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Original Article

The Conundrum of Deep Marginal Acquisition: A Comprehensive Review

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Abstract

The biologic width is considered an important tight seal around the tooth, which is critical in protecting the periodontium from any microbial injury and maintaining periodontal health. However - in many clinical scenarios - subgingival carious lesions and crown-root fractures may affect the biologic width dimension. Deep marginal acquisition is considered a critical factor for clinical success. Several protocols were highlighted in this review to solve this conundrum, including the functional crown lengthening procedure, which is considered the gold standard of care for managing deep subgingival margins. However, it has its limitations, including the risk of causing root exposure, furcation involvement in posterior teeth with high furcation, compromising crown-root ratio, besides risking implant threads exposure if it was performed besides implant, extending crestal bone recontouring to buccal and lingual walls, and in some cases to adjacent teeth to attain smooth bony architecture, and the complications of surgery such as post-operative pain, inflammation, edema and the risk of excessive bleeding.

Keywords:
Deep Marginal Acquisition, Functional Crown Lengthening, Thermacut Bur, Gingivectomy, Biological Width. Alveolar bone crest.

I. INTRODUCTION

This review was based on a systematic search on three search engines; Pubmed, Google scholar and Cochrane Library. The search was performed using keywords and MESH terms (AND/OR) to involve all possible articles related to this comprehensive review. The articles were then filtered based on prespecified inclusion criteria. The Main focus was on chosen studies that had relevance to restorative work, and impact of restorative treatment on periodontal health. This review was designed to highlight the followings; the role of biological width in maintaining periodontal health, clinical studies on surgical crown lengthening, and periodontal Tissue response to restorations.

Minimally invasive dentistry is now becoming the forefront of restorative dentistry, involving less traumatic treatment protocols and conservation of tooth structure and surrounding tissues, also enhancing the long-term survivability of treated teeth and improving the overall periodontal health (Veneziani, 2010). Bringing such philosophy into the clinical workflow can sometimes be challenging as some cases can challenge restorative dentists, such as dealing with deep subgingival interproximal carious lesions during restorative procedures using composite restorations. Exposing cavity margins is critical to achieving proper rubber-dam isolation, matrix adaptation, adhesion procedure, and composite placement (Magne and Spreafico, 2012).

The biological width is considered an important tight seal around the tooth, which is critical in protecting the periodontium from any microbial injury and maintaining periodontal health. (Schmidt et al., 2013) However - in many clinical scenarios - subgingival carious lesions and crown-root fractures may affect the biologic width dimension. Functional crown lengthening is a surgical procedure that is used to restore this important landmark, which plays an important role in maintaining periodontal health and the long-term stability of restorations. Functional crown lengthening is an effective procedure done before the prosthetic procedure with great success, provided that a certain protocol is being undertaken. It is done by achieving at least a 3 mm distance between the alveolar bone crest and the flap margin at the time of suturing. (Rosenberg, Cho, and Garber, 1999)

Several protocols have been proposed to solve this conundrum, including functional crown lengthening, considered the gold standard of care for the management of deep subgingival margins However, it has its limitations, including the risk of causing root exposure, furcation involvement in posterior teeth with high furcation, compromising crown-root ratio, besides risking implant threads exposure if it was performed besides implant, extending crestal bone recontouring to buccal and lingual walls, and in some cases to adjacent teeth to attain smooth bony architecture, and the complications of surgery such as post-operative pain, inflammation, edema and the risk of excessive bleeding. (Nobre et al., 2017)

II. Clinical studies on surgical crown lengthening

Ingber, 1977 published a paper describing the clinical technique and the importance of surgical crown lengthening to prevent violation of biological width and create enough ferrule to enhance the restorability of badly mutilated teeth or teeth fractures. This laid the foundation for choosing the appropriate treatment strategies based on crown root ratio after tooth restoration, the tooth's position in the arch relative to its strategic importance, esthetics, and the ability to maintain a healthy status after periodontal surgery.

Pontoriero and Carnevale, 2001 conducted a 12-month follow-up case series assessing wound healing after surgical crown lengthening procedures in the form of marginal periodontal tissues as an immediate outcome Functional Crown Lengthening (FCL), and 12 months, 30 patients were recruited in the study, featuring 84 teeth indicated for SCL, a baseline assessment was done including probing depth (PD), clinical attachment level (CAL), gingival and plaque indexes, and position of the gingival margin. After SCL, patients were re-evaluated at different intervals up to 12 months. It was concluded that marginal periodontal tissues rebounded in an occlusal direction from the defined level at surgery. It was found that tissue biotype played a key role in the healing response, favoring thick biotype, it was also found that age and gender didn't influence healing.

Lanning et al., 2003 conducted a case series to evaluate the impact of surgical crown lengthening on overall periodontal health in humans, as most studies during that period were investigating positional changes on free gingival margins but not the biological width and histological studies were performed to evaluate postoperative crestal bone resorption indicating re-establishment of the biological width were done on animals. Twenty-three patients satisfied the FCL inclusion criteria, including tooth fractures or preprosthetic margins. Measurements were taken from the line angles of the teeth that require crown lengthening, as well as from neighboring teeth, plaque and gingival indices, free gingival margin, crown attachment level, probing depth, and biological breadth were recorded. The alveolar bone crest was recontoured based on the planned prosthesis margin and biological width dimension. After six months, it was determined that BW had returned to the treated areas and that there had been a 3 mm increase in coronal tooth structure at the three and six-month marks.

Deas et al., 2004 conducted a case series to evaluate specific surgical measurements and the stability of crown height 6 months after surgical crown lengthening was performed. Twenty-five patients with thirty-four teeth to be treated were included in the case study. Surgical measurements were done at 1, 3, and 6-month intervals after surgery. It was found that the flap position relative to the alveolar bone crest at suturing has a direct relation to tissue rebound that had not been fully stable at 6 months. Clinicians were advised to achieve proper crown height clinically through osseous removal without relying on positioning the flap at the bone crest to gain the needed crown height.

Eleutério Diniz et al., 2007 conducted a 12-month case study to evaluate surgical crown lengthening using bitewing radiographs. Twenty-three subjects who required surgical crown lengthening in the premolar region were recruited for the study. The restorative margin was defined before surgery and remained unchanged during healing to act as a point of reference. Bitewing radiographs with a paralleling technique were taken before and after crestal bone recontouring and at different intervals up to 12 months. The lamina dura was observed to be intact at both mesial and distal alveolar crests, but only from the 3rd month, at 12 months, all alveolar crests presented lamina dura, with no significant radiographic changes in the bone crest seen during a 1-year healing period. It was concluded that bitewing radiographs showing proximal bone level following surgical crown lengthening could be used as a reference to evaluate any changes in the crestal bone level.

Arora et al., 2013 Conducted a case series to evaluate periodontal tissue changes

after 6 months following functional crown lengthening surgery and to assess different factors that can affect the gingival level stability after crown lengthening. It also tackled the conflict among previous studies on surgical crown lengthening. Contradictory results were reported regarding the stability of crown length gained at the time of surgery. For decades, the rule of 3 mm had been the cornerstone that governed alveolar bone removal during surgery. However, there was a shift in the current understanding of the different variations in supracrestal gingival tissue dimensions, customizing alveolar bone crest removal can be done based on differences in clinical parameters. Sixty-four patients who needed surgical crown lengthening were recruited. Clinical measurements were recorded across six surfaces of both treated teeth and neighboring teeth. These sites were labeled as treated sites, neighboring sites, and non-neighboring sites. Crestal bone reduction was performed based on the minimal amount of tooth structure required for restorative purposes and supracrestal gingival tissue dimensions at each treated site. Patients were reassessed at 3- and 6-month intervals. It was found that crown length, which was gained during surgery, significantly decreased 6 months after surgery, which was caused by tissue rebound. Suturing the flap =< 3 mm from the alveolar bone crest and thick-flat biotype was accompanied by a greater possibility of tissue rebound.

Schmidt et al., 2013 conducted a systematic review to evaluate the dimensions of the biological width in humans, owing to its role in maintaining periodontal health when performing restorative dentistry. Two reviewers conducted a systematic search of the literature using five electronic databases on human studies. They complemented their research by doing a manual search. They concluded that the studies varied in measurements of the biological width. From 2 meta-analyses, they obtained mean values of the biologic width (2.15 to 2.30 mm) but with a wide range of intra- and inter-individual variations ranging from 0.2 to 6.73mm. Many factors can affect the biological width, including tooth type, site, presence of restorations, and presence of periodontal diseases or surgeries. They concluded that there is no ‘’magic number’’ or universal dimension for the biological width and the necessity to establish periodontal health before assessing the biological width.

Antoniazzi et al., 2014 conducted a randomized clinical trial to monitor the periodontal dressing effects on both swelling and postoperative pain after crown lengthening surgery. Thirty-six patients were included in this study. After surgery, patients were randomly assigned to either a periodontal dressing group or the control group with no dressing. Pain and discomfort evaluation using a visual analogue scale (VAS), verbal rating scale (VS), and the number of analgesics consumed up to 1 week postoperative. Post-operative infection and marginal stability of gingiva were also evaluated. It was concluded that the use of periodontal dressing seemed advantageous after surgical crown lengthening. However, it was recommended to prescribe adequate post-operative analgesics to mitigate the possibility of strong pain, especially the day after surgery.

Gomes Tortoriello et al., 2016 conducted a case report to explore the possibility of performing the restorative procedure within the same visit of surgical crown lengthening. This provided an alternative procedure to enable the restoration of teeth immediately after surgical crown lengthening instead of the conventional technique, which involved delaying the restorative procedure for 6 weeks. The treatment plan involved surgical crown lengthening and modifying the alveolar bone crest level on the

buccal surface of the tooth, followed by rubber dam isolation, composite resin restoration was used to restore the cavity, followed by suturing in the same session. 7- days after surgery, removal of the sutures was done. The authors concluded that using this technique was viable and fast, with satisfactory outcomes, restoring function and esthetics for the patient.

Nobre et al., 2017 conducted a systematic review with meta-analysis to assess the impact of surgical crown lengthening on the clinical parameters in adjacent and non-adjacent sites compared to surgical sites. An electronic search was commenced across different databases from 1978 to 2015. Qualitative and quantitative data synthesis was made. Measuring clinical outcomes, including clinical attachment level and probing depth, were the primary outcomes measured. Four case series studies were included, and three were in the meta-analysis. All studies showed a high risk of bias. The surgery induced significant changes in treated, adjacent, and non-adjacent sites. There were greater changes in Pocket Depth. It was concluded that the surgical crown lengthening procedure can cause changes in clinical parameters in treated, adjacent, and non-adjacent sites, which should be considered while planning the surgical procedure.

Al-Sowygh, 2019 conducted a systematic review and meta-analysis to question the significance of surgical crown lengthening in achieving stable restorative treatment outcomes. Out of the five studies, two reported considerable tissue rebound following SCL. After six months, the tissue rebound had not completely stabilized. According to one study, the bone level must be decreased during SCL To reestablish the BW and put the prosthetic margin. Two studies found that when osseous resection was combined with an apical positioning flap, the clinical outcomes were more stable than in the control group. The systematic study concluded that there is still disagreement over whether SCL causes gingival rebound, restores biological width, or modifies clinical attachment.; However, to accurately evaluate the restorative outcomes of SCL, higher caliper randomized controlled trials with longer-term follow-up times are advised because of the significant danger of bias.

Yadav, 2021 conducted a literature review in which subgingivally extended dental carious lesions frequently infringe both junctional epithelium and supracrestal connective tissue attachment, which causes a clinical challenge. He mentioned two strategies to treat such a condition, either surgically by apical displacement of the supporting tissues or restoratively by relocating the margin to a supragingival location.

III. Tackling deep marginal acquisition

Dietschi D and Spreafico R., 2018 Proposed a cervical margin relocation of subgingivally extended margins, which was later modified in 2012 by Magne and Spreafico into deep marginal elevation. They proposed elevating subgingivally extended margins using direct composite restoration. While acquiring the cervical margin using a circumferential matrix, this technique was intended to facilitate impression-taking for indirect restorations by elevating the deep margin into a more supragingival location.

Frese, Wolff, and Staehle 2014 proposed a new technique for acquiring deep margins using Elektrotom. They conducted a case report to evaluate a new technique for exposing deep subgingival carious lesions, violating the biological width. A flowable composite was used to build up the first step to facilitate the rubber dam placement, then

finalizing the restoration after rubber dam placement. They concluded that the R2 technique could be a viable option in the restoration of deep subgingival interproximal carious lesions while maintaining strict oral hygiene measures.

Oppermann et al., 2018 compared the impact of resin restorations placed supra-gingivally vs impinging periodontal biologic width (PBW). They conducted their study on ten patients with at least two contralateral posterior teeth in need of proximal sub-gingival restorations. The test group (TG) (impingement of PBW with trans-surgical restorations) and control group (CG) (supra-gingival restorations after crown lengthening) were randomly assigned. The results of their study were that there was no statistical significance in using any of both techniques showing privilege of TG in visual plaque VP with 15% to 20% in CG and PDL probing depth PPD with 1.8mm to 2.5 in CG and clinical attachment loss CAL with 0.6 mm to 2.2 mm in GC while GC has privilege in Bleeding on probing BOP with 5% to 20% in TG. Authors attributed these results to the fact that with the presence of full crowns or amalgam restorations, the presence of pathogenic bacteria is commonly reported. This was reduced with composite due to its adhesive nature. They explain that their results differ from other studies owing to their study design (split Mouth), oral hygiene habits (controlled in methodology), and the presence of risk factors systemic or periodontal (controlled in inclusion and exclusion criteria). So, they concluded that proximal bonded restoration infringing on the periodontal biological width may not require clinical crown lengthening.

Venuti P. DDS. and Mirabella Eclano., 2018 conducted a review article about technical challenges involving subgingival cavity margins generated in restorative dentistry. Whether restoration is either direct or indirect, soft tissues can be an obstacle while facing deep margins. The author proposed a new classification with different approaches to acquiring deep subgingival cavity margins, including soft tissue retraction using a rubber dam, retraction cord, and Teflon tape. The second category includes soft tissue ablation, by using a blade, diode laser, electrosurgery, or soft tissue burs (Thermacut burs) which is a bur with no abrasives to ensure the cutting of the papilla and exposing the margin without the risk of damaging tooth surfaces, the third category includes Surgical crown lengthening (SCL), and lastly dental tissue elevation either by orthodontic extrusion or surgical extrusion technique (SET).

Ferrari et al., 2018 conducted a 12-month RCT to evaluate the influence of DME on periodontal health. Thirty-five patients with healthy periodontium vital teeth with deep proximal margins were selected. One week following prophylaxis and hygiene measures. Two calibrated and experienced operators recorded PPD, PI, GI, and BoP. The decision on whether to perform DME (Group 1) or place the indirect restoration margin directly to the deep dental structure. DME was done after fitting a matrix to the cervical margin of the tooth. After using the G-Premio bond to hybridize the dentin, a universal flowable resin composite was applied in 2-3 thin layers, and then final cavity preparation and impression of the cavity were done and sent to the lab to receive restoration. They found that DME had an increased BoP score compared to shoulder preparation, while other indices weren't statistically different between the two groups. They concluded that higher BoP is expected around DME vs deep margins and that it is a key technique-sensitive procedure.

However, Felemban et al., 2023 carried out a systematic review and meta-analysis with a

primary focus on the impact of deep margin elevation on the periodontal tissues. Online resources such as Embase, The Cochrane Library, MEDLINE-PubMed, and Google Scholar were used to conduct literature research. The search was conducted from 2010 and 2023. The keywords and MeSH terms that made up the search terms were "deep margin elevation," "coronal margin relocation," "periodontium," and "periodontal tissues." Twelve papers in total, including one randomized clinical trial, three systematic reviews, two prospective cohort studies, three case series, one clinical study, one pilot research, and one retrospective study, were chosen and examined for inclusion in the systematic review. It was concluded that Deep Margin Elevation (DME) is less intrusive than surgical crown lengthening, and the review raises potential benefits for DME. However, definitive impacts on periodontal tissue are still unknown, and additional research on clinical parameters and inflammatory biomarkers is required to validate the review's conclusions.

IV. Periodontal Tissue response to restorations

Lang, Kiel, and Anderhalden carried out a crossover RCT study in 1983 to find out if the sub-gingival microbiota changes when sub-gingival restorations with overhanging edges are placed. Nine dental students who had clinically healthy gingivae and spotless teeth gave their permission to take part in the study. Five MOD-cast gold onlays with 1 mm proximal overhanging borders were inserted into mandibular molars. Five identical onlays with clinically flawless margins took their place in a crossover configuration, acting as controls. Another five onlays were placed in reverse order in the remaining patients. Subgingival microbiological samples were taken before and every two to three weeks following placement. This was accomplished by puncturing the gingival sulcus next to the restoration for thirty seconds with a fine, sterile paper tip. They discovered that a subgingival flora closely resembled chronic periodontitis was established after restorations with overhanging margins were placed. Black-pigmented Bacteroides, higher anaerobe-to-facultative ratios, and higher proportions of gram-negative anaerobic bacteria were observed. There was a microbiota indicative of gingival health or early gingivitis after the restorations with clinically excellent margins were placed. Very few instances of Bacteroides with black pigmentation (1.6-3.8%) were found. Regardless of whether the restorations with the overhanging margins were implanted during the experiment's first phase or after the crossover, these changes in the subgingival microbiota were evident. Clinically, the locations where overhanging edges were positioned showed rising gingival indices. Therefore, to prevent chronic periodontitis and preserve gingival health, the authors advised against having overhanging restorations.

Santos et al., 2007 compared the use of RMGI (resin-modified glass ionomer) and Micro-filled Composite in the treatment of non-carious cervical lesions followed by CPF (Coronal positioning flap). The results of their study were that there was no statistical significance in using any of both materials, the factor that favored the use of RMGI was the quality of plaque formed on the restoration didn’t contain F. nucleatum polymorphum, which can be suspected periodontal pathogen. The reason for such results, as speculated by authors, was due to fluoride and aluminum release and the polishability of the restoration, which hinders plaque accumulation; also, the clinical performance of MC (Micro-filled composite) was accepted due to the polishability of the material.

Carvalho et al., 2018 conducted a randomized controlled clinical trial to assess the periodontal tissue response to RMGIC and

Nano-Filled Composite resin in the treatment of non-carious cervical lesions (NCCL) at baseline, three and six months. They recruited Twenty-one patients with bilateral NCCL (Split Mouth) in canines and pre-molars and with healthy periodontium. Using the William probe, probing depth, relative gingival recession, and relative clinical attachment level were collected from the labial surface of the tooth with the incisal edge as a reference since CEJ is lost within the NCCL, plaque and gingival indices were assessed using WHO probe by two calibrated operators. Both groups underwent initial prophylaxis treatment. Then, without any cavity preparation, a third operator isolated the lesions using a retraction cord and cotton rolls. Only 18 patients were evaluated (Split Mouth). They found no statistically significant difference in any of the indicators between the two restorations. They concluded that the restorative material didn't influence the gingival behavior, provided that adequate finishing and polishing was done to the restoration in a healthy periodontium.

Al Habashneh et al., 2019 conducted a randomized clinical trial where they compared gingival health when calcium silicate-based cement (Biodentin) was used to restore cervical carious lesions vs Glass-ionomer cement. Twenty-eight patients were recruited with good general health and good oral hygiene. Smokers and pregnant females were excluded. Participants were randomized into 2 groups of 14 by flipping a coin. Group 1 received GIC restorations, and Group 2 received Biodentin. Baseline records were taken before restorations; Probing pocket depth, Gingival Index, Plaque Index, BoP, and Gingival recession were recorded after scaling and hygiene instructions. Cavities were prepared minimally, and for hemostasis, a moist cotton pellet was applied using pressure. No rubber dam isolation was done, and restorations were placed according to the manufacturer's instructions. The same records were taken after 4, 12, and 24 weeks. The Plaque Index, Gingival index, and Probing Pocket Depth values were significantly higher in the Biodentin group. This could be attributed to its relatively long setting time (20 minutes), where surface loss and irregularities would occur. This happens due to the location and difficulty of isolating cervical cavities. Glass ionomer would provide restoration with good marginal adaptation, less surface roughness, and fluoride release. This fluoride release would interfere with bacterial adherence. The authors recommend avoiding Biodentin in cervical restorations due to its shorter longevity, higher cost, technique sensitivity, time consumption, and, most importantly, its adverse effect on gingival health.

V. Conclusions:

For many years, the gold standard of care for interproximal carious lesions that are subgingivally situated has been functional crown lengthening. To achieve smooth bony architecture, this gold standard has certain drawbacks, such as compromising crown ratio, increasing the danger of furcation involvement, being unable to operate next to dental implants or requiring extreme difficulties, and extending bone removal to buccal and lingual portions of alveolar bone, the latent period for healing can take anywhere from six weeks up to six months. Finally, for patients who have a high propensity for bleeding. To resolve this conundrum, several minimally invasive techniques for deep marginal acquisition should be investigated and validated.

VI. Conflict of interest:

No conflict of interest.

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VIII. Credit Statement

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Abbreviations
FCL (Functional Crown lengthening)
SCL (Surgical Crown Lengthening)
CAL (Clinical Attachment Level)
PD (Probing Depth)
CPF (Coronal Positioning Flap)
VAS (Visual Analogue Scale)
VS (verbal rating scale)