Original Article

A novel soft tissue cone-beam computed tomography study in the evaluation of gingival thickness associated with subepithelial connective tissue graft versus acellular dermal matrix in the management of gingival recession: A clinical study

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Abstract:
Background: Dental esthetic awareness among patients led the clinicians to introduce newer materials and predictable techniques that satisfy the patients’ esthetic demands. Aim: To evaluate and compare the efficacy of subepithelial connective tissue graft (SECTG) and acellular dermal matrix (ACDM) allograft in the treatment of Millers Class I or Class II recession with the determination of gingival thickness using an impertinent method, soft tissue cone-beam computed tomography (ST-CBCT). Materials and Methods: A split-mouth study with a total of ten patients with bilateral Millers class I or class II recession is randomly assigned by a coin toss method as Group I (SECTG) and Group II (ACDM) along with coronally advanced flap. Clinical parameters including recession height (RH), recession width (RW), probing depth, clinical attachment level (CAL), and height of keratinized tissue (HKT) were evaluated at baseline, 90th day, and 180th day for both groups. The thickness of keratinized tissue (TKT) was determined by most reliable, predictable and noninvasive method called ST-CBCT. Results: Statistically significant reduction in RH and RW, gain in CAL, and increase in HKT and TKT in both Group I and Group II were seen in 90th day and 180th day. However, when both Group I and Group II were compared between 0 and 180th day, the change in RH and RW, gain in CAL, and increase in HKT and TKT did not show any statistically significant change. Conclusion: The present study suggested that root coverage with both SECTG and ACDM is very predictable procedure and it is stable for 6 months. ST-CBCT is a newer dimension in periodontal imaging and will certainly aid clinicians in the execution of various treatment modalities with increased predictability.

Key words: Acellular dermal matrix allograft, soft tissue cone-beam computed tomography, subepithelial connective tissue graft

INTRODUCTION

Esthetics is the norm of the day. Increased awareness and economic feasibility have created more demands in the area of perioesthetics. Moreover, migration of gingival margin apically beyond the cementoenamel junction (CEJ) leads to denuded root surface, thereby resulting in hypersensitivity, marginal tissue loss, and attachment loss. Hence, procuring a predictable root coverage is a challenge to the periodontist, thereby periodontal plastic surgery becoming an integral part of periodontal practice. Various techniques with varied success rates have been proposed, namely double papilla graft, pedicle flap, coronally positioned flap and subepithelial connective tissue graft (SECTG), pouch, and tunnel technique. Among these procedures, till date, SECTG is considered the gold standard due to its dual blood supply from overlying pedicle.

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One such alternative, acellular dermal matrix (ACDM), first introduced in 1994 has been used for replacing soft tissue. It is basically cell free, but the extracellular matrix is retained. These extracellular matrix tissues are harvested from developmental human dermis and are converted into acellular, immunologically inert scaffold material. It heals by rapid revascularization, repopulation and then remodeled to patients own tissue rather than leading to scar formation. Acellular Dermal matrix (ACDM) is a structurally intact connective tissue matrix composed of Type I collagen. As it lacks the immunological components such as major histocompatibility complex, which is instrumental in rejection, and other inflammatory reactions, it is considered immunologically inert. In periodontal surgery, the first report of its use was elicited for increasing the width of keratinized gingiva and root coverage. Recently, the use of an ACDM has been reported with favorable clinical outcome in the coverage of denuded root surface with a range of mean root coverage of 86%. Of the many factors affecting the success predictability, tissue biotype is one of the critical factors which has a huge impact on the thickness of gingiva in the faciopalatal dimension. For predictable root coverage, a flap thickness of 0.8–1.2 mm is proposed. The term periodontal biotype was introduced to classify gingiva into thick-flat and thin-scalloped biotypes. A gingival thickness of <1.5 mm and >2 mm is considered as thin and thick biotype, respectively.

Gingival thickness can be estimated directly by visual study or many invasive and noninvasive methods which have been proposed in the literature. These include direct measurements, probe transparency (TRAN), ultrasonic device, transgingival probing by endodontic spreader, and most recently a novel method, soft tissue cone-beam computed tomography (ST-CBCT). Fu et al. reported that CBCT could be a more objective method to visualize and measure thickness of both hard and soft tissues than direct measurements. Normal CBCT evaluated measurement of distance of the CEJ to facial and bone crest. However, in contrast, ST-CBCT determined the measurement of distance of gingival margin to facial bone, thickness and width of facial gingiva, and measurement from CEJ to gingival margin, thus proving to be more advantageous and accurate than conventional CBCT.

This is one of the first studies to evaluate the thickness of gingiva after root coverage by ST-CBCT. Therefore, the purpose of this study was to evaluate the effectiveness of ACDM and to compare it with SECTG along with coronally positioned flap and to evaluate the gingival thickness measurement with ST-CBCT in the treatment of gingival recession in esthetic areas.

MATERIALS AND METHODS

This was a split-mouth study design where a total number of ten patients were selected from the department of periodontics. Twenty sites with bilateral Millers Class I or II buccal recession with age group between 18 and 45 years were randomly assigned to Group I and Group II. Inclusion criteria included anterior teeth or premolars with bilateral Class I or II buccal gingival recession, patients who perform optimal brushing technique, probing depth (PD) ≤3 mm without bleeding on probing, normal alignment of teeth, and patients who had not undergone any periodontal surgery for the past 1 year. Smokers, patients with any systemic disease, teeth with root caries, or teeth with any traumatic occlusion were excluded from the study.

Patients were briefed about the study and informed consent was obtained. Ethical committee approval was obtained from the university.

By coin toss method, two sites were selected in the same patient and divided into Group I and Group II for root coverage procedures. In Group I, the selected ten sites were treated with SECTG and flap advanced coronally. In Group II, the ten sites were treated with ACDM graft along with coronal advancement of flap.

All the clinical parameters were recorded from the mid-buccal point of involved tooth. Recession height (RH) which was measured as the distance between CEJ to the gingival margin, recession width (RW) the linear distance from mesial to distal extension of gingival margin at the level of CEJ, PD distance between gingival margin and the bottom of the sulcus, clinical attachment level (CAL) the distance between the base of the pocket and a fixed point on the crown such as the CEJ, width of the keratinized tissue the distance between the gingival margin and the mucogingival junction (MGJ) and thickness of keratinized tissue (TKT) which was estimated using ST-CBCT. This novel method is based on CBCT technology. Thickness of gingiva was done using ST-CBCT on the facial aspect of the involved tooth 3 mm from the gingival margin toward the facial crest of the bone [Figure 1]. All ST-CBCT measurements were gathered at Aarthi Scans, Vadapalani, Chennai. Scanning was done using Kodak 9500 cone-beam three-dimensional (3D) system. Image was visualized using Cs 3D imaging software and required measurements were obtained [Figure 2].

Surgical procedure

In Group I patients following anesthesia with 2% lignocaine (plus epi nephrine), two horizontal incisions were made at the right angle to abutting interdental papillae without the intervention of gingival margin of adjoining teeth. Intrasulcular incision was placed at the labial aspect of the involved teeth with no vertical releasing incisions, and partial thickness flap was raised up to MGJ. The flap was then elevated apically, thereby emancipating the tension and thereby facilitating coronal advancement of the flap. De-epithelization was done to the intact distal and mesial papillae [Figure 3a and b].

Harvesting connective tissue graft

The trap door design technique was followed to harvest the donor palatal tissue. A no. 15 blade was used to make a...
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Figure 1: The gingival thickness (represented as b and c in the figure) was measured midway between the gingival margin and the facial bone crest (a-d); this was measured 3 mm from the gingival margin (a and b); perpendicular to the long axis of the tooth

Figure 2: Soft tissue cone-beam computed tomography horizontal incision 3–4 mm apical to gingival margin of the first premolar to the first molar. Mesiodistally, two perpendicular incisions were placed. The edge of the prepared palatal flap was then lifted and held using tissue forceps, and connective tissue was exposed and harvested using periosteal elevator after placing a perpendicular incision to the bone around the edge of the connective tissue. The trap door was then secured back and sutured with 3–0 black silk and a surgical stent with coe-pak was placed [Figure 4a-c].

Figure 3: (a) Preoperative clinical measurements recorded in Group I patients; (b) flap reflection done

Figure 5: (a) Connective tissue positioned and sutured; (b) flap advanced coronally and sutured

Placement of connective tissue graft to the recipient site
The procured connective tissue graft (CTG) was trimmed to remove all glandular and adipose tissues and then placed on the recipient bed. A firm pressure was applied to the graft with moist gauze pack for 2–4 min, thereby allowing the graft to adhere and adapt on to the recipient site [Figure 5a]. The graft was positioned with resorbable 4–0 vicryl suture. Then, the overlying flap was coronally advanced with no tension and secured with 3–0 black silk suture [Figure 5b].

In Group II patients, the surgical procedures were similar to Group I with the exception of use of ACDM graft as graft material instead of SECTG [Figure 6a and b]. ACDM was aseptically rehydrated in saline for 10–15 min according to the manufacturer’s guidelines [Figure 6c and d]. ACDM has a connective tissue side and basement side [Figure 6e]. The basement side should be placed adjacent to tooth and bone. The graft was positioned with 4–0 vicryl absorbable suture and the flap was advanced coronally and sutured with 3–0 black suture [Figure 6f and g].

Figure 4: (a) Incisions for trap door; (b and c) connective tissue harvested

Figure 6: (a and b) ACDM graft material; (c and d) ACDM graft rehydrated; (e) ACDM graft side

Post Surgical care
Systemic antibiotics and analgesics were prescribed. Sutures were removed after 2 weeks. All patients were instructed not

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to brush at the surgical site for 15 days initially after surgery. During this period, plaque control was obtained with 0.12% chlorhexidine solution rinse, which was used twice a day. The surgical sites were evaluated on follow-up visits postoperatively at 90th and 180th day. All the clinical parameters were again recorded by the same examiner and postoperative clinical photographs were taken at baseline (0 day), 90th day (3rd month), and 180th day (6th month) as shown in Figure 7a-d.

**Soft tissue cone-beam computed tomography analysis**

ST-CBCT of the entire maxilla was recorded to evaluate the gingival thickness at the operated site, at baseline, 3 months, and 6 months [Figure 8a and b]. At the time of CBCT scanning, the patients were asked to wear a plastic lip retractor to aid in positioning the soft tissues of the lips and cheeks away from the gingival tissue and for the tongue to remain in the oral cavity. CBCT parasagittal sections were taken to evaluate the soft tissue thickness, and the measurements were directly done through reliable tools in the software, thereby not hampering the reliability of the study.

**RESULTS**

The data collected were analyzed statistically to find the mean, standard deviation, and tests of significance of mean values and parameters by Wilcoxon signed-rank test and Mann–Whitney U-test. In the present study, $P < 0.05$ was considered as the level of significance.

Tables 1 and 2 show the clinical data at baseline, 90th day, and 180th day for Group I (SCTG) and Group II (ACDM). In this study, there was a significant gain in RH, RW, CAL, height of keratinized tissue (HKT), and TKT in both Group I and Group II from baseline to 90th day and 180th days [Tables 3 and 4]. On intergroup comparison, RH and RW showed a statistically significant reduction with $P = 0.005$ from baseline to 90th day [Table 5]. However, at 180th day, the mean change of RH and RW was not statistically significant with $P = 0.177$ and 0.062, respectively [Table 6]. The mean change of HKT did not show any statistically significant results in 90th and 180th days [Tables 5 and 6].

On comparison of CAL from 0 to 90th day between Group I and Group II, it was statistically significant with $P = 0.002$ [Table 5], but on 180th day comparison, it did not show a statistically significant reduction with $P = 0.749$ [Table 6]. There was not much statistically significant difference in TKT from baseline to 90th day with $P = 0.376$ and baseline to 180th day ($P = 0.179$) on intergroup comparison [Table 7].
DISCUSSION

Gingival marginal recession remains a highly pervasive problem for its impact on both hypersensitivity and esthetics. Over the years, surgical coverage of recession is a potentially useful therapy as it is more predictable and several techniques have already been described in the past decade with varying degrees of success. High levels of vascularity in the form of dual blood supply from both graft and overlying flap make SECTG still the most reliable and predictable graft for root coverage.[4,7,10] However, the risk of necrosis, postoperative pain, and hemorrhage due to an additional palatal donor site causes great discomfort to the patient. Moreover, less volume of the tissue limits its application to treat multiple recession defects. Thereby, it led to the introduction of an alternative material Alloderm (ACDM), which provided a comparable result to SECTG with increased HKT, gingival thickness, and complete root coverage. Alloderm has advantages such as decreased postoperative morbidity, no need of second surgical site, unlimited supply of the graft, shelf life of 2 years, nonimmunogenic, available in various sizes, and saves time for the clinician and the patient.[47,48]

The results from this study showed ACDM group to be equivalent to SECTG group in terms of reduction in gingival recession and the amount of root coverage with a gain in height and TKT; thus, our results are in accordance with previous studies.[14,19-21]

In this study, reduction in the RH and RW at 3–6 months in the Alloderm group could be attributed to the movement of the gingival margin coronally on the denuded roots following tissue grafting. The creeping attachment described by Matter and Cimasoni is a result of healing of soft tissue grafting, which starts at 1 month after grafting and up to 1 year.[23] Harris referred 0.85 mm creeping attachment through SACT following 1 year[4] and Pini Prato et al. reported a creeping attachment of 0.43 mm through the coronally advanced flap[23] whereas Woodyard et al. (from 2 to 6 months) and Henderson et al. (from 2 to 12 months) using Alloderm did not show any creeping attachment, thus indicating a high amount of coverage only at the beginning with no more additional healing after 2 months.[11,12] Although there is no report of creeping attachment using Alloderm in other studies, the only reason of the increase in root coverage in this study should be linked to creeping attachment.

A major portion of ACDM graft is made of collagen that enhances fibrin linkage, increases chemotactic activity for fibroblasts, and induces platelet attachment.[11,49] This could be
At the histological level, ADM-treated sites show an inflammatory reaction akin to a foreign body reaction. It is said that the tissue that forms following Alloderm grafting is akin to a scar tissue as it is a nonvital graft taken from a genotypically different person and this results in its inability to transform into keratinized epithelium and may result in a scar-like tissue, leading to wound contracture.

However, contrary to the above-mentioned studies, a significant increase in the HKT was observed in both groups in the present study, but in both the groups, when compared at 180th day, there was no statistically significant difference between the two groups and these results were consistent with those reported by few studies. It is clear that following the insertion of SCTG under the coronal flap, the connective tissue would be able to induce epithelial cells for keratinization, but Alloderm keratinization is not clear. Harris et al. 2004 reported that CTG epithelization occurs when taken from keratinized donor sites and ACDM also showed the same induction mechanism as it has been taken from keratinized donor skin. Therefore, that possibility cannot be ruled out and could be the reason for the observed results seen in our study.

A significant increase in the TKT was observed in both groups in the present study. However, when both the groups were compared at 180th day, there was no statistically significant difference in TKT between the two groups. The results obtained are in line with that of Paolantonio et al. and Aichelmann-Reidy et al. The increase in the thickness might be due to biological interaction of the ADMA graft and the flap. The fiber-rich mesenchymal tissue of ADMA allows for revascularization and regeneration of connective tissue.

Tissue biotype is considered a major risk factor for buccal recession. Therefore, knowledge of thickness of soft tissue is imperative. Assessment of gingival thickness is limited to clinical examinations (transgingival probing). Some studies have applied CBCT for the measurement of soft tissues such as the thickness of buccal or lingual gingiva. Moreover, ST-CBCT possesses the capability to collimate the X-ray beam to the desired area of interest, thereby reducing the patient’s exposure to radiation, with less scanning time. Hence, this tool is more advantageous compared to other imaging modalities.

This is the first attempt to evaluate soft tissue thickness using ST-CBCT in root coverage procedures. According to the present study findings, improvement in clinical parameters with ACDM is comparable to SCTG. An expressive improvement has been achieved with ST-CBCT, a reliable resource for diagnostic and therapeutic treatment plan purpose, which allows viewing three-dimensional images of the tissues. Studies have proven that ST-CBCT is accurate in measuring soft tissue thickness to the extent of 0.1 mm. Similar results were found by Moudi et al. in 2019. Minimal sample size may be the limitations of our study. However, further comparison of ST-CBCT with clinical and conventional methods using larger sample size is needed to prove this effect.

CONCLUSION

Our study confirms the application of ACDM as an alternative to SCTG in the treatment of gingival recession, since it minimizes the patient’s morbidity. This novel, noninvasive soft tissue CBCT tool, for gingival thickness assessment, can be used as an adjunct for periodontists in improving periodontal therapy and reducing its concerned risk factor.

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Conflicts of interest
There are no conflicts of interest.
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