

水雷射與數位微笑設計 (DSD) 於美容牙科應用

- 從理念到實現 -



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引言

現代社會大眾對於牙醫的需求不僅僅是功能取向而已，越來越多人追求的目標是一口整齊迷人的笑容，美觀的笑容不僅是社交必備工具外，更是建立自我自信的來源！但在臨床常常會遇到醫師、病患與技師之間常常溝通不良，不知道彼此需要的是什麼而造成治療的結果不能滿足三方彼此的需求，耗時且花費用！現在可以透過數位微笑設計 (Digital Smile Design) 在電腦上做設計在轉移成蠟型然後於病人口內實際模擬，透過視覺化的溝通讓醫師、病患及技師瞭解是不是病患所期待的，同時可以提早檢視治療計畫正不正確！這就是所謂理念的部分，實際臨床治療可以透過顯微鏡高倍率下備製貼片、牙冠邊緣及清除多餘黏膠及搭配水雷射精準地達到軟硬組織的修形以達微創目的。水雷射具有滅菌、傷口創傷小恢復快、術後不需縫線且無痛舒適等好處，不僅病人接受度及舒適度大幅提昇外且能微創、精準地實現治療計畫，從理念到實現重建滿意笑容。

臨床案例

25歲女性矯正治療完不滿意門牙不美觀
臨接面樹脂填補及左上正中門齒與右上
正中門齒大小不一致。(Fig.1)

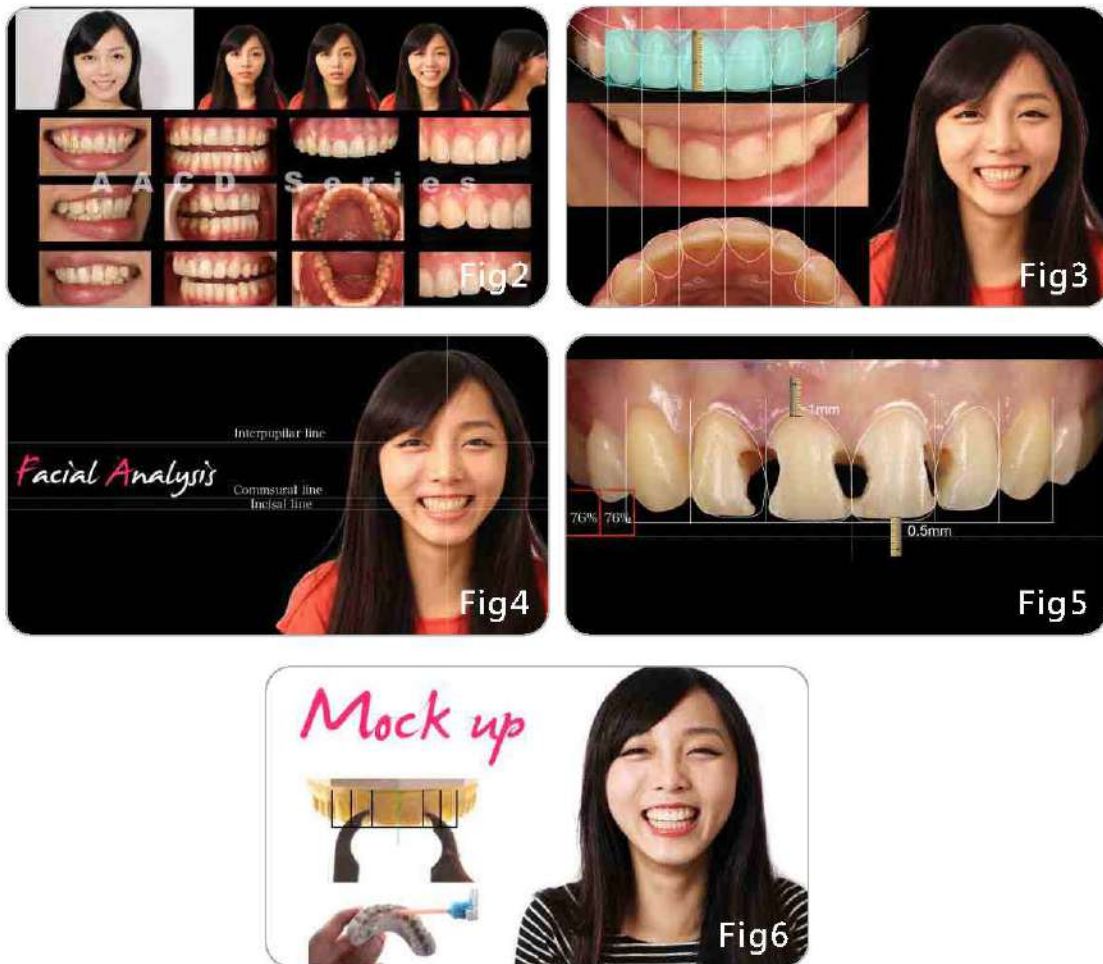
Step.1 數位微笑設計

數位微笑設計 (Digital Smile Design) 是由巴西醫師Christian Coachman所創立的觀念，許多人都誤解DSD是一個軟體，其實DSD是一個將溝通視覺化的概念，可利用Keynote、PowerPoint或Photoshop完成線條設計以用來作為跨科整合治療、與病患及技師溝通的工具！設計的出發點是以臉部為導向的治療計畫



(Facial Driven Treatment Plan) ，設計出與臉部和諧的笑容，而不僅僅著重於口腔。

此病例先透過攝影棚高品質影像收集口外及口內影像資料 (Fig.2) DSD分析臉部水平線與咬合平面及臉部中線與上頷中線彼此平行無偏移後 (Fig.3 Fig.4) 分析兩顆正中門齒長寬比，發現其右上正中門齒需牙冠增長1mm，左上正中門齒長度需增長0.5mm才能達到大小一致 (Fig.5) ，透過事前的分析就是可以很明確的與醫師病患溝通問題何在、需要牙冠增長多少及告知技師之後修復物實際長度與寬度等詳盡的溝通，技師在依照所設計的模擬圖製作出診斷蠟型，再利用臨時修復材在口內實際模擬讓病人感受整體美的改變及驗證治療計畫是否正確 (Fig.6)



Step.2 鉅雅各雷射牙美觀牙冠增長術

鉅雅各雷射 (Er: YAG Laser波長 2940nm , LiteTouch, Syneron Israel) 此波長的吸收光譜峰值波長位在水及HA(hydroxyapatite)附近，於硬組織作用原理為牙釉質、齒槽骨內含的水吸收雷射能量後溫度急速上升，液體瞬間汽化產生微爆破效應及HA吸收雷射能量後融化，在利用水分子微爆破效應將HA碎片化以達修形硬組織之目的;對於軟組織的作用機制則是利用軟組織內的水份爆破達到切割目的。利用Er-YAG

Laser根據DSD設計調整右上正中門牙軟組織牙齦尖端 (Zenith) 正確高度及修整底下齒槽骨建立適當生物寬度 (Fig.7.8)

功率設定：

Gingivectomy:2w,50mJ,40Hz,100% waterspray(局部麻醉下)

Osteoectomy:3.5w,100mJ,35Hz,100% waterspray



Step.3 顯微陶瓷貼片重建笑容

移除臨界面原有樹脂後，利用Er-YAG Laser移除深部齲齒，使用Er-YAG Laser可以達到滅菌、封閉牙本質小管、移除Smear layer及利用微爆破效應與HA融熔創造許多微小孔洞以取代磷酸酸蝕劑，大幅減少病人術後敏感不適、降低牙髓感染風險及增加粘接流程的成功率。

移除深部齲齒後先利用樹脂修復臨界面窩洞，然後在顯微鏡下進行貼片磨製 (Fig.9)、高倍率下邊緣精修 (Fig.10)、二矽酸鋰陶瓷貼片製作 (Fig.11)、貼片粘接及粘接後黏膠清除流程，精準的控制每一個細節以達微創之目的。病人術後得到滿意的笑容，軟硬組織皆呈現理想健康的狀態 (Fig.12 Fig.13)





結論

完美微笑的重建需要跨學科知識的整合及善用各項工具來進行最小侵入性治療 (Minimally Invasive Treatment) 並達到令人滿意的成果。從DSD理念為出發點，透過視覺化的溝通讓醫師、病患及技師間的溝通更為直接，讓彼此了解想要及需要，最重要的是能事先驗證治療計畫是否正確，能否滿足病患的需求！鉅雅各雷射能精確地掌握軟硬組織的處理，以達滅菌、傷口小恢復快、不需縫合、病人舒適度及接受度高等優勢並在顯微鏡放大視野的幫助下控制臨床備牙、修復體製作、粘接及清潔等步驟，從理念到實現重建口腔軟硬組織健康及建立病人自信的笑容。

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Management of severe gingival recession using a double papilla connective tissue graft: A 2-year follow-up case study

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前言摘述 (中文摘要版)

嚴重牙齦萎縮之雙乳突瓣併結締組織移植治療： 兩年追蹤病例報告

Management of severe gingival recession using a double papilla connective tissue graft: A 2-year follow-up case study

發表於《Clinical Advances in Periodontics》(美國牙周病學會期刊, 2025)

本病例報告探討一名30歲女性因長期以指甲摳抓牙齦而造成下顎犬齒7mm深、5mm寬之嚴重牙齦萎縮。經衛教與行為矯正後，採行「雙乳突瓣合併自體結締組織移植」(Double Papilla Flap + Subepithelial Connective Tissue Graft, DPF+SCTG)進行治療。手術後達成近乎完全的根面覆蓋，角化牙齦由1mm增至6mm，且牙齦厚度顯著提升。以超音波檢測確認移植組織整合良好，術後兩年追蹤期間，即使病患在中途曾因習慣復發造成輕度再萎縮，仍觀察到「creeping attachment (牙齦自然再附著)」現象，最終維持穩定且美觀之結果。

本研究顯示，DPF+SCTG對於單牙深且寬的牙齦萎縮具有高預測性與長期穩定性，能有效兼顧美觀與功能；同時強調病人行為控制與術後維護為成功關鍵。研究亦示範超音波為非侵入性軟組織評估工具，可客觀監測移植癒合與厚度變化。此案例提供嚴重牙齦萎縮治療之臨床參考，凸顯在高難度個案中，自體結締組織移植仍為兼顧美觀與長期穩定的重要選項。

CASE STUDY

Management of severe gingival recession using a double papilla connective tissue graft: A 2-year follow-up case study

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Abstract

Background: This case study presents the treatment of a 7 mm deep and 5 mm wide RT1 gingival recession on the mandibular left canine in a 30-year-old systemically and periodontally healthy female, with the defect being associated with a self-injurious habit.

Methods: Following counseling, self-injurious habit cessation, and oral hygiene reinforcement, a double papilla flap (DPF) plus subepithelial connective tissue graft (SCTG) procedure (DPF+SCTG) was performed. After de-epithelialization of the gingival margin, horizontal and vertical incisions were made, and a partial-thickness DPF was elevated. The SCTG was placed at the cemento-enamel junction level and covered by the DPF.

Results: Nearly complete root coverage was achieved, with recession depth reduced to 1 mm and keratinized tissue width increased from 1 mm to 6 mm. Ultrasound imaging confirmed successful graft integration and thick gingiva. At 2-year follow-up, creeping attachment was observed after the patient discontinued the self-injurious habit, despite a prior recurrence that had caused additional trauma. The successful surgical outcome resulted in patient satisfaction, plaque control improvement, and prevention of further recession, benefiting the ongoing orthodontic treatment.

Conclusions: DPF+SCTG is an effective approach for treating an isolated deep and wide RT1 recession, providing long-term benefits, particularly when combined with behavior modification in patients with self-injurious habits.

KEYWORDS

case study, gingival recession, plastic surgery procedures, self-injurious behavior, surgical flaps, tissue transplantation, ultrasonography

Key points

- **Technique choice and patient behavior management:** The combination of double papilla flap and subepithelial connective tissue graft effectively achieved significant root coverage and increased keratinized tissue width in a patient with self-injurious habit. However, patient behavior management was crucial in preventing recurrence.
- **Long-term stability and creeping attachment:** Despite a relapse due to the patient's habit, the thickened gingiva facilitated natural healing through creeping attachment, reinforcing the importance of both surgical intervention and behavioral modifications in maintaining long-term stability.

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- **Ultrasound for non-invasive monitoring:** Ultrasound imaging confirmed successful graft integration and determined tissue thickness, highlighting its potential as a non-invasive periodontal healing monitoring tool.

Plain language summary

Gum recession is a common condition where the gum tissue pulls away from the teeth, exposing the roots and making them more prone to damage. This report describes the treatment of a 30-year-old woman who had severe gum recession on her lower left canine tooth, caused by her long-term habit of scratching the gums with her fingernail. To restore the lost tissue and protect the tooth, a double papilla flap (a surgical technique that moves nearby tissue) along with a connective tissue graft (transplanted tissue from the roof of the mouth) was used. Over 2 years, the recession was reduced by almost 90%, and the tissue over the tooth became healthier and stronger. Although her habit caused some recession to return, the thickened tissue allowed for natural healing once she controlled her habit again. This case highlights how proper surgical technique selection and execution, combined with patient behavior changes, can successfully treat severe gum recession. It also demonstrates how ultrasound imaging can be used as a non-invasive tool to monitor soft tissue healing over time.

INTRODUCTION

A 30-year-old female presented to the Ohio State University (Columbus, Ohio) School of Dentistry Graduate Periodontology Clinic, in November 2022. She reported noticing “receding gums” on her mandibular left canine and planning to undergo orthodontic therapy.

Medical and dental history

The patient relayed having orthodontic treatment at age 15 and currently taking anti-anxiety medication. She denied smoking, any systemic disease, or periodontal disease history.



FIGURE 1 Clinical presentation of gingival recession on the mandibular left canine (tooth #22) at the initial visit. Inflammation is evident at marginal gingiva.

Clinical examination

Examination resulted in diagnoses of generalized gingivitis in a reduced periodontium (non-periodontitis patient), gingival recession and thick phenotype.¹ Tooth #22 exhibited a 7 mm deep and 5 mm wide buccal RT1(B-)² gingival recession. Since the anatomical cemento-enamel junction (CEJ) was indistinguishable, the clinical CEJ was determined by referencing the contralateral homologous tooth (Figures 1 and 2).³ At the midfacial of the tooth, ~1 mm keratinized tissue width and 3 mm probing depth with bleeding on probing were present.

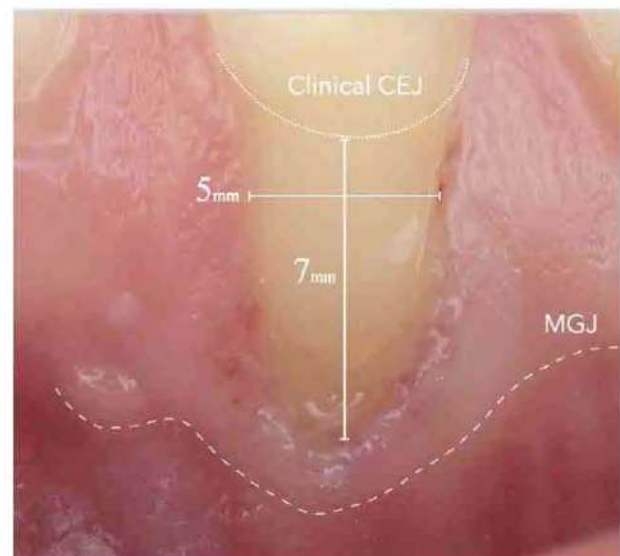


FIGURE 2 The clinical cemento-enamel junction (CEJ) of tooth #22 was determined by referencing the contralateral homologous tooth and adjacent teeth. Following CEJ determination, gingival recession dimensions were 7 mm deep and 5 mm wide (at most coronal portion). Note limited width of keratinized tissue present.

FIGURE 3 Preoperative clinical images of tooth #22. (A) Occlusal view (B) facial view: a small step was observed at the apical portion of the exposed root surface.



Etiology

The etiology was partly attributed to tooth position (rotation, prominence), possibly related to orthodontic treatment history. However, the primary etiology was trauma from habitual fingernail scratching.⁴ The patient admitted to picking at her gingiva with her fingernail whenever she felt anxious, a habit she had maintained for ~10 years. A small step was observed at the apical portion of the exposed root (Figure 3), possibly also related to the habit.

MATERIALS AND METHODS

Treatment plan

Following counseling, the patient committed to breaking her harmful habit. Oral hygiene instructions, prophylaxis, and scaling and root planing on tooth #22 were performed prior to surgery. Considering the recession depth, shallow vestibule, and limited keratinized tissue present, a double papilla flap (DPF) with a subepithelial connective tissue graft (SCTG) was proposed as the optimal treatment approach,^{5,6} to which the patient consented.

Surgical procedure

Following local infiltration anesthesia (2% lidocaine with 1:100,000 epinephrine, Lignospan, Septodont USA, Lancaster, Pennsylvania, USA), de-epithelialization of the gingival margin was performed using an internal bevel on mesial side and an external bevel on distal side (Figure 4). Horizontal incisions were then made ~1.0 mm coronal to CEJ, followed by intrasulcular incisions. Vertical incisions were placed along the line angles of the adjacent teeth, extending beyond the mucogingival junction. A split-thickness flap was elevated, transitioning to a full-thickness flap at the apical portion of the defect up to the bone crest (Figure 4). The two surgical papillae were sutured together with simple interrupted sutures using 5-0 chromic gut sutures (5-0

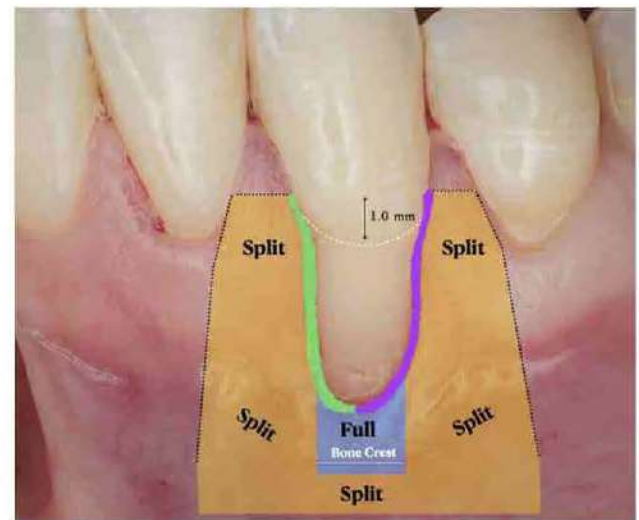


FIGURE 4 Double papilla flap design. The white dotted line represents the clinical CEJ. Horizontal and vertical incisions (black dotted lines) are outlined. Yellow shaded areas indicate split-thickness flap elevation, and blue shaded areas indicate full-thickness flap elevation. Internal bevel (green line) and external bevel (purple line) incision outlines along the gingival margin indicate area of gingival margin de-epithelialization.

Chromic Gut 687G, Ethicon, Somerville, New Jersey, USA) (Figure 5).

Meticulous root planing was performed, aiming to clean and smooth the root surface and reduce its prominence. A SCTG, 1.0-1.5 mm thick (Figure 6), was harvested from the palate using the double incision technique⁵ and then deepithelialized. Following trial positioning, the graft was precisely trimmed to fit the recipient bed and stabilized at the CEJ level with two vertical mattress sutures using 5-0 polyglycolic acid (PGA) sutures (5-0 PGA Resorbable, Osteogenics Biomedicals, Lubbock, Texas, USA) at the mesial and distal aspects, with knots placed on the lingual (Figures 7 and 8). Additionally, two periosteal anchor sutures using the same 5-0 PGA material were positioned at the apical corners of the graft (Figure 8).

A periosteal-releasing incision ensured tension-free flap repositioning, allowing complete coverage of the graft. The DPF was positioned slightly coronal to the CEJ and

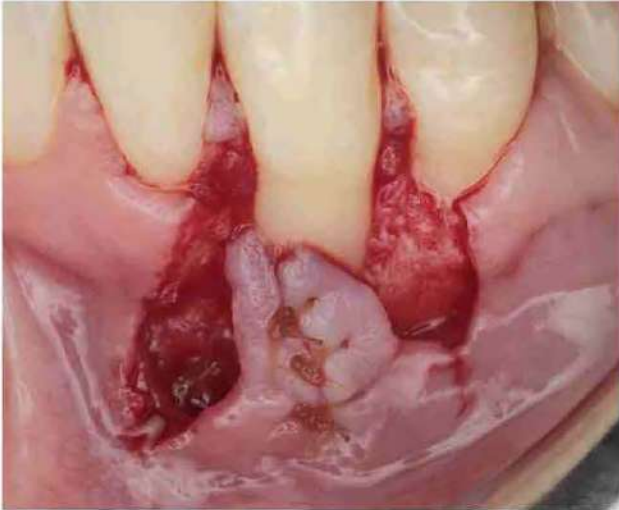


FIGURE 5 Coaptation of the two surgically created papillae and suturing with simple interrupted sutures.

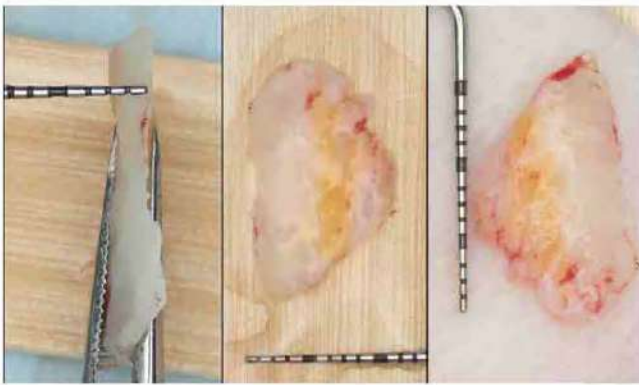


FIGURE 6 Harvested subepithelial connective graft, approximately 1.0–1.5 mm thick.

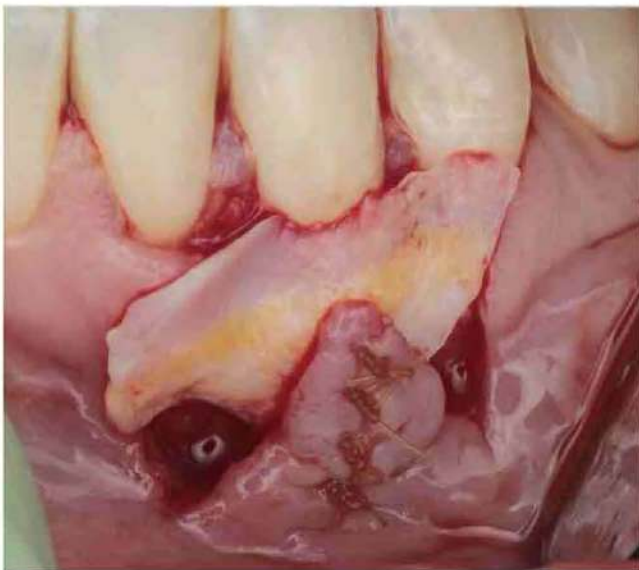


FIGURE 7 Trial positioning of the graft. Note additional simple interrupted suture, placed to secure the two papillae tips (compare to Figure 5).

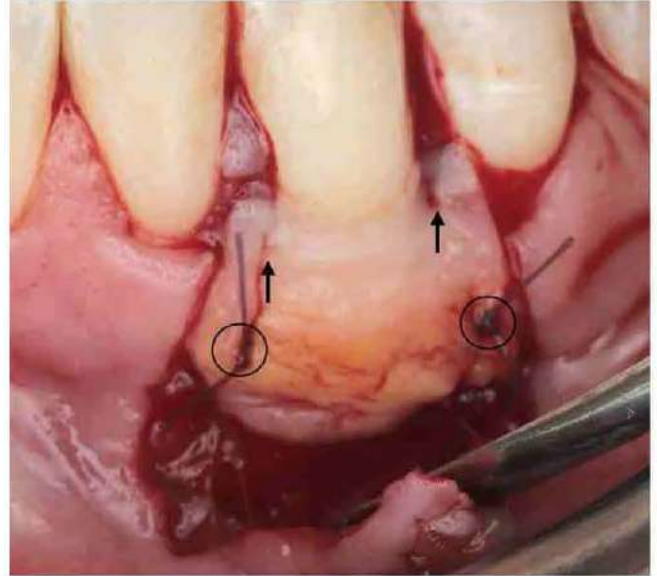


FIGURE 8 Graft stabilization at clinical CEJ level, using two vertical mattress sutures (mesial and distal; black arrows) at the coronal aspect, with knots placed on the lingual, to minimize interference with the contact between flap and graft. Two periosteal anchor sutures (mesial and distal; black circles) were positioned laterally at the apical graft area.

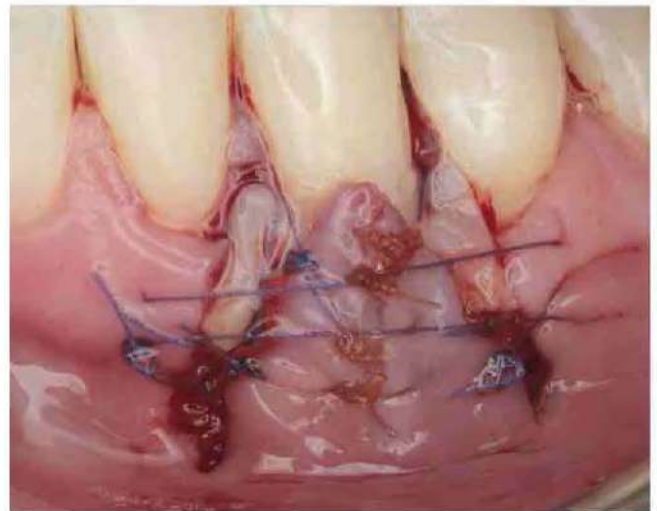


FIGURE 9 Flap stabilization. The pedicle flap was coronally advanced and secured with a sling suture. Simple interrupted sutures were placed mesially and distally to stabilize the flap to the adjacent attached gingiva. Lastly, a horizontal suture was added over the flap for additional stabilization, avoiding trauma to the flap or graft.

secured with a sling suture using 5-0 PGA sutures (5-0 PGA Resorbable, Osteogenics Biomedicals, Lubbock, Texas, USA). Additional simple interrupted sutures (same 5-0 PGA material) were placed mesially and distally to stabilize the flap to the adjacent attached gingiva, and a horizontal suture (also 5-0 PGA) was placed over the flap for additional support (Figure 9). Gentle pressure was applied with moist gauze for 5 min to minimize dead space before dismissing the patient.



FIGURE 10 Clinical images of postoperative healing course. (A) Three-week follow-up (first postoperative visit). Healing was uneventful, without complications or signs of infection. Slight erythema and edema are present. (B) Six-week follow-up. (C) Six-month follow-up. (D) Ten-month follow-up. Note the mature appearance of the tissues and the gradual blending of the flap and graft with the surrounding tissue (compare A and B to C and D).



FIGURE 11 Thirteen-month follow-up. An ulcer was observed at the gingival margin, with slight recession recurrence.

Postoperative care

The patient was instructed to avoid crunchy and solid foods for 14 days and mechanical plaque control in the area for 4 weeks, and to rinse with 0.12% chlorhexidine solution (0.12% Chlorhexidine, PerioGard® Rinse, Colgate-Palmolive, New York, New York, USA) twice daily for 1 min during the first week. Topical cleaning with cotton swab soaked in 0.12% chlorhexidine solution was instructed, until resumption of mechanical plaque control. The patient was prescribed ibuprofen (600 mg, every 6 h, as needed for pain). Normal brushing with a soft-bristle toothbrush was resumed 4 weeks postoperatively, while flossing was reintroduced at 6 weeks.



FIGURE 12 (A) Cloth glove worn by the patient during sleep to prevent unintentional scratching of the gingiva. (B) Clinical image at the 15-month follow-up, showing evidence of creeping attachment (compare with Figure 11).



FIGURE 13 Ultrasound probe placement for soft tissue assessment.

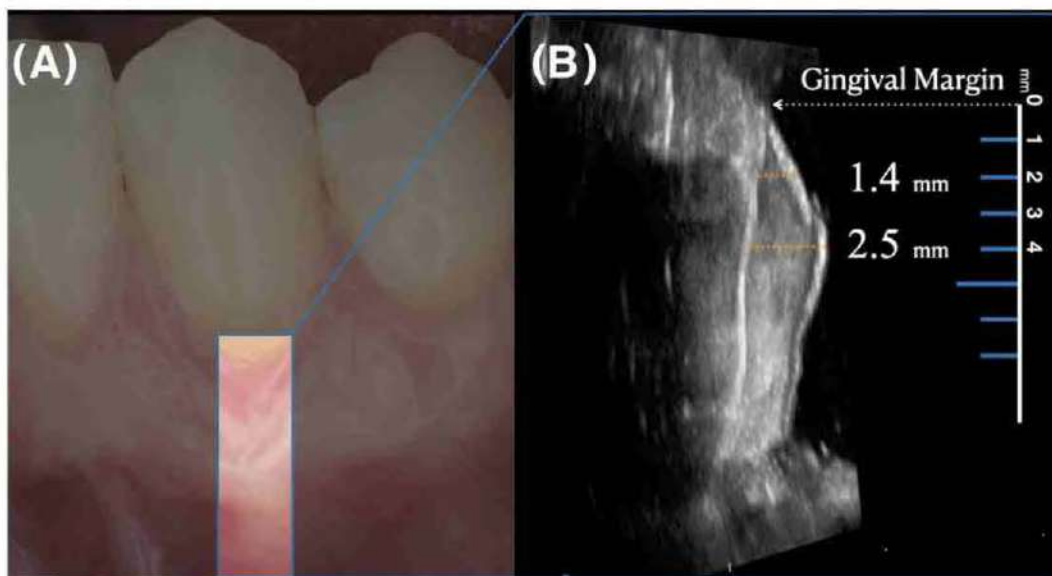


FIGURE 14 Ultrasound assessment of soft tissue thickness at the 15-month follow-up. (A) Clinical view. (B) Ultrasound image demonstrating successful graft integration and soft tissue thickness measurements of 1.4 mm and 2.5 mm at distances of 2 mm and 4 mm from the gingival margin, respectively.

RESULTS

Follow-up

The patient's first postoperative visit was delayed until week 3 (Figure 10A), due to a COVID-19 infection. At this visit, the patient reported no discomfort, healing progressed uneventfully with no complications or signs of infection, and sutures were removed. The gingival margin and areas around the sutures appeared slightly erythematous and edematous.

Between 3 weeks and 10 months postoperatively (Figure 10A–D), the operated tissues gradually blended with the surrounding gingiva and incision lines progressively faded. At 10-month follow-up (Figure 10D), the gingival tissue appeared mature, thick, and firm. However, at 13 months, an ulcer developed at the gingival margin, with a new gingival recession defect (Figure 11). The patient admitted to unconsciously picking again at her gingiva while sleeping. To minimize further damage, she decided to wear cloth gloves during sleep (Figure 12A). Scaling and oral hygiene instructions were provided at this visit. During the subsequent 2-month healing period, creeping attachment⁷ was observed, likely due to habit avoidance and increased tissue thickness (Figure 12B). At the 15-month follow-up, an ultrasound scan was performed (Figures 13 and 14). The ultrasound images confirmed successful graft integration and robust tissue thickness (Figure 14B). The recorded tissue thickness measurements were 1.4 mm and 2.5 mm at 2 and 4 mm from the gingival margin, respectively (Figure 14B). At the 18-month follow-up (Figure 15), additional creeping attachment was noted, further reinforcing the role of increased gingival



FIGURE 15 Eighteen-month follow-up visit. Additional creeping attachment and tissue maturation are evident (compare with Figures 11 and 12).

dimensions in providing long-term tissue resistance to future recession.⁸ Improved tissue contouring was also evident at this visit, further contributing to the stability and esthetics of the surgical outcome.



FIGURE 16 Two-year follow-up visit. Note tissue stability (compare with Figure 15). At the time, the patient was undergoing orthodontic treatment.

Treatment outcome

At the 2-year follow-up (Figure 16), the patient was under active orthodontic treatment, and the gingival margin remained stable, demonstrating significant improvement from baseline (Figure 17, Table 1). Treatment resulted in

TABLE 1 Clinical outcomes at 2 years, compared to baseline.

Outcome	Baseline	2 years
BOP	Yes	No
CAL (mm)	10	2
GT (mm)*	–	2.5
KTW (mm)	1	6
PD (mm)	3	1
REC (mm)	7	1

Abbreviations: BOP: bleeding on probing; CAL: clinical attachment level; GT: gingival thickness; KTW: keratinized tissue width; PD: probing depth; REC: recession depth. *Gingival thickness was measured at 15-month follow-up visit using ultrasound images, at a position 4 mm apical to the gingival margin, that is, 5 mm apical to the cemento-enamel junction.

86% root coverage, improved clinical attachment level, increased keratinized tissue width, and absence of bleeding on probing (Table 1). The patient expressed high satisfaction with both the esthetic and functional (reduced hypersensitivity, improved ease of oral hygiene) outcomes of the treatment.

DISCUSSION

This case demonstrates the successful management of a deep and wide RT1² gingival recession with DPF+SCTG. The chosen surgical approach, shown to be effective in deep recession defects,^{5,6} achieved substantial keratinized tissue gain and excellent root coverage (Figures 17 and 18).

The key factors in this case's long-term success were the proper management of the underlying etiology and the chosen surgical approach. Identification of self-injurious

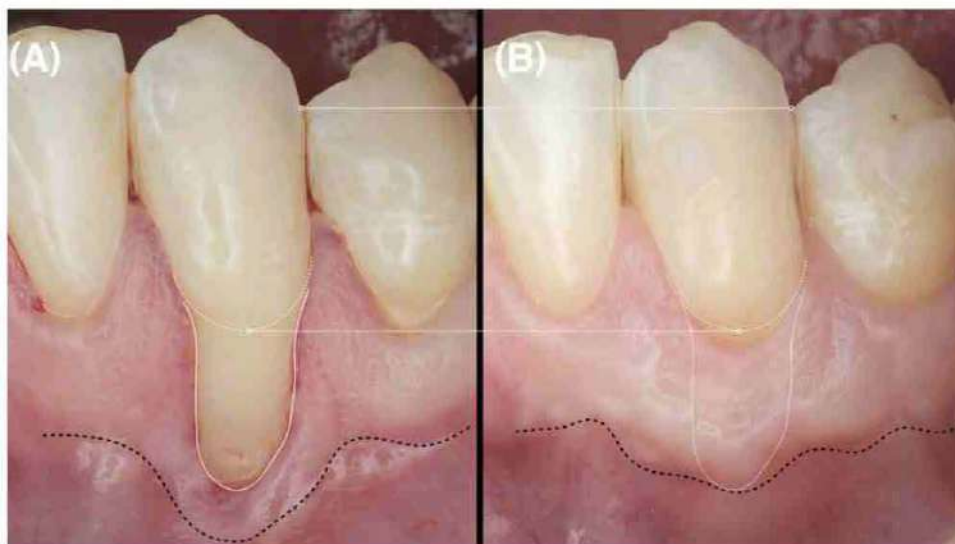


FIGURE 17 Comparison between pre-operative and 2-year follow-up appearance. (A) Pre-operative clinical image showing severe gingival recession with significant root exposure and marginal tissue inflammation. (B) Two-year follow-up clinical image demonstrating successful root coverage and increased keratinized tissue width with no evidence of inflammation. The white dashed lines indicate the clinical CEJ and its corresponding position in both images, for reference. The solid white lines indicate the outline of the recession defect. The black dashed lines represent the mucogingival junction, highlighting its relative position before and after treatment.



FIGURE 18 Clinical timeline from pre-operative to last postoperative follow-up visit.

behavior, counseling, and patient willingness to stop the destructive habit were essential in etiology management. The chosen bilaminar technique (DPF+SCTG) resulted in significant gingival thickness and width increase, factors shown to enhance dimensional stability, reduce susceptibility to recession,⁸ and promote more favorable healing compared to thin gingiva.⁹ In this case, even after trauma recurrence (Figure 11), the thickened gingiva likely facilitated creeping attachment (Figures 12B and 15) once the patient again modified her behavior (Figure 12A). This underscores the importance of both surgical planning and patient compliance in management of cases such as the present one.

Furthermore, ultrasound imaging (Figure 14) confirmed successful graft integration and increased soft tissue thickness, highlighting the potential of this non-invasive tool for assessing periodontal wound healing.¹⁰

Although the patient expressed high satisfaction with the treatment outcomes, the nature of this report (retrospective case) precluded the collection of any standardized patient-centered outcome measures. This represents a limitation of this case study.

CONCLUSIONS

DPF+SCTG applied to a severe mandibular anterior gingival recession defect achieved stable root coverage, increased gingival thickness and keratinized tissue width, and obtained an esthetic gingival contour. However, long-term success also relies on patient education and behavior modification, particularly in individuals with self-injurious habits. By achieving root coverage, DPF+SCTG also resulted in improved plaque control, reduced root caries risk, and minimization of further recession risk, which is especially important in patients, such as the one presented here, who are undergoing orthodontic treatment.

AUTHOR CONTRIBUTIONS

Yu-Chang Wu conceived the case study, contributed to case documentation and patient care through therapeutic services, and drafted and revised the manuscript. Oscar Duran-Garnica and Hsun-Liang Chan contributed to the acquisition, interpretation, and analysis of the ultrasound images. Dimitris N. Tatakis contributed to patient care through supervision of therapeutic services, critically revised the manuscript, and oversaw the completion of the report. All authors read and approved the final version of this manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are included in this article.

PATIENT CONSENT STATEMENT

Verbal and written informed consent were obtained from the patient for the treatment provided, as well as for the publication of all associated clinical information and images.

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How to cite this article: Wu Y-C, Duran-Garnica O, Chan H-L, Tatakis DN. Management of severe gingival recession using a double papilla connective tissue graft: A 2-year follow-up case study. *Clin Adv Periodontics.* 2025;1-9.
<https://doi.org/10.1002/cap.10368>

