire finish line was smoothened with a similar sized finishing burs, producing a wide heavy round shoulder with bevel.

Direct interim restorations were fabricated and temporarily cemented. Abutments were prepared for impression by double retracting cords applied to all surfaces except at the proximal surface with the deep finish line where a single retraction cord was applied. Impression was made and poured; the final cast was sawed and ditched by a professional technician under loop magnification, then, scanned using a CAD-CAM machine.

HBW was copied to the CAD/CAM software and drawn by a digital ruler to the digital die on the wide deep finish line of SS, a knife edge margin was designed according to the measurements, leaving the rest finish line exposed, thus, producing the concept of CMS, while for the remaining finish line; it was contoured to completely cover the heavy chamfer finish line **(figure 1)**. As for CS, the heavy chamfer finish line was covered completely with no modification **(figure 2)**. The contact area was designed carefully to occupy the middle third of the proximal surface. Accordingly, new indirect interim acrylic restorations were milled and tried intra-orally

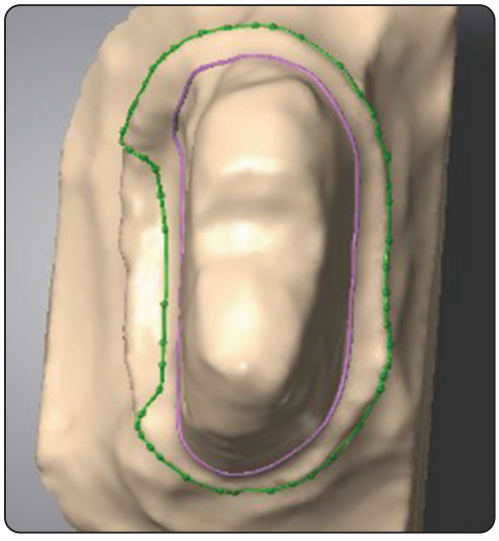

Fig. (1) A- Computerized die image showing an occlusal view of contoured heavy chamfer finish line and CMS on the wide heavy round shoulder with bevel.

Fig. (1) B- Monolithic zirconia crown (CMS) on the die presenting the exposed finish line which was produced according to the measurements of HBW on the computerized die.

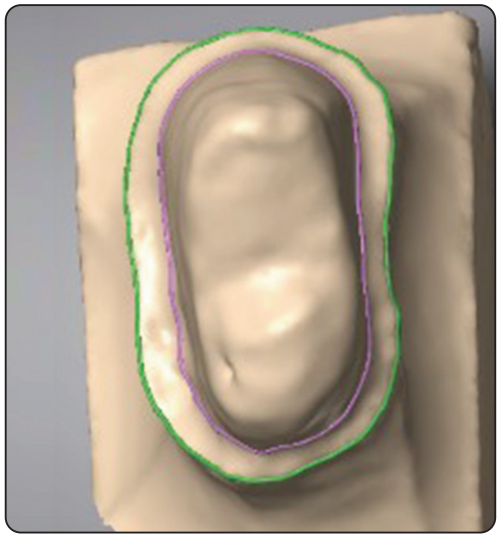

Fig. (2) A- Computerized die image showing an occlusal view of contoured heavy chamfer finish line (CS).

Fig. (2) B- Monolithic zirconia crown on the die, showing complete finish line coverage (CS).

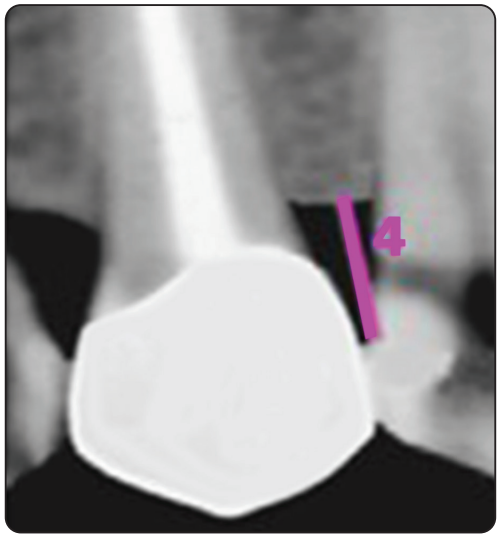

Fig. (3) A- X-ray of second premolar with CMS crown.

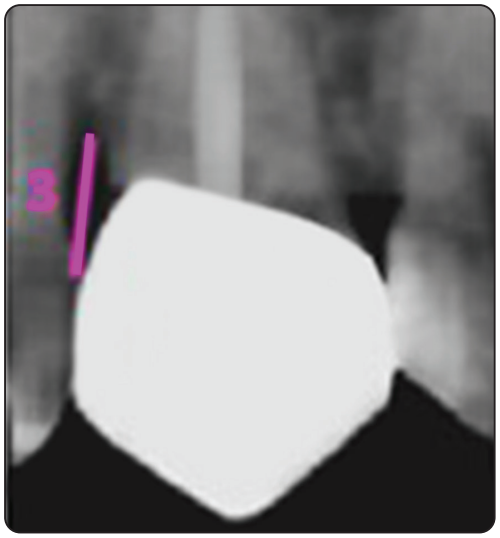

Fig. (3) B- X-ray of first premolar with CS crown.

then cemented; any needed changes were done and adjusted to the computerized design. Monolithic zirconia crowns that mimic the indirect interim restoration were milled and tried. A periapical x-ray was done to examine the marginal adaptation of the deep proximal margins and to measure the height of the interdental papilla space between the contact area and the crestal bone level to make sure that it is less than 5mm.[10] The indirect interim acrylic restorations were removed after at least 7 days and the final zirconia crowns were cemented **(figure 3)**.

Methods of evaluation

Abutment teeth were examined clinically according to the following parameters: Modified plaque index (MPI) [11] and gingival index (GI)[12] on the buccal and palatal surfaces of the crown, modified bleeding index (MBI)[11] and periodontal probing depth (PPD),[3] measuring from free gingival margin to the deepest probing pocket depth only on the affected half of the crown represented by the mid-buccal, mid-lingual and the affected proximal half at its buccal and palatal surfaces.

Six and twelve months after the restorations, radiographic examination using CBCT scans was performed by measuring the distance from crown margin to the crestal bone in the three examined sites, the middle apical, and the most buccal and most palatal crestal bone. Marginal bone loss was then calculated by the difference between the baseline and the new VBW measurement taken on each follow up sessions. The established BW at six and twelve months was measured between finish line and crestal bone at the three examined sites, and statistically analyzed.

Statistical analysis

Collected data was tabulated and analyzed within and between the two types of crown margins. Data were fed to the computer using IBM and SPSS software. Mean and standard deviation was calculated for normally distributed data. Comparison between two independent study groups were done using independent t-test. Significance of the obtained results was judged at the 5% level. Correlation coefficient (r) was used where the variables were represented by the values of the first and second observations in the same individual. Results can be significant when $p < 0.05$.

RESULTS

There was no statistically significant difference in MPI between both CMS and CS abutments on buccal and palatal surfaces, since plaque was carefully controlled to be as minimum as possible. No statistically significant differences were found in GI between SS and CMS in both buccal and palatal surfaces except at 12 months, both sites showed a significant improved GI at the end of the study with better values for CS **(figure 4)**.

There was no statistical difference of MBI between both SS and CMS abutments at baseline, as well as 12 months. At 6 months, CS showed a significant lower MBI than CMS. At 12-month, both treated sites had a better MBI than baseline **(figure 5)**.

CMS showed significant increase in PPD during the 12 months, whereas CS was significant only in the first 6-month **(figure 6)**. Values of MBL **(table 1)** indicated that bone loss was significant in the middle apical bone in both sites. Established biological width measurements **(table 2)** confirmed that the significant bone loss took place in the first 6-month at all examined sites for CMS. For CS significant palatal crestal bone loss was noted in the first 6 months while the middle and apical bone loss was significant throughout the study period. Positive correlation was found between PPD and MBL in both groups.

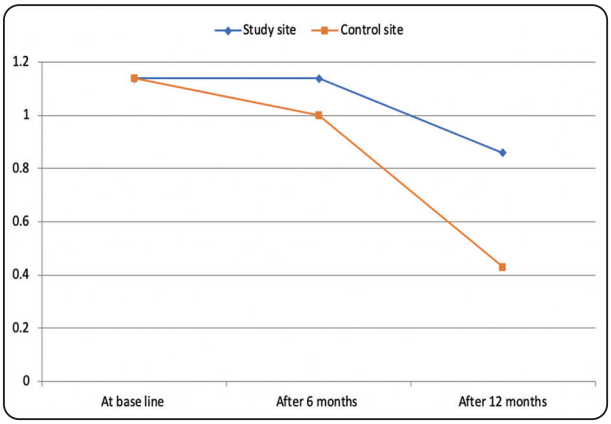

Fig. (4) Line chart representing mean GI (gingival index) of buccal surface at different time periods in each site.

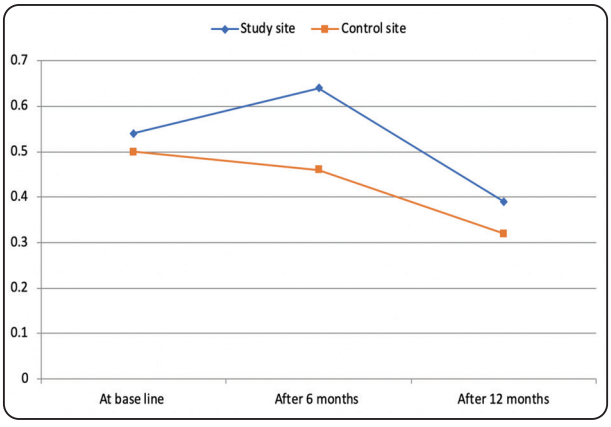

Fig. (5) Line chart representing mean MBI (modified bleeding index) at different time periods in each site.

TABLE (1) Comparison of mean MBL in each site on the affected half of the crown.

			Experimental period		
Parameter	Surface	Site	After 6m	After 12m	P3
MBL	Most buccal	CMS	0.19	0.18	0.741
		CS	0.13	0.26±0.29	0.077
		P	0.425	0.107	
	Middle apical	CMS	0.26±0,23	0.40±0.29	0,022*
		CS	0.36±0.35	0.50±0.42	0.037*
		P	0.042*	0.089	
	Most palatal	CMS	0.14±0.17	0.22±0.20	0.013*
		CS	o.17±0.23	0.19±0.24	0.356
		P	0.311	0.411	

: Significant at P ≤ 0.05** ***P3 comparison between 6 months and 12 m

TABLE (2) Comparison of established biological width in each site on the affected half of the crown.

			Experimental period					
Parameter	Surface	Site	Base line	After 6m	After 12m	P1	P2	P3
MBL	Most buccal	CMS	1.72±0.7	1.9±0.79	1.9±0.76	0.05*	0.05*	0.655
		CS	1.55±0.5	1.0±0.59	1.85±0.63	0.064	0.098	0.064
		P	0.318	0.301	0.623			
	Middle apical	CMS	1.07±0.4	1.4±0.29	1.47±0.37	0.03*	0.01*	0.689
		CS	1.06±0.2	1.38±0.2	1.55±0.32	0.03*	0.013	0.03*
		P	0.485	0,436	0.652			
	Most palatal	CMS	1.91±0.6	1.04±0.6	1.04±0.65	0.01*	0.01*	0.655
		CS	1.13±0.6	1.3±0.54	1.32±0.54	0.04*	0.04*	0.356
		P	0.265	0.213	0.219			

***: Significant at P ≤ 0.05**
P comparison between control and study____ P2 comparison between base line and 12 m
P1 comparison between base line and 6 m P3 comparison between 6 months and 12 m

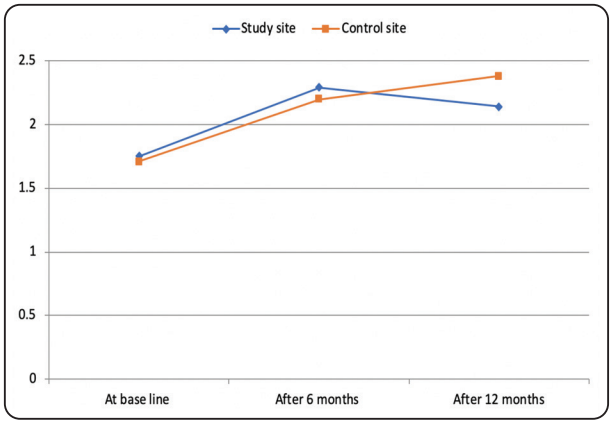

Fig. (6) Line chart representing mean PPD (probing pocket depth) at different time periods in each site.

DISCUSSION

Data from our study reported some early inflammation, this phenomenon was expected due to soft tissue healing with some marginal bone remodeling. However, this theory can only be speculated since no histologic study was available at this moment. Interestingly, significant bone loss was observed in the middle and apical crestal bone at 6-month in both groups (CMS and CS), and it continued increasing to 12-month in CS group. This was in agreement with Noguchi et al [13] who stated that destruction of periodontal tissue and loss of attachment is increased in tissue containing long junctional epithelium caused by infiltration of inflammatory cells and osteoclasts. Similarly, Bosshart et al also noted that in the phase of pocket formation, long junctional epithelium is permeable and allow inflammatory factors to be infiltrated to the marginal papilla.[14]

MBI and GI, at 6 months period, showed significant increase which could be due to inadequate oral hygiene since patients were unable to perform proper flossing technique. This was also demonstrated and supported by Oppermann et al,[15] who showed that good oral hygiene is key for low plaque index especially in cases with subgingival restoration. At 12-month, with the improvement of patient's oral hygiene, we observed MBI and GI was significantly reduced in both groups.

For PPD, both groups showed increase PPD with no significant difference between the two over the study periods. This was probably due to the attachment loss associated with the presence of long junctional epithelium.[13] These results confirm with Santamaria et al., where an increased pocket depth was observed with restorations placed closer to the bone level in animals under excellent plaque control.[16]

Marginal bone level1-1-2023MBL was present through the whole period of the study. The biggest changes occur in the first 6 months at both groups with CMS group has less MBL, then it showed no significant increase up to 12- month, except at the middle and apical crestal bone in CS group. This is agreement with Tal et al,[5] who found that there was no further bone loss when normal healthy junctional epithelium was re-established. This implies that CMS approach had positive effect in reducing MBL especially in the exposed finish margin line.

CMS had wider BW at 12-months than SS, which is directly proportional to the increased MBL and the increased PPD. This might suggest that the body is trying to re-establish the normal BW in CS but in case of CMS group, it was reduced.

Several approaches were published to minimize the impact on periodontium, such as 1) retraction cord with 15% aluminum chloride was used for gingival retraction since it has better outcomes in deep margins with minimal sulcus depth;[17] 2) zirconia restoration material was selected because more tissue friendly with minimal gingival inflammation;[18] 4) ensure no pressure was put on the temporary restorations to avoid inflammation and recession;[19] 5) utilize knife edge margin to achieve a smaller marginal opening so it was ease to seal [20] and less likely to have residual cement;[21]

CONCLUSIONS

This pilot trial supports CMS approach can reestablish biological width and maintain a healthy supracrestal tissue attachment with better bone level without negative influencing on the clinical parameters up to one year follow-up.

REFERENCES

1. Gary MJ, K. WRD: Physiologic Dimensions of the Periodontium Significant to the Restorative Dentist. Journal of Periodontology., 1979; 50:170–4.
2. Patroni S, Chiodera G, Caliceti C, et al.: CAD/CAM technology and zirconium oxide with feather-edge marginal preparation. Eur J Esthet Dent., 2010; 5:78–100.
3. Periodontology AAo. Glossary of periodontal terms, 4th edition. 2001.
4. Allan P, Robert E, Hom-Lay W: Interactions between the gingiva and the margin of restorations. J Clin Periodont., 2003; 30:379–85.
5. Haim T, Michael S, Areyh D, et al.: Periodontal response to long-term abuse of the gingival attachment by supracrestal amalgam restorations. J Clin lPeriodont., 1989;16:654–9.
6. Nobre CMG, de Barros Pascoal AL, Albuquerque Souza E, et al.: A systematic review and meta-analysis on the effects of crown lengthening on adjacent and non-adjacent sites. Clin Oral Invest., 2017; 21:7–16.
7. Lazzara RJ, Porter SS: Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. Int J Perio Rest Dent., 2006; 26:9–17.
8. Pereira JR, de Ornelas F, Rodrigues Conti PC, et al.: Effect of a crown ferrule on the fracture resistance of endodontically treated teeth restored with prefabricated posts. J Prosthet Dent., 2006; 95:50–4.
9. Grossmann Y, Sadan A: The prosthodontic concept of crown-to-root ratio: A review of the literature. J Prosthet Dent., 2005; 93:559–62.
10. Karuna J, S. BC, Himanshu K, Sumidha B, B MI: Clinical assessment of interdental papilla competency parameters in the esthetic zone. J Esthet Rest Dent., 2017; 29:270–5.
11. Mombelli A, van Oosten MA, Schurch E Jr, et al.: The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiol Immunol., 1987; 2:145–51.
12. Loe H: The Gingival Index, the Plaque Index and the Retention Index Systems. J Periodontol., 1967; 38:610–6.
13. Noguchi S, Ukai T, Kuramoto A, et al.; The histopathological comparison on the destruction of the periodontal tissue between normal junctional epithelium and long junctional epithelium. J Periodont Res., 2017; 52:74–82.
14. Bosshardt DD: The periodontal pocket: pathogenesis, histopathology and consequences. Periodontol 2000., 2018; 76:43–50.
15. Oppermann RV, Carvalho Gomes S, Cavagni J,et al.: Response to Proximal Restorations Placed Either Subgingivally or Following Crown Lengthening in Patients with No History of Periodontal Disease. Int J Perio Restor Dent., 2016; 36:116–24.
16. Santamaria MP, Suaid FF, Carvalho MD, et al.: Healing patterns after subgingival placement of a resin-modified glass-ionomer restoration: a histometric study in dogs. T Int J Perio Restor Dent., 2013; 33:679–87.
17. Rajambigai MA, Raja SR, Soundar SI, et al.: Quick, painless, and atraumatic gingival retraction: An overview of advanced materials. J Pharm Bioallied Sci., 2016; 8:S5–S7.
18. Saravanakumar P, Thallam Veeravalli P, Kumar VA, et al.: Effect of Different Crown Materials on the InterLeukin-One Beta Content of Gingival Crevicular Fluid in Endodontically Treated Molars: An Original Research. Cureus., 2017; 9:e1361.
19. 19. Burns DR, Beck DA, Nelson SK: A review of selected dental literature on contemporary provisional fixed prosthodontic treatment: Report of the Committee on Research in Fixed Prosthodontics of the Academy of Fixed Prosthodontics. J Prosthet Dent., 2003; 90:474–97.
20. Comlekoglu M, Dundar M, Özcan M, et al:. Influence of cervical finish line type on the marginal adaptation of zirconia ceramic crowns. Oper Dent., 2009; 34:586–92.
21. Nemane V, Akulwar RS, Meshram S: The Effect of Various Finish Line Configurations on the Marginal Seal and Occlusal Discrepancy of Cast Full Crowns After Cementation - An In-vitro Study. J Clin Diagnost Res., 2015; 9:ZC18–21.