Steiner 分析法

量化齒顎矯正治療目標，讓矯正治療不再霧裡看花

陳國強 醫師

- 國立陽明交通大學牙醫學士
- 日本大阪齒科大學齒科矯正學博士
- 美國南加州大學進階矯正學研修
- 美國Tweed Foundation研究員
- 台灣口腔矯正學會秘書長
- 特殊需求者口腔醫學科專科醫師

前言

在台灣會有自覺需要牙齒矯正而主動到門診諮詢的病患，通常不會是太簡單的病例。最常遇到的情況有兩種：第一種病患雖然顏面的下三分之一沒有明顯美觀問題，但是牙齒擁擠的程度卻非常厲害；第二種病患是雖然齒列並沒有特別擁擠，咬合關係和功能也還算正常，但是牙齒及嘴唇突出的問題卻很明顯。

以上這兩種情況並沒有哪一種比較簡單，因為解決前者牙齒擁擠問題的時候，假如直觀的只把牙齒整平(leveling)，前牙就會向外傾斜(flare out)，反而造成嘴唇突出(bimaxillary protrusion)而影響顏面美觀，時常已經過了預估的治療時間一大半之後才發現，不拔牙矯正是沒辦法達到讓患者接受的治療結果；解決後者牙齒及嘴唇明顯突出問題的時候，通常一開始就會比較明確知道要拔牙矯正幫病患內收(retraction)前牙，但是不同病患的條件跟嚴重程度又不盡相同，所以需要拔哪一顆牙齒或是門牙需要內收的量當然也不一樣！很多醫師心中永遠的痛，都是低估了患者的難度，積年累月的幫患者治療後的結果還是不盡理想，於是慢慢的對矯正治療敬而遠之，甚是可惜！

如何同時把齒列排整齊，又把齒列擺在適合這位病患顏面的前後位置，才能讓病患同時有良好的功能(function)、穩定性(stability)、美觀(esthetics)，其實在矯正的歷史上這個問題困擾著所有的醫師，所以您並不孤單，您的問題就是大家的問題！

而Dr. Steiner在側顱(lateral cephalometrics)影像技術問世之後，利用學者們的研究結果整理出不同上下顎(ANB。)關係時，適合擺放上下顎門牙的前方界線。就有如在幫病患做全口假牙重建口腔功能時，必須先決定出前牙適當的位置，以此原則所製作出的全口假牙，自然有良好的功能(function)、穩定性(stability)，而且同時帶來美觀(esthetics)的效果。

這種以終為始(Begin with the end in mind)的治療觀念，讓醫師可以僅利用測量病患的齒列模型(dental cast)和側顱分析(lateral cephalometrics)的數據就能量化病患是否需要拔牙？拔牙之後門牙需要內收多少？而後牙又能往前移動多少？這些問題自然就迎刃而解了。後人雖然稱之為Steiner Analysis，但是各位醫師大可不用拘泥於他的名字而猶豫到底要不要使用，因為即使當初沒有Dr. Steiner融會貫通的整理出此分析法，仍然很快也會有其他優秀的醫師能整理出相同觀念的分析法！

Dr. Steiner生平簡介

1968年Dr. Steiner獲頒American Board of Orthodontics (ABO) 當中的Albert H. Ketcham Memorial Award

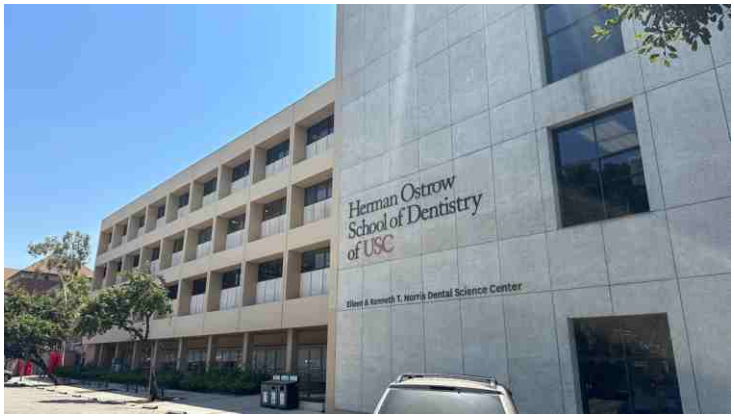
Dr. Steiner全名Dr. Cecil C. Steiner (1896, June, 6 ~ 1989, February 11, 享年97歲)，Dr. Steiner出生於加州，他的父親是農場主人，所以他青少年期大部分的時間都在農場工作，他就讀的小學和中學總共只有12位學生及一位老師，當時在班上的外號是valedictorian (畢業生致辭代表)，是因為班上想找男生致畢業辭，而他剛好是班上唯一的男生。

對於在農場長大，已經習慣在烈日下操作各式農具的Dr. Steiner，會選擇當牙醫的原因是有天他進城裡補了三顆牙齒，牙醫收了他三塊美金，相當於他工作三天的收入，但是最讓他印象深刻的是牙醫師可以穿著乾淨的白袍在乾淨的工作環境中操作著精密的器具。於是他告訴校長他想要念大學，而且未來想要當牙醫的想法，雖然他的成績並非頂尖，但是校長仍然鼓勵他並為他寫了推薦函得以順利進入大學(University of California, Berkeley)，接著在University of California, San Francisco (UCSF)獲得牙醫學位。

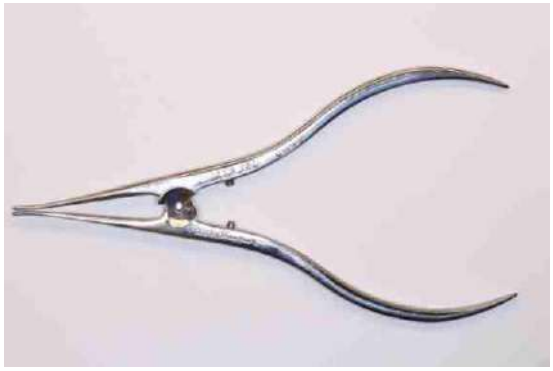
但是Dr. Steiner學習矯正之路也並非一帆風順，執業之後感到所學不足所以想申請進入Dr. Edward Hartley Angle (1855-1930) 的The Angle School of Orthodontia，但是在與Dr. Angle的面談中卻因為回答不出Dr. Angle有關於自然學家達爾文的問題而被打了回票，還好Anna Hopkins Angle (1872 ~ 1957, Dr. Angle的妻子，大家又稱為Mother Angle) 開了20本書單給Dr. Steiner 研讀，才得以在第二次會談後進入Angle

School，成為Dr. Angle的第二位學生，並在畢業後跟Dr. Angle一起從事教學及研究，之後也在University of California, San Francisco (UCSF) 及University of Southern California (USC) 教授矯正，並在世界各地教導他所設計的分析方法，如今大家稱之為Steiner Analysis。

Dr. Steiner最為著名的文章有Cephalometrics for You and Me (1953)，Cephalometrics in Clinical Practice (1959)，Use of Cephalometrics as an Aid to Planning and Assessing Orthodontic Treatment (1960)。Dr. Steiner在1968年因為對矯正界的貢獻而榮獲American Board of Orthodontics (ABO) 當中的Albert H. Ketcham Memorial Award。



Dr. Steiner也參與了University of Southern California (USC) 矯正科的成立，至今在矯正科仍然懸掛有Dr. Steiner的畫像及雕像，足以證明Dr. Steiner對其矯正科的貢獻。
（筆者攝於2025/8）

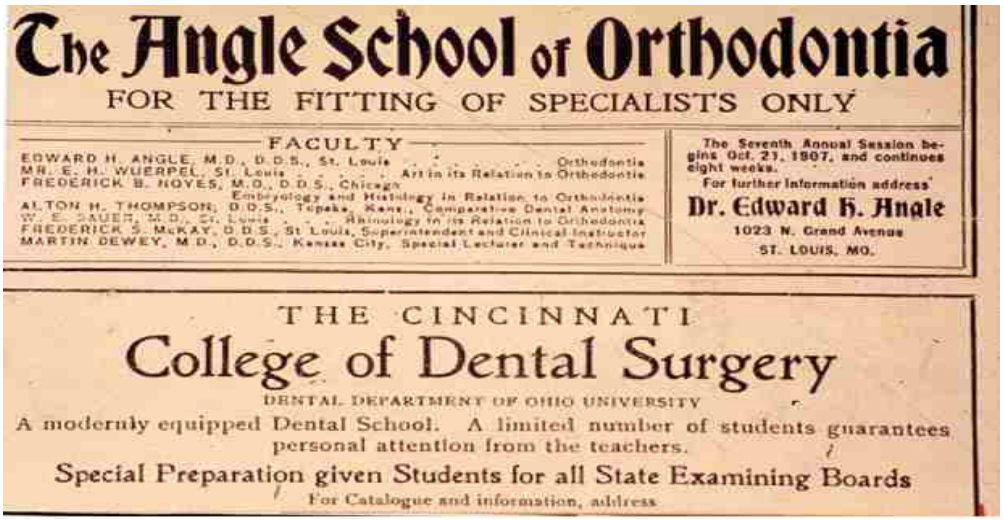


Dr. Steiner設計用來代替徒手結紮ligature wire的tying plier，所以現在稱之為Steiner tying plier

Steiner Analysis簡介

引用Steiner在Cephalometric in clinical practice文章首段給讀者的話"Do you really want to know what you are doing to your patients, or are you afraid to find out? Do you suspect that, if you did know, you might sometimes be unhappy? If you did not like what you found, would you do something about it? "

在測顱技術尚未發展的二十世紀初，即使是身為大師的Dr. Angle，治療病患時仍然要依靠經驗和美感為主的目視法：一邊治療一邊觀察病患的顏面變化，但是每個人對於美的概念卻是很主觀的。這也是為什麼The Angle School of Orthodontia的教師名單中，當代藝術家Edmund Henry Wuerpel (1866 ~ 1958, 美國畫家、長期教育家，也是聖路易斯華盛頓大學附屬聖路易斯學院和美術館的第二任館長，推廣色調主義Tonalism) 負責教授Art in its Relation to Orthodontia，而且名列在Dr. Angle之後，在所有其他醫師之前，可見其教學內容對矯正治療的重要性。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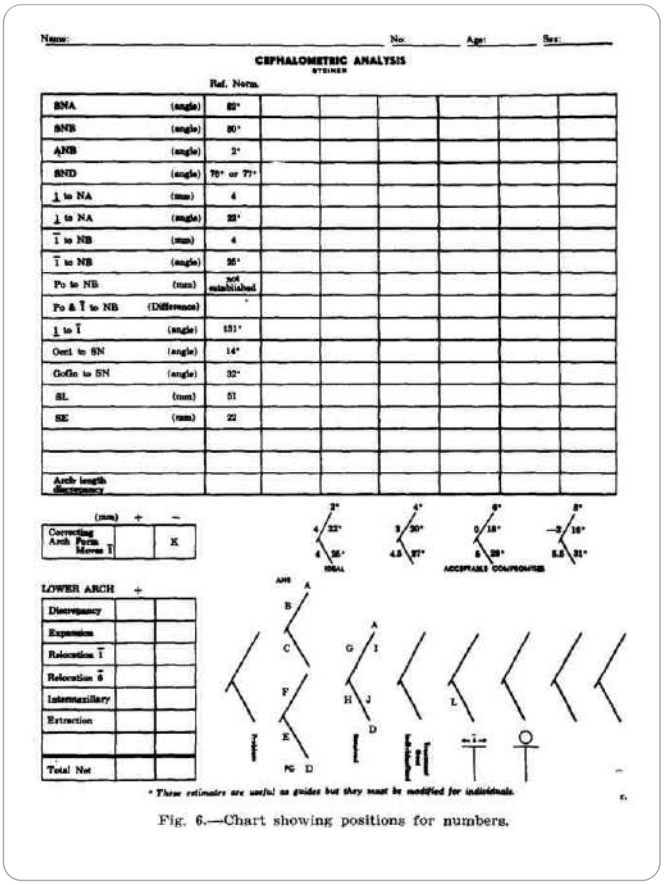
而測顱技術在Dr. Holly Broadbent Sr. (1894 ~ 1977) 的標準化發展之後，矯正醫師們終於有工具可以用來具體的觀察人類的頭顱，並且受惠於Dr. Broadbent對發育的研究成果，讓後來的學者們開始明白齒列位在顏面部前後程度不同的差別。雖然側顱X光片仍然是2D的呈現，但其提供了病患齒列位於顏面部前後位置的資訊，補足了病患的牙齒模型無法提供的整體資訊，避免矯正治療淪為Model Diagnosis。

Dr. Steiner更利用此觀念將病患三度空間的問題量化，讓矯正治療單純化而且同時達到良好的功能(function)、穩定性(stability)及美觀(esthetics)，是當今最廣泛又實用的矯正分析法之一。在此分析法問世不久，便有日本學者也依照此分析法制定出了適合日本人使用的治療參考數據，足以說明此分析法的實用性。

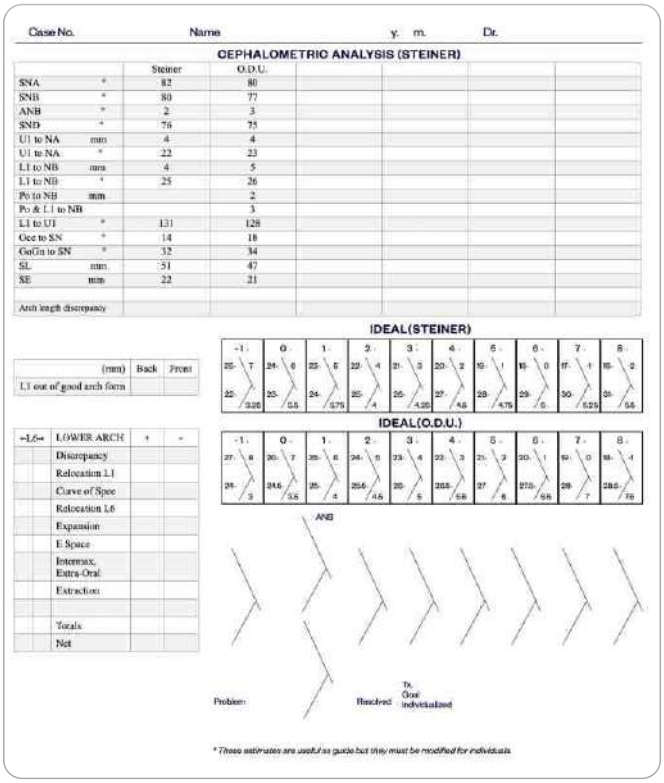
測顱技術的發展已經超過一個世紀，如今材料學和矯正產品已經非常成熟，科技部分甚至還有AI的輔助，矯正治療的過程跟以往比較起來已經輕鬆非常多，讓醫師們節省了很多的時間和體力。但是不管時代如何改變，最後仍然需要由醫師設定出具體的治療目標才行，因為只有一開始就有正確的治療方向，才是最快又對病患最好的治療！



CEPHALOMETRIC ANALYSIS

Fig. 6.—Chart showing positions for numbers.

Steiner分析法原始表格



CEPHALOMETRIC ANALYSIS (STEINER)

IDEAL(STEINER)

IDEAL(O.D.U.)

筆者所使用的Steiner分析法表格，
文中將各部分依序介紹。

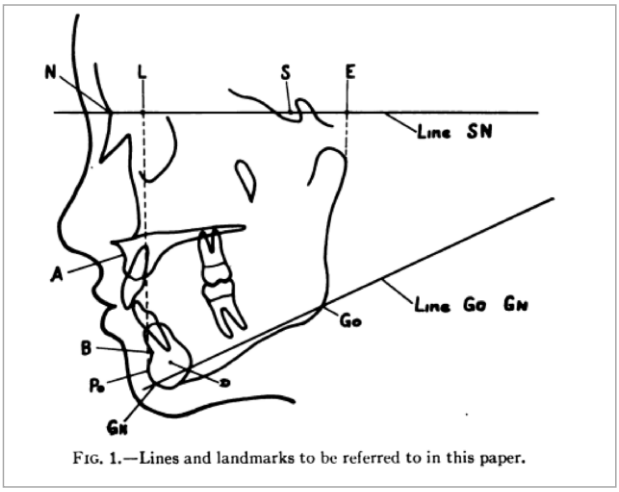


Fig. 1.—Lines and landmarks to be referred to in this paper.

Steiner analysis使用的參考點：
（示意圖擷取於Dr. Steiner文章，可見病患面向左方，因為當時側顱X光片方向尚未統一面向右方。）
S: Sella, N: Nasion, A: point A, B: point B,
Pog: Pogonion, Go: Gonion, Gn: Gnathion,
D: 側顱X光片上chin的幾何中心點,
L: Pog至S-N line的垂足,
E: TMJ後緣至S-N line的垂足。

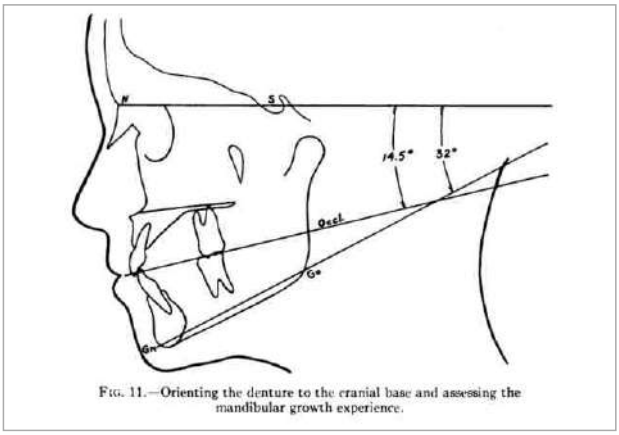


Fig. 11.—Orienting the denture to the cranial base and assessing the mandibular growth experience.

Steiner analysis使用的參考線：
SN Line, Occlusal Line, GoGn Line

(一) 計測項目

		Steiner	O.D.U.
SNA	°	82	80
SNB	°	80	77
ANB	°	2	3
SND	°	76	75
U1 to NA	mm	4	4
U1 to NA	°	22	23
L1 to NB	mm	4	5
L1 to NB	°	25	26
Po to NB	mm		2
Po & L1 to NB			3
L1 to U1	°	131	128
Occ to SN	°	14	18
GoGn to SN	°	32	34
SL	mm	51	47
SE	mm	22	21

由Dr. Steiner及O.D.U所提供的參考值(附註：O.D.U.為Osaka Dental University, Japan)

SNA(°)：上顎骨跟顱底的前後相對位置
SNB(°)：下顎骨跟顱底的前後相對位置
ANB(°)：上下顎骨前後相對位置

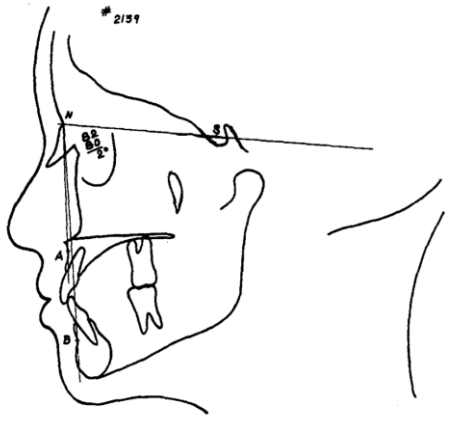
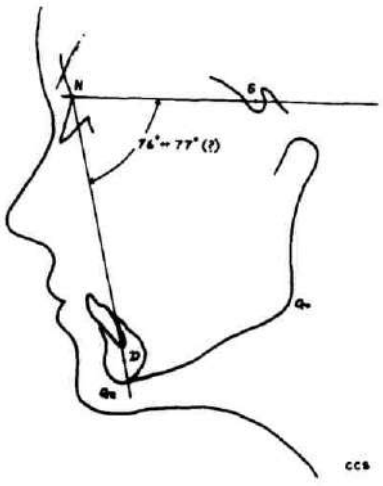
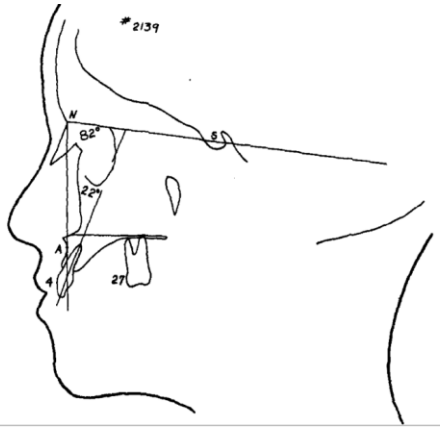


Fig. 2.—Jaw relationships, employing angles SNA and SNB.

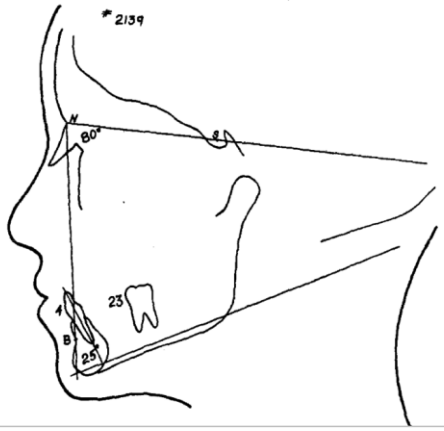
SND(°)：可用來比較治療前後下顎骨前方位置的變化



U1 to NA(mm)：上顎正中門齒向前突出的量
U1 to NA(°)：上顎正中門齒向前傾斜的程度

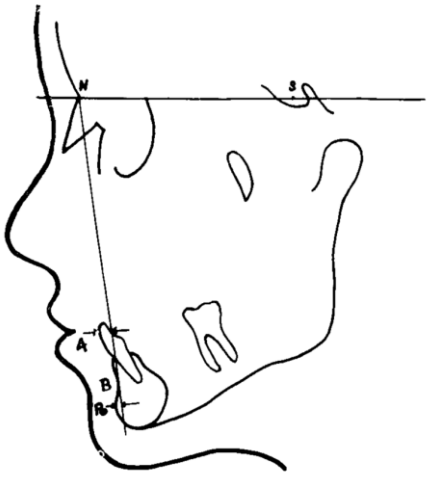


L1 to NB(mm)：下顎正中門齒向前突出的量
L1 to NB(°)：下顎正中門齒向前傾斜的程度

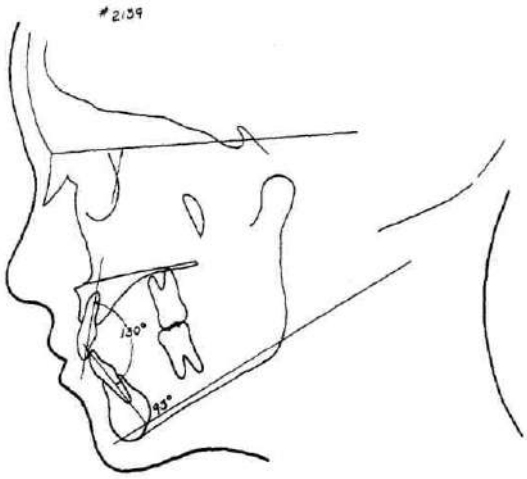


Po to NB(mm)：就Dr. Holdaway提出的Holdaway ratio，當(L1 to NB) : (Po to NB) = 1 : 1時，有最穩定的咬合及美觀性，是最理想的治療結果。

Pog & L1 to NB(mm)：等於(L1 to NB)減去(Po to NB)的差距。個別差異相當大，沒有實際使用此數值，但可當成對病患顏面特徵的參考。

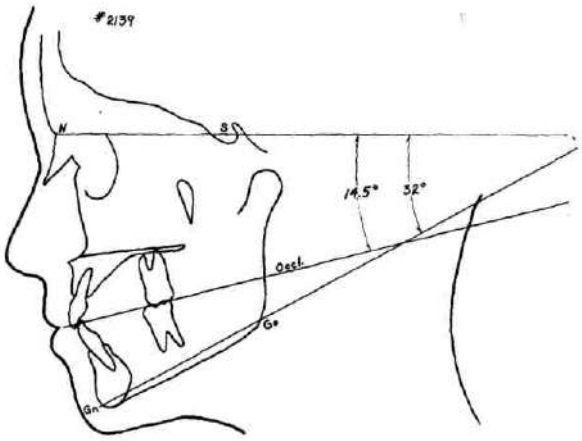


U1 to L1(°)：即interincisal angle，表示上下顎門齒突出程度。



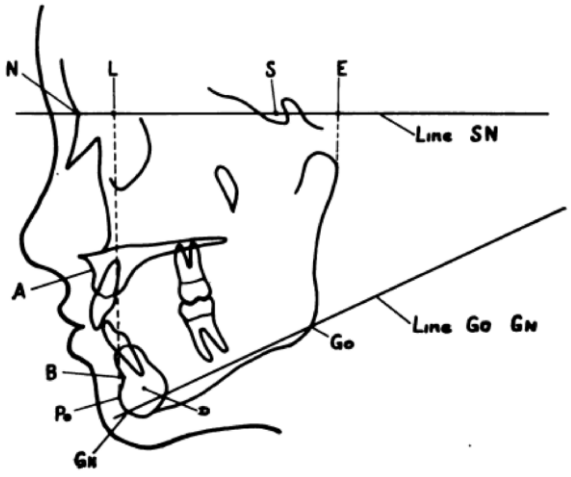
Occ to SN(°)：用來表示denture base的角度，可用來了解咬合面的改變及錨定(Anchorge)保留的困難度。

GoGn to SN(°)：角度愈大，治療難度愈大。



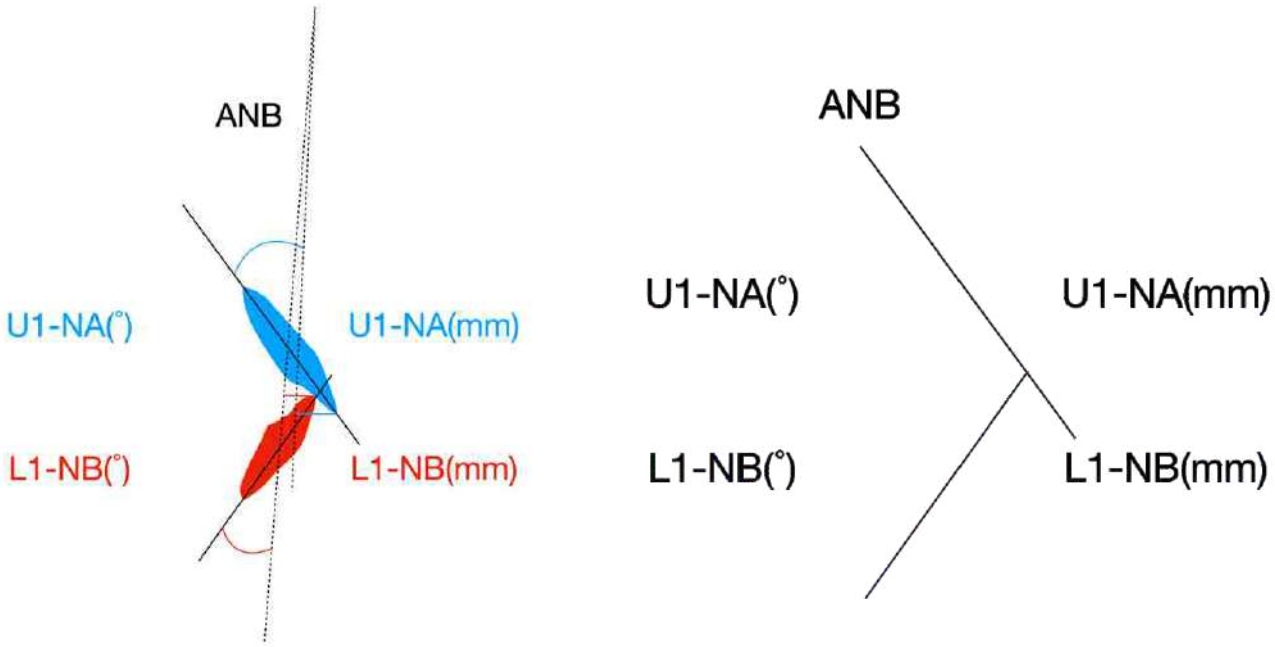
SL（mm）：表示Pog的相對位置，若SL相對較長，且非high angle，表示有較好的發育方向及潛力。

SE（mm）：表示TMJ的相對位置，若SE相對較短，下顎可能有順時針方向成長或旋轉。



（二）Chevron使用方式

Chevron圖案是以簡化方式書寫出由側顱X光片取得的ANB, U1 to NA（mm）, U1 to NA(°), L1 to NB（mm）, L1 to NB(°)數值。



左：簡化前，右：簡化後

IDEAL(STEINER)

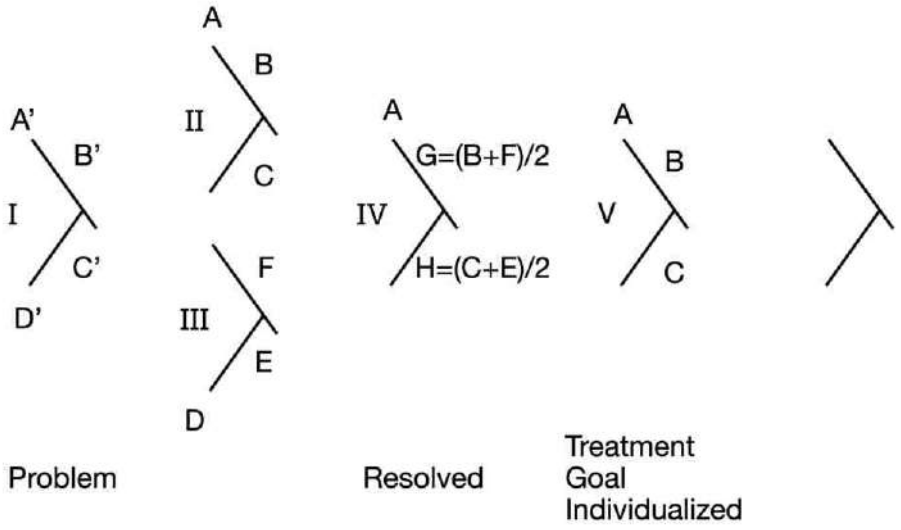
-1	0	1	2	3	4	5	6	7	8
25° 7 22° 3.25	24° 6 23° 3.5	23° 5 24° 3.75	22° 4 25° 4	21° 3 26° 4.25	20° 2 27° 4.5	19° 1 28° 4.75	18° 0 29° 5	17° -1 30° 5.25	16° -2 31° 5.5

IDEAL(O.D.U.)

-1	0	1	2	3	4	5	6	7	8
27° 8 24° 3	26° 7 24.5° 3.5	25° 6 25° 4	24° 5 25.5° 4.5	23° 4 26° 5	22° 3 26.5° 5.5	21° 2 27° 6	20° 1 27.5° 6.5	19° 0 28° 7	18° -1 28.5° 7.5

ACCEPTABLE COMPONENTS, 由Dr. Steiner及O.D.U所提供的參考值
(附註：O.D.U.為Osaka Dental University, Japan)

Chevron I ~ Chevron V



Chevron I

稱為Problem。由病患側顱X光片量測得到的數據，A＇代表病患的∠ANB。

Chevron II

先決定A，再由ACCEPTABLE COMPONENTS選擇而來的。

數值A的計算方式：

若Problem的A'是偶數，則A=A'/2；

若Problem的A'是奇數，則A=(A'+1)/2。

B、C則利用A對照ACCEPTABLE COMPONENTS查表，例如A=3，對照O.D.U.建議值則B=4、C=5。

當然還有很多因素都會影響∠ANB的變化，例如病人的年齡、性別、生長、合作程度、醫師使用的治療方式及技術等，在設定數值A的治療目標時應該有整體的考量之後才決定出治療目標的∠ANB。

Chevron III

D：預估治療完成時Pog to NB（mm）的數值，此數值與成長潛力有關，正值發育期成長潛力好的病人，每年可預估增加0.5mm。

E：根據Holdaway ratio，當治療結果E=D時，有最穩定的咬合及美觀性。即前面提到的(L1 to NB):(Po to NB)=1:1。

F：因為B、C的差距剛好讓上下顎門牙能有咬合，以E為參考值用等差數列的方式推算出F，B-C=F-E，即F=(B+E)-C。

Chevron IV

稱為Resolved，可視為將Chevron II及Chevron III的概念取平均值，則G=(B+F)/2、H=(C+E)/2。

Chevron V

稱為Treatment Goal Individualized，須由醫師的經驗依年齡、性別、生長、遺傳、臉型、口腔習慣等稍作調整。

（三）Box Score使用方式

因為治療的順序是先解決下顎的空間問題，再由上顎齒列配合調整至Class I咬合，所以Box Score當中是填入由下顎得到的數值。

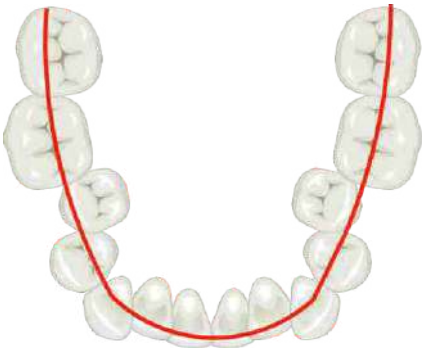
此表格就像收支紀錄表一樣，若是收入等於或大於支出是最好的情況，當收入小於支出，代表病患問題嚴重，無法完全解決其問題。

解決病患的問題時會耗損掉空間的項目計為負值（單位：mm），而能夠提供空間的項目計為正值，主治醫師就能以計算的結果來判斷是否需要拔牙，而且知道拔牙空間是否足夠達到理想的治療目標。當拔牙空間不敷使用時，就要降低治療目標，因為齒列必須要排整齊，所以通常是減少門牙往後拉的距離。

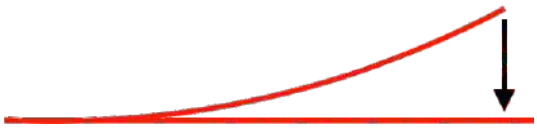
1. Box Score：能提供空間的項目紀錄在（+）號下方空格內；會耗損空間的項目紀錄在（-）號下方空格內。
2. L1 is out of good archform：若其中一顆下顎正中門齒block out，其相對於ideal archform突出的距離為將其排入牙弓所需空間，計為負值。
3. Discrepancy：ideal archform上的arch length為available space，排列所有牙齒所需的空間稱為required space。將available space減去required space，常見為負值。

(mm)	Back	Front
L1 out of good arch form		

←L6→	LOWER ARCH	+	-
	Discrepancy		
	Relocation L1		
	Curve of Spee		
	Relocation L6		
	Expansion		
	E Space		
	Intermax, Extra-Oral		
	Extraction		
	Totals		
	Net		



4. Relocation L1：若要減小L1-NB(mm)至理想穩定的位置時需要將L1內移，此時內移的量會耗損掉拔牙空間。又因為牙弓有左右兩側，L1內移的量乘以兩倍後計為負值。
5. Curve of Spee：兩側Curve of Spee取平均值，即為將其整平時所需要的空間，計為負值。

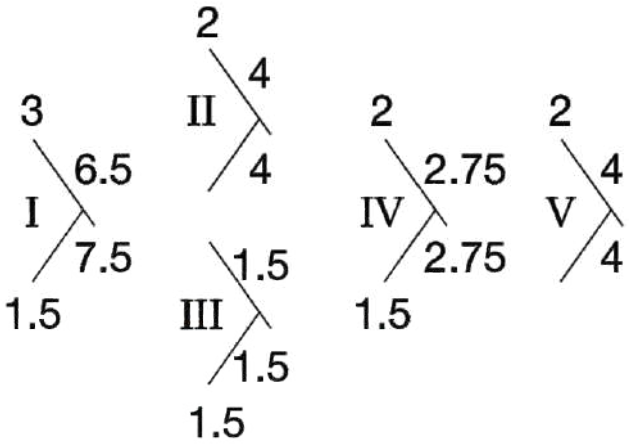


6. Relocation L6：下顎第一大臼齒有mesial tipping時，將其upright之後可得到空間，通常單側最多2mm，因為牙弓有左右兩側，計算時乘以兩倍後計為正值。
7. Expansion：下顎牙弓通常不擴大，若是牙弓狹窄，擴大以單側2~3mm為限，計算時乘以兩倍後計為正值。
8. E space：第二乳臼齒存在時可以幫助保留Leeway Space，單側2mm，計算時乘以兩倍後計為正值。
9. Intermaxillary：在molar relationship Class II case，若為了改善molar relationship而使用Class II elastics，此時下顎大臼齒單側會向前2mm，計算時乘以兩倍後為4mm，計為負值。
10. Extraction：為了有效地解決所有三度空間的問題，以上總計小於負4mm的病患則需要拔牙。因為拔第一小臼齒或是第二小臼齒，在拔牙區近心及遠心剩餘的牙齒數目不同，即錨定(anchorage)不同，若拔除兩側第一小臼齒總共得到15mm，將其計為正值，通常後方齒列會向前移動三分之一，即總共失去5mm，計為負值；若拔除兩側第二小臼齒總共得到15mm，將其計為正值，通常後方齒列會向前移動二分之一，即總共失去7.5mm，計為負值。
11. Total：正負值應該相等。
12. Net：應該等於零。若為負值則需要可額外利用lingual arch或head gear來增加錨定來防止後牙近心移動而喪失錨定(anchorage loss)，就可以減少拔牙空間的喪失，前牙能後退的空間就能增加。假如所有空間已經利用到極限Net仍然為負值，就需要調整治療目標，稱為compromised 或acceptable treatment goal，通常藉由減少下顎門齒向後的移動量來達成。
13. ←L6→：也稱為Saving space，以治療目標為準，前方齒列後退時沒有利用到的拔牙空間，等於容許後牙往前移動的量。若是兩側牙弓都有拔牙，就將所有剩餘的拔牙空間除以2稱之，記錄在表格左側向右箭頭欄的位內，表示下顎第一大臼齒運動方向等同側顱X光片的近心方向。

(四) 病例解析

台灣18歲女性，主訴上下前排牙齒不整齊，而且嘴唇突出影響美觀。資料收集結果： ANB= 3° 、 U1-NA= 6.5mm、L1-NB= 7.5mm、Pog-NB=1.5mm、space discrepancy= 3mm、Curve of Spee= 3mm。

Chevron使用方式：



Chevron I

紀錄病患數值ANB= 3° 、U1-NA= 6.5mm、L1-NB= 7.5mm、Pog-NB= 1.5mm

Chevron II

因為ANB= 3° ，為了達到良好穩定性及外觀所以ANB目標設定為(3+1)/2= 2，

接著查表IDEAL (Steiner)得知ANB= 2° 時，理想U1-NA= 4mm, L1-NB= 4mm，將其記錄。

Chevron III

因為病患已無生長潛力，預期Pog-NB= 1.5mm在治療結束時沒有改變，經由Holdaway Ratio得知此時L1-NB= 1.5mm美觀性最佳。並參考Chevron II的U1-NA= 4mm，L1-NB= 4mm利用等差方式推測出此時U1-NA= 1.5mm上下門齒列可以有咬合接觸。

Chevron IV

將Chevron II及Chevron III的U1-NA、L1-NB數值平均之後寫上。

Chevron V

經由參考病患臉型、咬合面、口腔習慣等，仍然採用ANB= 2° 、U1-NA= 4mm、L1-NB= 4mm為治療目標。

Box Score使用方式：

紀錄Discrepancy= 3mm， Relocation L1由Chevron得知L1-NB由7.5mm退後至4mm需要(7.5-4)= 3.5mm空間，又牙弓有左右兩側所以乘以2之後得到需要7mm， Curve of Spee= 3mm。以上所需空間總計3mm (Discrepancy)+7mm(Relocation L1) + 3mm(Curve of Spee)= 13(mm) ，大於4mm所以屬於需要拔牙矯正的情況。

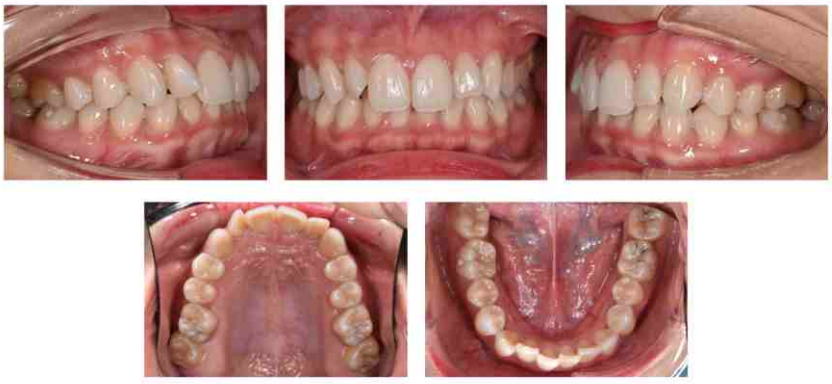
估計拔兩側第一小臼齒可以得到15mm，減去所需空間13mm，代表可以喪失的拔牙空間為僅為2mm。此病例能容許喪失的拔牙空間(2mm)小於拔第一小臼齒前後對拉會喪失的空間(5mm)，所以需要主治醫師視情況使用head gear、lingual arch等裝置來增加固定源，亦即增加錨定(anchorage)。

	(mm)	Back	Front
L1 out of good arch form			

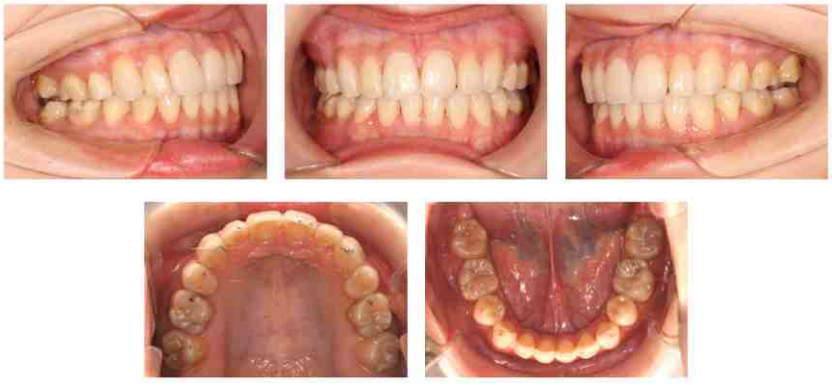
←L6→		LOWER ARCH	+	-
		Discrepancy		3
		Relocation L1		7
		Curve of Spee		3
		Relocation L6		
		Expansion		
		E Space		
		Intermax, Extra-Oral		
	2	Extraction	15	2
		Totals	15	15
	1	Net		0

又因為牙弓有左右兩側故將2mm除以2得到1mm，代表單側後牙可容許近心移動1mm(即Saving space=1mm)，將其記錄在表格左側有向右箭頭處。

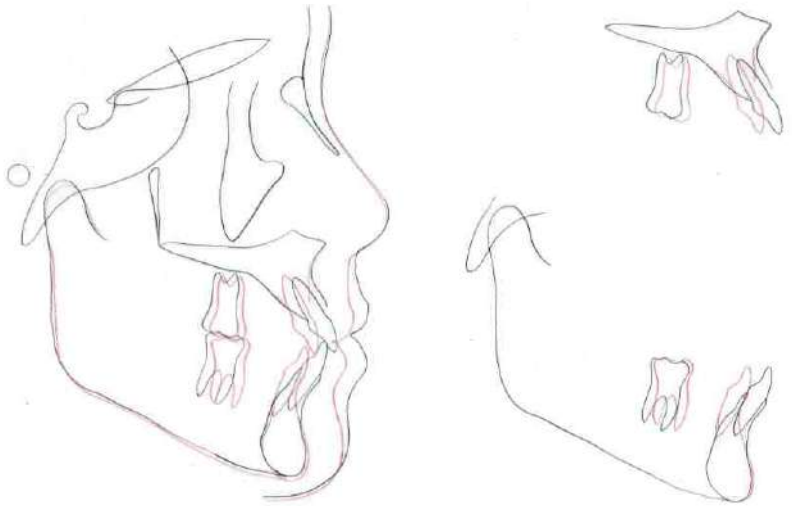
治療結果：



上：治療前，下：治療後



Superimpose：



治療前—
治療後—

結語

即使是臨床各項數值相近的病患，治療的過程或是結果也不可能完全一樣，所以雖然無法每個病例都百分之百達到設定的治療目標，但是原則上也是能愈接近治療目標愈好，才能達到一開始制定治療目標的意義：同時幫病人達到良好的功能(function)、穩定性(stability)、美觀(esthetics)。

Dr. Steiner所設計的分析法計算容易，非常好入門，並且蘊含矯正的各種觀念，例如：功能、成長、垂直控制等，更可以在每位病患治療結束之後藉由側顱X光片疊影(superimpose)來檢視是否有達到當初設定的治療目標，是精進矯正治療不可或缺的一部分，也是本文開頭Dr. Steiner給讀者的話所想要傳達的觀念。相信只要各位醫師能妥善運用個人擅長的矯正裝置，加上經驗的累積，臨床上必定能達到醫師及病患皆大歡喜的治療效果！

" The mind of a child is as tender and as lovely as the petals of a full blown rose. Beware how you touch it! Meet it with all the reverence of your being. Use it with gentle respect and fill it with the honey of love, the perfume of faith and the tenderness of tolerance. Thus shall you fulfill the mission of your life."

EDMUND H. WUERPEL,
(The Angle Orthodontist, Vol. I, No. 1)

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The Game Changer: 3M rely X universal resin cement 臨床案例分享

楊宜憲 醫師

- 高雄醫學大學牙醫學士
- 新竹三口品體系-品馥牙醫診所
- 3M/Solventum Taiwan講師
- Tokuyama 台灣特約講師
- GC Taiwan美學樹脂講師
- Osstem OIC特約講師

在現在樹脂黏著劑百家爭鳴的年代，各家牙材公司無不使出渾身解數來推出性質更加優異的產品。Minimal invasive的概念在這十年間慢慢變成牙醫師的共識，並且在修復材料的多元化以及材料物理性質的大躍進，更推波助瀾的讓Bonding/adhesive成為贋復物黏著方式的顯學。這十年間，無論是在bonding agent 或者流動樹脂甚至是樹脂黏著劑，都有跨時代並且長足的進步。

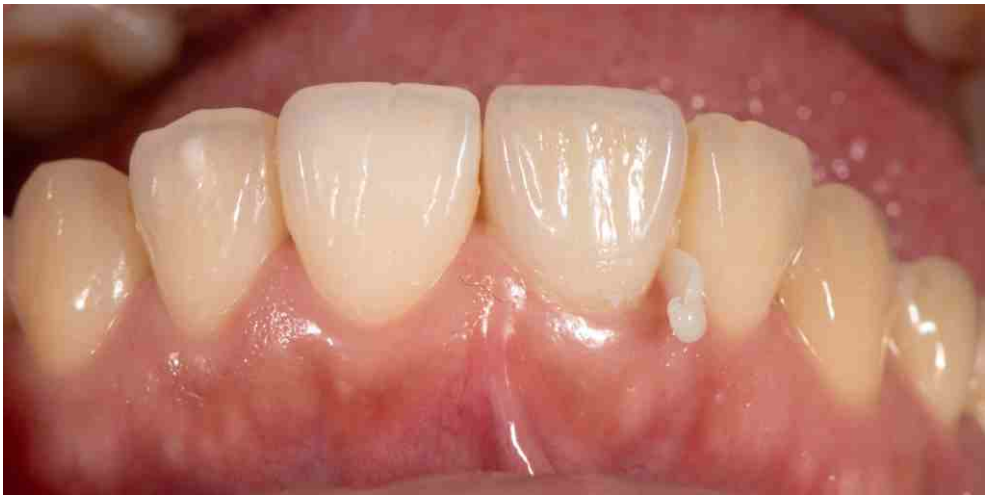
當然各家廠牌都有其優缺點，但筆者自己在多方比較之下，終究還是鍾情於此款樹脂黏著劑。筆者身為臨床操作的醫師，並沒辦法

實際進行材料特性的實驗，因此終究只能仰賴各家機構作出的研究來比較其在牙齒與陶瓷等修復性材料上鍵結強度高低。然而，其餘的性質表現如：黏著劑的可清潔性、黏著後對於贋復物的顏色變化、黏著後對於牙周組織健康的影響等等，都可以從臨床上的案例來略知一二，以下筆者簡單跟各位分享數個使用3M Rely X Universal Resin Cement黏著的案例，並藉由這些案例來介紹其臨床上優異的操作性質與便利性。

一、優異的可清潔性與新的流變設計

牙冠是每一位牙醫師日常都會進行的贋復治療，但由於美觀區域會有邊緣接色的問題，也因此往往我們在設計邊緣的時候，都會設計成齦下的邊緣形式，來讓接著區域能夠被牙齦擋住，達成美觀的治療成果。當然影響治療的好壞，其一是牙冠與支台邊緣的密合度，如果中間的gap太過巨大，甚至有overhang的情況，就容易形成死角，導致牙菌斑、細菌藏匿於其中，又加上齦下邊緣的設計讓病人難以自行清潔到深部的區域，容易引發後續發炎問題。熟練的牙醫師與牙技師的技術與經驗，密合度的問題並不難解決。所以在邊緣密合的情況下，不可控的因素就變成黏著劑物理特性：是否可以有效的清除殘膠。

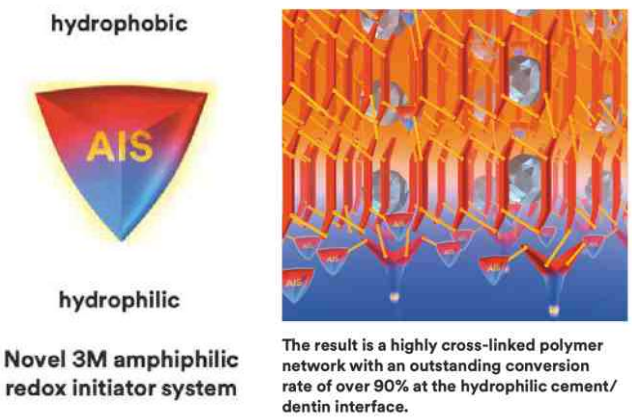
3M Rely X Universal Resin Cement（圖一）非常適合使用Tack-cure技術來進行黏著，在藍光短暫照射下，黏著劑即會硬化為半固體的狀態，此狀態非常容易可以把多餘的殘膠挑除，相較於其他的樹脂黏著劑，可能會變成粉粉的固態或者依然帶有流動性，這兩種狀態都不是非常容易清潔。

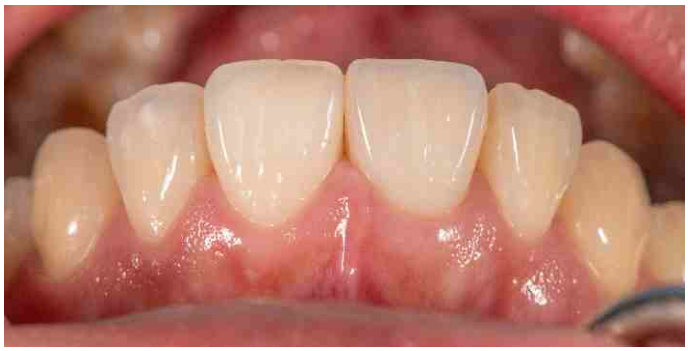


(圖一)

3M針對黏著劑的流變狀態做了一些設計跟調整，聚合前的流動性極佳，得以讓我們輕易的將贋復物置入到定位，並且減少了光起始劑（Photoinitiator)的含量，讓tack curing後的黏著劑不至於固化太快，硬度過高。而為了補償因此可能喪失的bond strength，3M加入了新研發的自凝起始劑（Self-cure initiator; amphiphilic redox initiator system, AIS)（圖二）雙極性（單一分子同時含有親水端及疏水端）的特性使其能夠形成高度交聯的聚合狀態，形成較高的Dentin bond strength[1]。兼顧清潔性、美觀性以及良好的鍵結強度，就是筆者選擇使用它的重要原因 (圖三)。

(圖二)



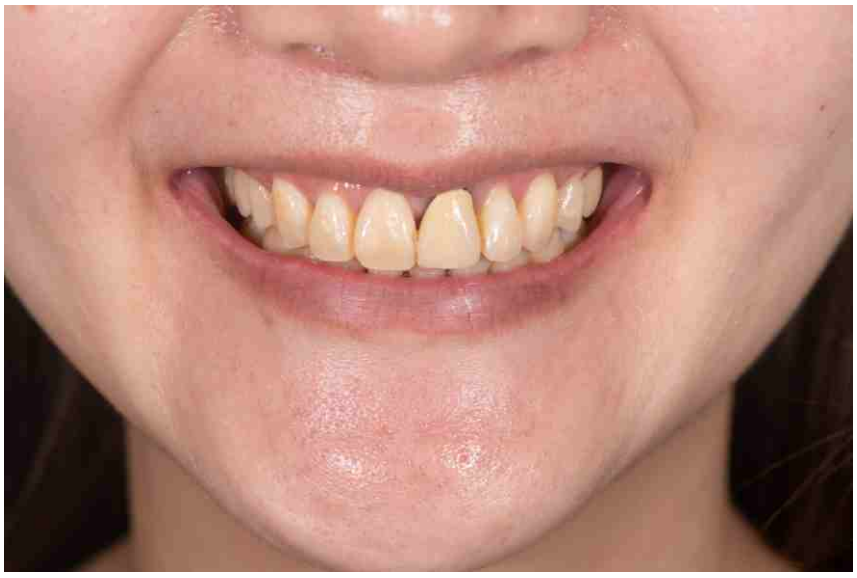


(圖三) 黏著過後兩週以上的追蹤，顏色表現良好，牙齦健康。

二、黏著後對於贋復物的顏色影響

前一代的產品：3M Rely X U200最為人詬病的事就是黏著後的顏色變化，甚至會顯灰，在美觀區域中這樣的表現無疑是致命的。尤其是永久黏著後要重新拆下製作有太多的時間及成本折損。U200中含有的胺類光起始劑，在研究中黏著後七天跟剛黏著完相比，有顯著的顏色改變[2]。

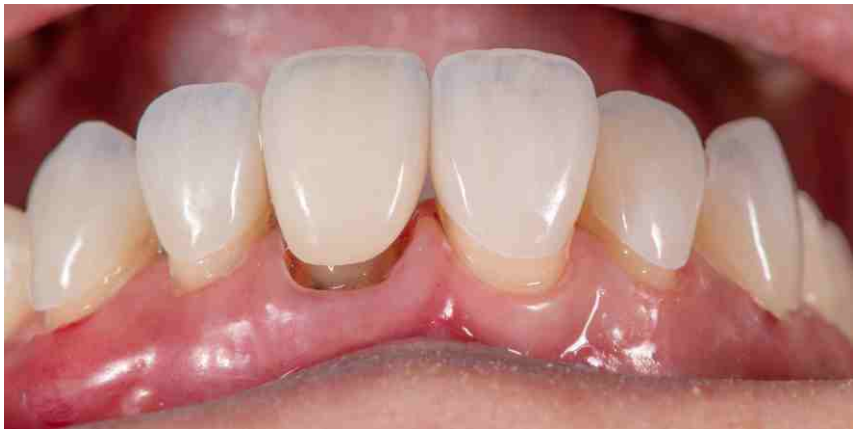
以下分享一位前牙13至23牙位的前牙美學重建患者，患者因矯正結束後牙齦不協調與前牙外型顏色問題前來筆者門診求診。（圖四）經過六個月牙根覆蓋手術追蹤及臨時假牙置換後到了最終贋復階段。



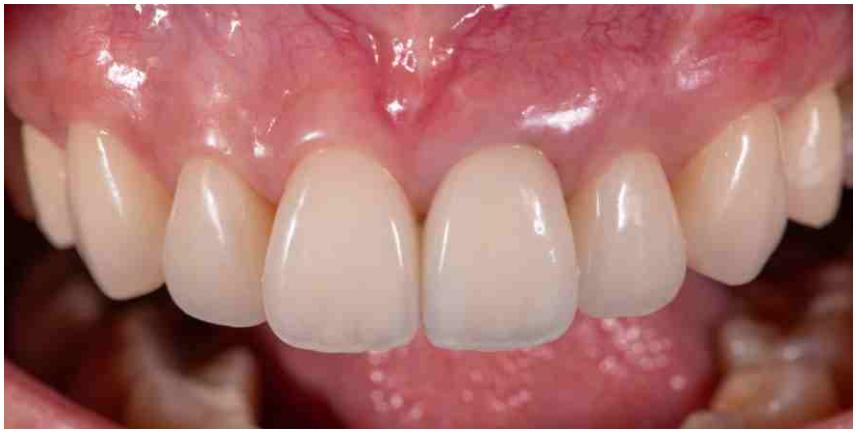
(圖四)
術前狀態，舊假牙邊緣不理想。同時伴隨有其他牙齦協調問題。

3M Rely X Universal Resin Cement因為光起始劑的減量改善了前一代U200黏著後變色的問題。

筆者嘗試運用在前牙美觀區長石貼片及牙冠的黏著上（圖五、六），相對U200而言，顏色的變化並不顯著，雖沒有以專業的測色計進行實驗，在臨床兩個月的追蹤中，筆者以及病人皆未提起或者察覺顏色變化的問題。



(圖五)
黏著前：左上正中門齒為全瓷冠，其餘牙齒為長石瓷貼片。



(圖六)
術後黏著一週追蹤，牙齦健康、顏色穩定。

在其公司內部的研究之中，長期將各家黏著劑的樣品浸泡在模擬口腔染色環境（36°C 咖啡）24小時過後，3M Rely X Universal Resin Cement變色程度是各家樣品中最少的(圖七）1 。雖然長期仍有待追蹤實際使用狀況下是否可達到跟實驗研究相似的結果，然也可證明在貼片類型的案例中，短期的美觀達成應當是可以達成的。

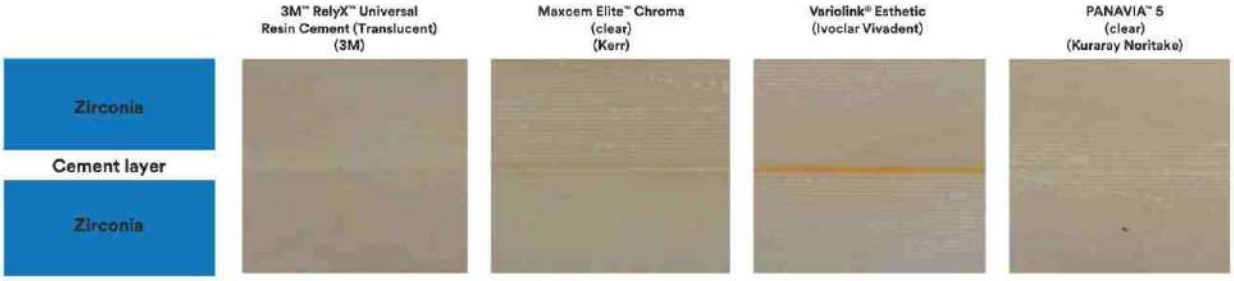


Fig. 14: Discoloration of cement layers after 24 hours of storage in coffee solution.
Source: 3M internal data

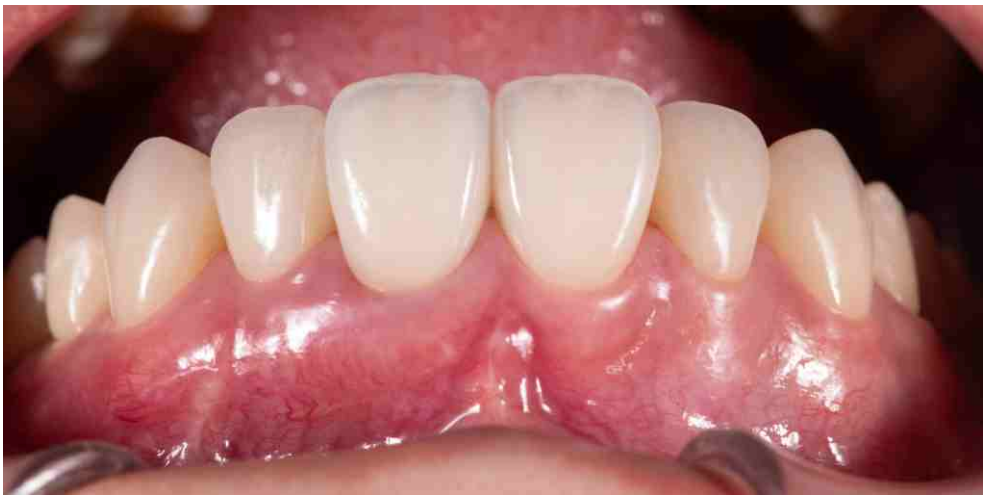
(圖七) 3M內部進行染色程度測試

綜合以上結論，筆者才會開始在美觀區的黏著使用3M Rely X Universal Resin Cement。

三、黏著後對於牙周組織健康的影響

同樣一個案例，由於殘膠能夠去除乾淨的特性，兩個月追蹤，牙齦依舊保持健康的狀況（圖八、九）。

(圖八)
術後患者的笑容照片，可見前牙顏色協調



(圖九)
術後兩個月追蹤，無論左上正中門牙的牙冠，抑或是其他顆長石貼片均顏色穩定、牙齦組織健康

當然新世代的產品終究需要更長期的案例追蹤才有辦法證明其在市場的價值與地位，但優秀的產品只需要醫師們親身體驗過，就可以明白其強大的地方，期待未來能夠有更多的案例與長期追蹤，再與各位醫師們分享成果。

1. 3M™ RelyX™ Universal Resin CementTechnicalProduct Profile
https://assets.solventum.com/is/content/mmmspinco/3M-RelyX-Universal-Cement-TPP_USpdf
2. Yagci F et al. Discoloration Behavior of Resin Cements Containing Different Photoinitiators Int J Periodontics Restorative Dent. 2021 May-Jun;41(3):e113-e120. doi: 10.11607/prd.5376

Root Coverage Using a Microsurfaced Acellular Dermal Matrix: A Retrospective Case Series

吳昱璋 醫師

- 美國牙周病暨植牙專科醫師
- 美國俄亥俄州立大學牙周病學碩士
- 美國牙周病理事會院士
- 中國醫藥大學牙醫系學士
- 美國臨床案例競賽第一名（2024,Michigan)
- 前美國俄亥俄州立大學臨床助理教授/指導醫師

前言摘述

微表面處理去細胞真皮基質之根面覆蓋：回溯性病例列報告

Root Coverage Using a Microsurfaced Acellular Dermal Matrix: A Retrospective Case Series

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

本研究評估「微表面處理去細胞真皮基質」（microsurfaced ADM, mADM）搭配隧道術（tunnel technique）與前庭切口等微創牙周軟組織手術，用於多顆 RT1 類型牙齦萎縮之臨床成效。傳統自體結締組織移植（SCTG）雖為根面覆蓋的金標準，但需第二手術區，增加病人疼痛與術後不適。本研究回溯多位病患之治療紀錄，結果顯示 mADM 可在無自體取材負擔的情況下，達成良好的根面覆蓋、角化牙齦寬度增加與厚度改善。所有病例術後癒合良好，無移植物外露、感染或重大併發症；病人主觀不適感輕微，且對美觀結果與舒適度均高度滿意。

研究指出，mADM 經微表面處理後具良好生物相容性與軟組織整合能力，為治療多顆牙齦萎縮提供一項具臨床潛力的替代選項。作者同時強調，未來仍需更大樣本與長期隨訪研究，以驗證其與自體結締組織移植間的長期穩定性與可預測性。

CASE STUDY

Root coverage using a microsurfaced acellular dermal matrix: A retrospective case series

Yu-Chang Wu[1] | **Guo-Liang Cheng**[1] | **Shaun Rotenberg**[1,2]

[1]Division of Periodontology, College of Dentistry, The Ohio State University, Columbus, Ohio, USA

[2]Private Practice, Columbus, Ohio, USA

Correspondence
Yu-Chang Wu, Division of Periodontology, College of Dentistry, The Ohio State University, 305 W. 12th Avenue, Columbus, OH 43210, USA.
Email: wu.4898@osu.edu

Abstract

Background: Acellular dermal matrices (ADMs) have been used for root coverage for over 25 years, yet few advancements have improved clinical outcomes or reduced complications. This case series evaluated the use of a novel microsurfaced ADM (mADM), which features a microtextured surface designed intended to promote healing and improve graft integration, for treating gingival recession defects.

Methods: Eleven RT1 gingival recession defects from five patients were treated using mADM between January and May 2023 by a single surgeon (S.R.). A modified vestibular incision subperiosteal tunnel access technique was used for multiple recession defects, while a subperiosteal pouch technique was performed for single-tooth recession defects. Clinical outcomes were assessed at baseline and 12 months. Pair *t*-tests were utilized to compare changes overtime.

Results: The mean recession depth reduced from 3.64 ± 0.50 mm to 0.73 ± 0.79 mm after 12 months. Keratinized tissue width increased from 2.32 ± 0.81 mm to 3.36 ± 0.92 mm. Gingival phenotype remained thick for all the cases. Significant root coverage was achieved ($p < 0.05$) with no graft exposure; complete root coverage was observed in 45.5% (5/11). Patients reported minimal discomfort and satisfactory healing.

Conclusions: Within the limits of this retrospective case series, mADM may be considered a viable option for the treatment of RT1 gingival recession defects. Future randomized clinical trials should be performed to compare this matrix with other options to deal with recession defects.

KEYWORDS
acellular dermis, dental esthetics, gingival recession, plastic surgery, wound healing

Key points

- In this case study, the novel microsurfaced acellular dermal matrices (mADM) demonstrated significant root coverage improvements in RT1 gingival recession defects, with a mean recession reduction from 3.64 to 0.73 mm at 12 months, achieving 80% root coverage and complete coverage in 45.5% of treated sites.
- The mADM may serve as a promising alternative to autogenous grafts, but larger-scale randomized clinical trials are necessary to confirm long-term efficacy and patient-reported outcomes.

Plain Language Summary

For decades, gum recession—when the gum tissue pulls back from the teeth and exposes the roots—has been treated with acellular dermal matrices (ADMs) made from donated cadaver tissue, avoiding the need to harvest tissue from the patient. Although traditional ADM is widely used, concerns exist regarding its healing and long-term stability. In this case series, a new type of ADM called microsurfaced ADM (mADM) was used. Like ADM, mADM is derived from cadaver tissue but has a specially textured surface intended to support graft integration with the gums. Five non-smoking patients were treated with mADM and followed for 12 months. The treatment resulted in excellent root coverage without complications such as graft exposure or infection. Patients reported very little discomfort and were satisfied with the esthetic outcome. Within the limits of this study, these findings indicate that mADM may offer a viable alternative for treating RT1 gum recession defects. Nonetheless, further randomized clinical trials are needed to compare its initial healing, long-term outcomes, and patient-reported outcomes with other treatment options.

INTRODUCTION

Advancements in periodontal plastic surgery techniques and materials have continuously progressed to improve clinical outcomes. While the subepithelial connective tissue graft (SCTG) remains the benchmark for root coverage and augmentation of keratinized tissue,[1] its use is limited due to the morbidity associated with a secondary surgical site.[2,3] Additionally, the anatomy of the hard palate can constrain the treatment of multiple teeth, necessitating multiple surgeries.[4] For over 25 years, soft tissue augmentation involving the use of an acellular dermal matrix (ADM) has been utilized as an alternative to autogenous tissue. ADM eliminates the need for a donor site, enabling clinicians to address multiple sites in one procedure.[5] However, studies indicate that ADM may offer less long-term stability and minimal gains in keratinized tissue compared to SCTG.[5,6] Nonetheless, ADM remains a viable alternative to SCTG.[7]

ADM, sourced from human tissue and processed to remove dermal cells, retains a bioactive matrix.[8] Initially developed for treating burn wounds in medicine,[8] ADM has been integrated into dentistry to facilitate root coverage and to augment tissue thickness.[9,10] Despite widespread adoption, there have been limited advancements in ADM since its inception, primarily centered on optimizing storage and hydration methods.[11]

A novel microsurfaced ADM[12] (mADM; Microderm, Osteogenics Biomedical, Lubbock, TX, USA) was recently developed intended to enhance healing and clinical outcomes. mADM is a freeze-dried allograft processed without the use of antibiotics that is microtextured to increase its surface area.[12] The microsurfacing technique involves creating microcuts on the surface of ADM[12] that are visible clinically and in more detail with the use of scanning electron microscopy (Houston Electron Microscopy) (Figure 1). Marinelli et al.[13] conducted a study comparing mADM to conventional ADM in treating 20 patients with deep burn wounds. The findings indicated that mADM led to increased cell infiltration, improved graft integration, and reduced graft shrinkage between 12 and 19 days postoperatively compared to traditional ADM.[13]

The purpose of this report is to describe the usage of mADM in the treatment of gingival recession for root coverage in five cases with descriptions and outcomes up to 12 months.

MATERIALS AND METHODS

Study design and population

This retrospective case series included five non-smoking patients (aged 38–62 years), presenting with a total of 11 teeth requiring treatment, sought care primarily due to concerns about periodontal health and tooth sensitivity associated with gingival recession (RT1)[14,15] caused by aggressive tooth brushing. These were the first five mADM-treated cases at a periodontal specialty practice in Columbus, Ohio (January–May 2023), each with at least 1 year of follow-up.

All surgeries and clinical measurements (Tables 1 and 2) were performed by a single experienced periodontist (S.R.) in a private practice setting. None of the surgical sites had undergone any previous surgical intervention. Baseline clinical measurements (Table 1), including recession depth (REC), clinical attachment level (CAL), gingival phenotype, and keratinized tissue width (KTW), were recorded on the mid-buccal aspect of the tooth, and recorded to nearest mm using a UNC-15 periodontal probe both preoperatively and 12 months postoperatively. The gingival phenotype was assessed based on the transparency of the

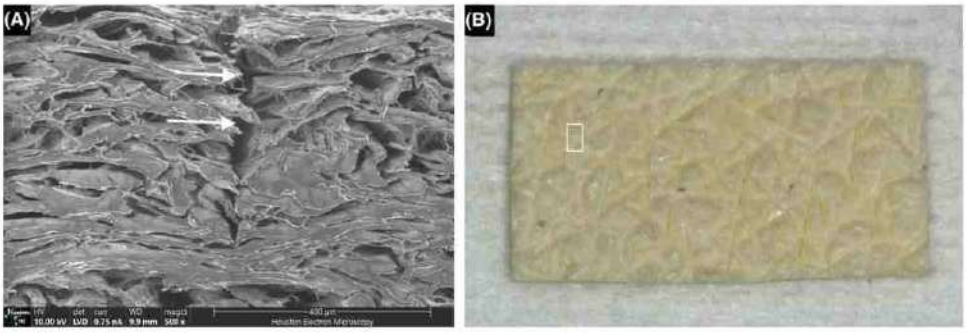


FIGURE 1 (A) Scanning electron microscopy (SEM) image of microsurfaced acellular dermal matrix (mADM) at 500× magnification, revealing a textured microcut surface that enhances surface area. The layered microstructure is irregularly arranged, with a visible central separation or cleft (indicated by arrows), further highlighting the microstructural variations. Scale bar = 200 µm. (B) Clinical image of a dehydrated 1 cm × 2 cm piece of mADM, demonstrating its micro-textured surface. The rectangular box highlights a clinically visible microcut. Image provided courtesy of Osteogenics Biomedical. Copyright © 2025, Osteogenics, Lubbock, TX, USA. Used with permission.

TABLE 1 Baseline clinical measurement and diagnosis of the five cases.

Case	Tooth (no.)	REC (mm)	PD (mm)	Recession type[15]	Phenotype	KTW (mm)	CEJ (A/B)[17]	Step (±)[17]
1	#19	4	1	RT1	Thick	2	B	+
	#20	3	2	RT1	Thick	4	B	+
	#21	4	1	RT1	Thick	3	B	+
	#22	4	1	RT1	Thick	3	B	+
2	#11	4	2	RT1	Thick	2	A	+
	#12	4	1	RT1	Thick	1	B	+
3	#19	3	2	RT1	Thick	2	B	+
	#20	3	1	RT1	Thick	2	A	+
	#21	4	1	RT1	Thick	2	A	+
4	#5	3	2	RT1	Thick	3	B	+
5	#3	4	2	RT1	Thick	2	B	–

Abbreviations: CEJ, cementoenamel junction; KTW, keratinized tissue width; PD, probing depth; REC, recession depth.

periodontal probe when inserted into the gingival sulcus.[16] The presence/absence of the cementoenamel junction (CEJ) and cervical discrepancies were also recorded for defect classification.[17] All the treated teeth are associated with a non-carious cervical lesion (NCCL):

- Seven teeth were classified as Class B+ (unidentifiable CEJ with the presence of a cervical step).
- Three teeth were classified as Class A+ (identifiable CEJ with the presence of a cervical step).
- One tooth was classified as Class B– (unidentifiable CEJ with no cervical step).

In cases where the anatomical CEJ was not clinically visible due to the presence of NCCL, the clinical CEJ was predetermined following the method described by Zucchelli et al.[18] Specifically, the ideal vertical dimension of the interdental papilla was measured from the adjacent teeth and used as a reference to estimate the level of the clinical CEJ. The gingival margin position after surgery was expected to correspond to this predetermined clinical CEJ. Care was taken to differentiate cervical abrasion lines from the actual CEJ to avoid misinterpretation of the root coverage outcome.

The follow-up period extended to 12 months. All patients provided informed consent for the surgical procedure, data collection, and publication of intraoral photographs.

Recipient site preparation

After administering local anesthesia (2% lidocaine with 1:100,000 epinephrine; Lignospan, Septodont USA), the exposed root surfaces were instrumented using a universal ultrasonic insert and Gracey 7/8 curette. A 50 mg/mL tetracycline solution was then applied for 1 min to exposed root surfaces, followed by thorough irrigation with water. Odontoplasty was not performed on any cases. For multiple adjacent gingival recession defects (cases 1–3) (Figures 2–4), a modified vestibular incision subperiosteal tunnel access[19]

TABLE 2 Twelve-month postoperative clinical measurements.

Case	Tooth (no.)	REC (mm)	PD (mm)	CAL (mm)	KTW (mm)	Phenotype
1	#19	2	2	4	3	Thick
	#20	1	2	3	5	Thick
	#21	1	2	3	4	Thick
	#22	0	2	2	4	Thick
2	#11	0	2	4	3	Thick
	#12	0	2	4	2	Thick
3	#19	2	1	3	2	Thick
	#20	0	2	2	3	Thick
	#21	0	2	2	4	Thick
4	#5	1	2	3	4	Thick
5	#3	1	2	3	3	Thick

Abbreviations: CAL, clinical attachment level; KTW, keratinized tissue width; PD, probing depth; REC, recession depth.

was performed using a combination of sulcular incisions and a 5–8 mm vestibular access incision (VAI). Initial tunnel preparation was carried out through the VAI apical to the mucogingival junction (MGJ), extending from the most anterior to the most posterior teeth planned for treatment. Once this was completed, full-thickness tunnel preparation continued coronal to the MGJ until the gingival margin and base of the papilla were reached. To complete the recipient site, passive communication was established between the gingival margins of the target teeth and the vestibular tunnel apical to them. For single tooth gingival recession defects (cases 4 and 5) (Figures 5 and 6), a subperiosteal pouch technique was utilized to prepare the recipient site.[20]

mADM preparation

In each case, the mADM was trimmed to the appropriate dimensions while still in its dehydrated form. Specifically, the width was standardized at 10 mm, and the length was determined by measuring from the mesial interdental area of the most mesially affected tooth to the distal interdental area of the most distally affected tooth, ensuring complete coverage of the recession sites. Due to its microsurfacing properties, mADM rapidly hydrates upon contact with liquid. To ensure thorough hydration with the patient's own blood, the mADM was inserted dry, directly into the prepared recipient site, without pre-hydration with any other fluid.

mADM insertion and suturing

For cases 1 and 2 (Figures 2 and 3), the mADM was introduced into the recipient site through the VAI and was passively delivered into final positioning.[19] For case 3 (Figure 4), the mesial papilla of the most anterior tooth to be treated was elevated to create an entryway for the mADM at a more coronal position in order to avoid encroaching on the mental foramen. For cases 4 and 5 (Figures 5 and 6), mADM was inserted through the gingival margin into the subperiosteal pouch.[20] Care was taken to distribute the material evenly in the recipient space, ensuring it did not fold or twist during insertion. Once properly adapted, the material was sutured together with the overlying flap using 5-0 polyglycolic acid (PGA; PGA Resorba, Osteogenics Biomedical) or a copolymer of glycolic acid and caprolactone (PGA-PCL; Glycolon, Osteogenics Biomedical) sutures via sling sutures. In all cases, each tooth being treated received its own sling suture. Finally, tissue adhesive (PeriAcryl 90HV, Glustitch, Delta) was applied over each suture knot to secure the knot, ensuring its stability and preventing displacement during the healing process.

Postoperative instructions

Patients were instructed to avoid solid foods for 14 days and to use a 0.12% chlorhexidine solution (Colgate PerioGard Rinse, Colgate-Palmolive) twice daily for the first 7 days. They were also prescribed systemic antibiotics for 7 days (amoxicillin 500 mg three times daily). For patients allergic to penicillin, azithromycin was prescribed instead (250 mg twice daily on the first day, followed by 250 mg once daily from days 2 to 5). For pain control, patients were advised to take 600 mg ibuprofen every 6 hours for the first 48 hours postoperatively. After the first week, patients were advised to use an extra-soft toothbrush and to clean only the supragingival areas. Normal brushing resumed 4 weeks postoperatively. Sutures were left to be resorbed naturally and were not removed during the 2- or 4-week postoperative visits.

Statistical analysis

Descriptive statistics were used to present the clinical outcomes, with means ± standard deviations. Pair *t*-tests were used to statistically compare the clinical outcomes between

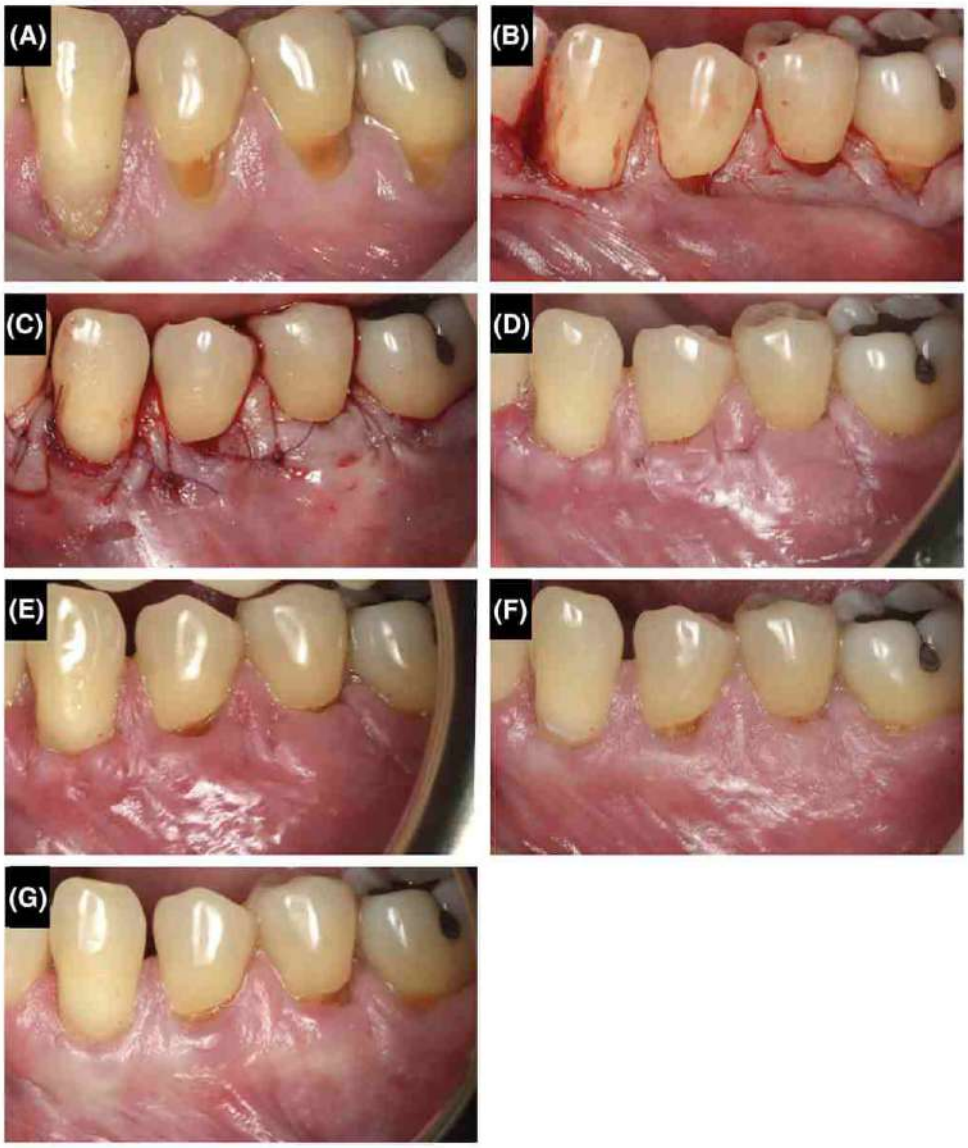


FIGURE 2 Case 1: (A) RT1 buccal gingival recession defects (3–4 mm) were noted from the mandibular left first molar to the left canine. (B) Recipient site was tunneled full thickness with the use of a vestibular access incision (VAI). (C) After the microsurfaced acellular dermal matrix (mADM) was trimmed, inserted, and positioned, the mADM and the flap were secured dependently with sling sutures. (D) Two weeks postoperatively: uneventful healing was observed. (E) Four weeks postoperatively: excellent results were apparent. (F) Eight weeks postoperatively. (G) One year postoperatively: the gingival margin was stable. Gingival color and texture appear thicker and of a natural appearance.

baseline and 12 months. A *p*-value threshold of 0.05 was set for statistically significance. The analyses were performed at the Ohio State University (Columbus, Ohio, USA).

RESULTS

Demographic data

A total of five patients (three females and two males) with RT1 gingival recession were included in this case series. The mean age of the patients was 50 years, ranging from 38 to 62 years. A total of 11 teeth were treated, with individual cases involving between one and four teeth. Two patients had a single-tooth recession defect, while the remaining three had multiple adjacent recession defects.

Clinical outcomes

The clinical measurements at the 12-month follow-up are shown in Table 2. The clinical outcome comparison between baseline and 12-month follow-up is summarized in Table 3. At the 12-month follow-up, significant improvements were observed in REC, CAL, and KTW. The mean REC decreased from 3.64 ± 0.50 mm at baseline to

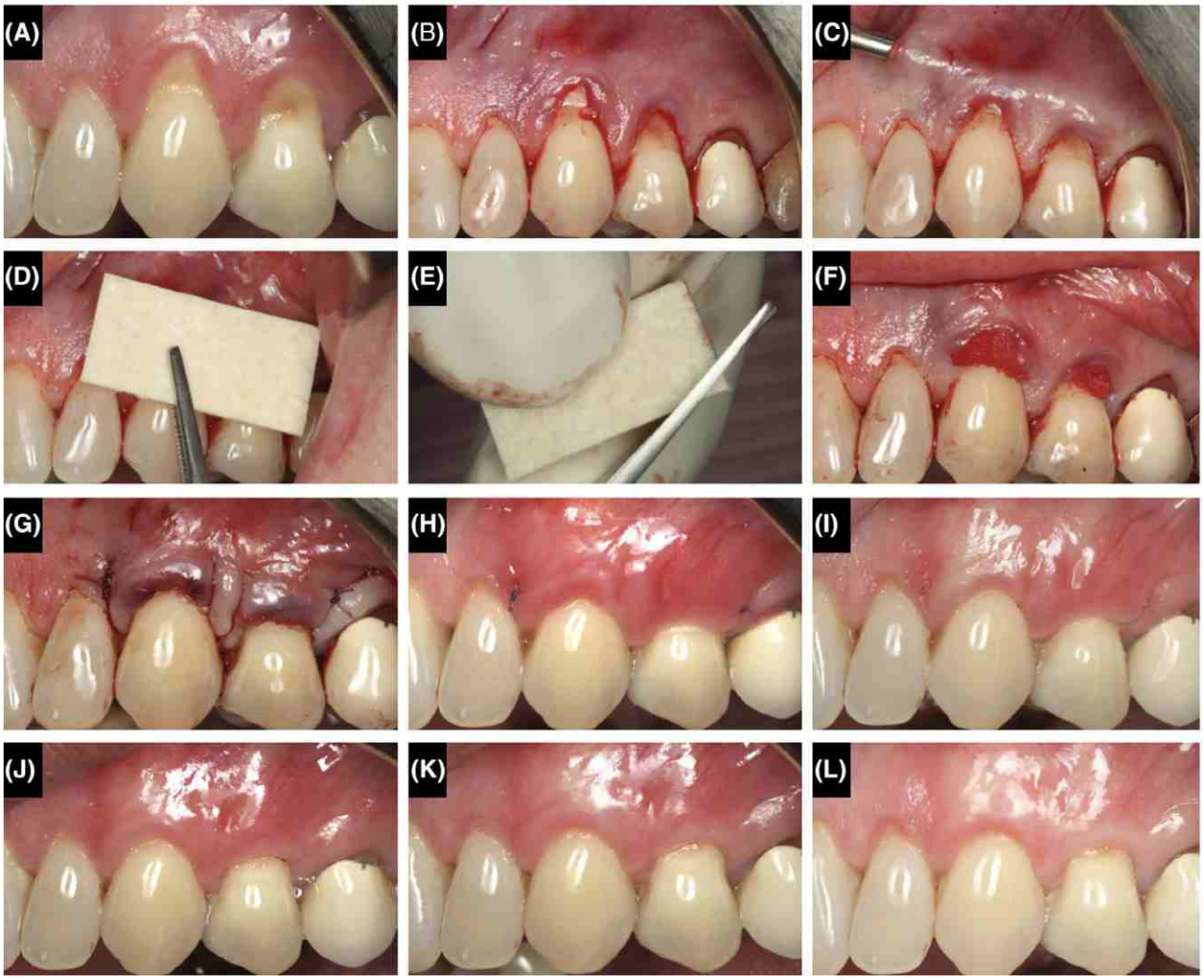


FIGURE 3 Case 2: (A) RT1 buccal gingival recession defects (4 mm) were observed from the maxillary left canine to the first premolar. (B) Recipient site was prepared using a vestibular access incision (VAI) placed in the alveolar mucosa mesial to tooth #23, along with sulcular incisions. (C) A full-thickness tunnel was created to allow for complete coverage of the microsurfaced acellular dermal matrix (mADM) and adequate coronal advancement. (D) Appropriate dimensions of the mADM were measured. (E) mADM was trimmed dry to the correct size. (F) Final position of the mADM was confirmed. (G) mADM and the flap were secured using sling sutures. (H) Two weeks postoperatively: healing was uneventful, with gingival color appearing red and some swelling observed. (I) Four weeks postoperatively: the gingiva appeared pink and healthy. (J) Nine weeks postoperatively. (K) Four months postoperatively. (L) One year postoperatively: root coverage outcome remained stable.

0.73 ± 0.79 mm at 12 months (p = 0.00000327), demonstrating a substantial gain in root coverage. Similarly, KTW increased from 2.32 ± 0.81 mm to 3.36 ± 0.92 mm (p = 0.0000227), indicating a significant augmentation in keratinized tissue. The CAL showed a statistically significant improvement, decreasing from 5.00 ± 0.63 mm at baseline to 3.00 ± 0.77 mm at 12 months (p = 0.00000646). In contrast, probing depth (PD) increased slightly from 1.45 ± 0.52 mm to 1.91 ± 0.30 mm, but this change was not statistically significant (p = 0.0531).

The mean percentage of root coverage (%RC) at 12 months was 80.0%. The mean recession reduction was 2.91 ± 1.04 mm.

Complete root coverage (CRC) was achieved in five sites (45.5%), specifically in:

- Case 1: tooth #22
- Case 2: teeth #11 and #12
- Case 3: teeth #20 and #21

The gingival phenotype remained thick in all cases before and after the procedure.

No adverse events were observed at any postoperative visits for all patients. At the 2- and 4-week follow-ups, only minimal inflammation was noted and all patients reported minimal postoperative discomfort. Importantly, there were also no signs of graft necrosis at any postoperative visit. Patients consistently reported a positive recovery experience, with none reporting any unusual odors or tastes associated with necrotic graft tissue. By the 12-month postoperative follow-up, all treated sites demonstrated

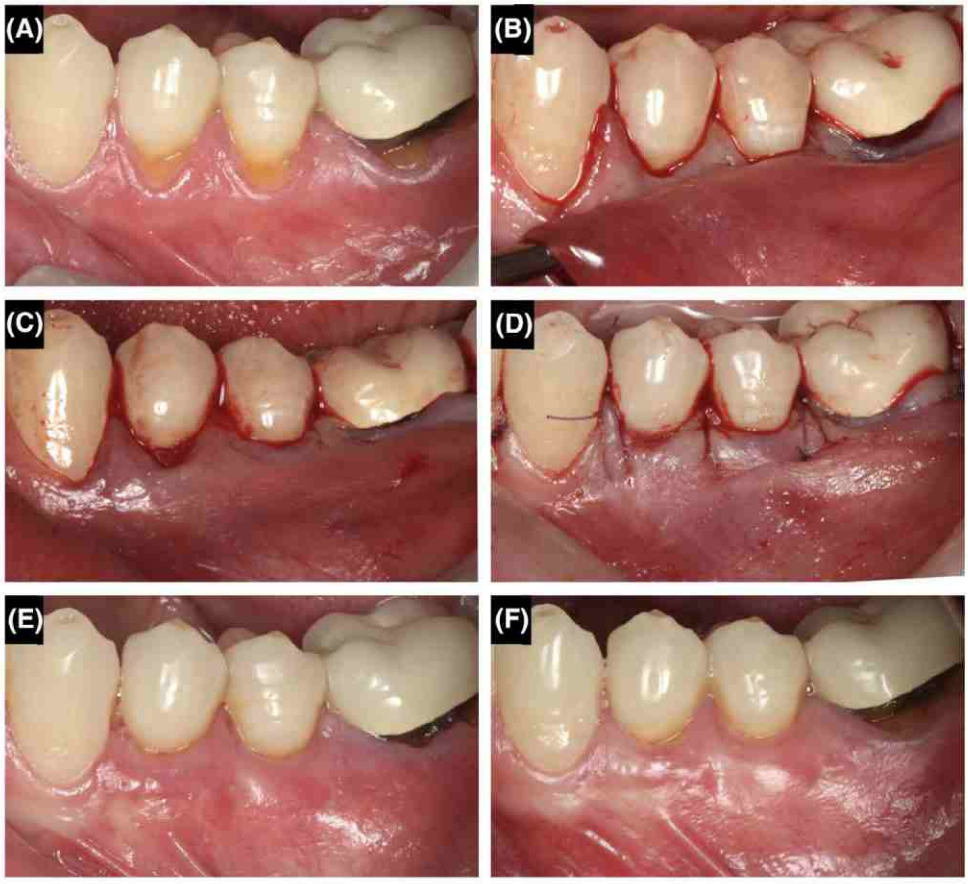


FIGURE 4 Case 3: (A) RT1 buccal gingival recession defects (3–4 mm) were observed from the mandibular left first premolar to the first molar. (B) Tunnel flap was prepared with the full-thickness approach using a vestibular access incision (VAI). (C) Microsurfaced acellular dermal matrix (mADM) was inserted and positioned without any folding. (D) mADM and the flap were sutured using sling sutures. (E) Four weeks postoperatively: healing was uneventful. Complete root coverage on the first and second premolar was observed. (F) One year postoperatively: root coverage outcome remained stable, with natural gingival color and texture.

increased root coverage, as shown in Tables 2 and 3. Additionally, in case 5, while tooth #3 was the primary site treated for gingival recession, the crown on tooth #4 was replaced during the course of treatment. Importantly, all patients reported complete resolution of tooth sensitivity and expressed satisfaction with the final esthetic outcome, effectively addressing their primary concerns regarding periodontal health and sensitivity associated with gingival recession.

DISCUSSION

Over the last 25 years, there have been minimal modifications to the physical properties of ADM. Although ADM has demonstrated clinical success, shortcomings remain when compared to autogenous tissue in the treatment of mucogingival deformities.[5,6] This case series introduces a novel, modified ADM that employs microcuts to increase the material's surface area—a design rationale intended to potentially facilitate graft integration and improve clinical outcomes.[13] In a previous study, Marinelli et al.[13] demonstrated that microsurfaced grafts enhance integration into the wound bed and promote effective healing by increasing the surface area at the graft-to-host interface, leading to greater cellular infiltration and graft thickness. Additionally, the material can be inserted without pre-hydration and rapidly absorbs blood. In comparison, other soft tissue allografts need either a pre-hydration process for several minutes[5] or are packaged in a glycerol saline solution.[21]

In this case series, five patients (mean age 50 years) with a total of 11 RT1 recession defects were treated using mADM. At the 12-month follow-up, significant improvements were observed: the mean REC decreased markedly from 3.64 ± 0.50 mm to 0.73 ± 0.79 mm, and the KTW increased from 2.32 ± 0.81 mm to 3.36 ± 0.92 mm. Additionally, the CAL improved significantly, decreasing from 5.00 ± 0.63 mm to 3.00 ± 0.77 mm. The overall mean %RC reached 80.0%, with CRC achieved in 45.5% of the treated sites. Importantly, all patients reported complete resolution of tooth sensitivity, minimal postoperative discomfort, and no adverse events were observed, supporting the potential of mADM as a viable treatment option for gingival recession defects. Furthermore, in all cases presented, root coverage was increased with good stability up to the 12 months.

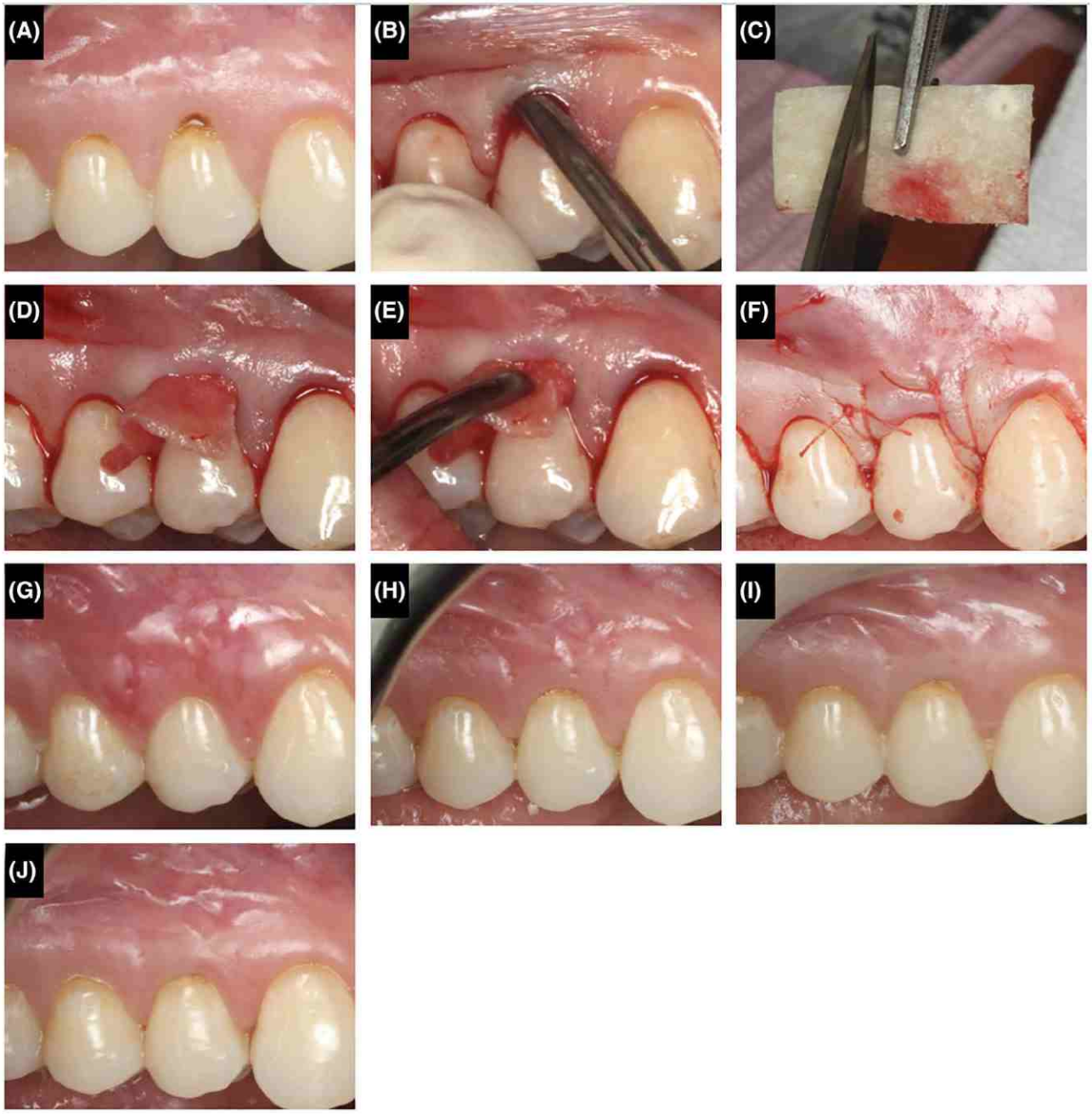


FIGURE 5 Case 4: (A) RT1 buccal gingival recession defect (3 mm) was observed at the maxillary right first premolar. (B) A pouch was prepared through the gingival sulcus of the tooth. (C) Microsurfaced acellular dermal matrix (mADM) was trimmed to a proper dimension. (D) mADM was inserted via the gingival sulcus. (E) mADM was placed into the prepared pouch. (F) mADM and the flap were secured with sling sutures. (G) Two weeks postoperatively: healing was uneventful, with gingival color appearing red and some swelling observed. (H) Three months postoperatively. (I) Five months postoperatively. (J) One year postoperatively: root coverage outcome remained stable, with natural gingival color and texture.

A noteworthy finding in this case series was the complete resolution of tooth sensitivity in all patients at the 12-month postoperative follow-up. A systematic review by Antezack et al. highlighted that dentin hypersensitivity suppression is significantly associated with the %RC achieved and the reduction of exposed root dentin,[22] underscoring the critical role of CRC in addressing tooth sensitivity. The complete resolution of dentin hypersensitivity observed in this case series could be attributed to the high root coverage percentage (80%), similar to the mean root coverage of 80.9%[23] of Miller I and II[24] reported by a systematic review from AAP. These outcomes may indicate that mADM could provide predictable root coverage and improved the dentin hypersensitivity.

Despite the promising outcomes observed in this case series, certain limitations must be acknowledged. First, the lack of a clearly defined clinical CEJ as a reference point for evaluating outcomes was a challenge due to

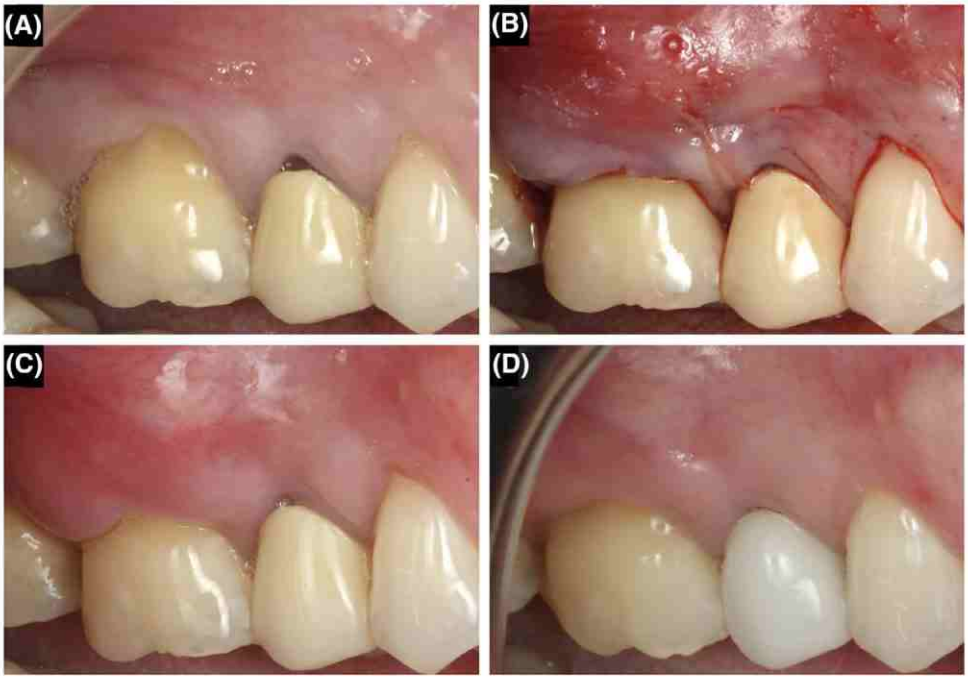


FIGURE 6 Case 5: (A) RT1 buccal gingival recession defect (4 mm) was observed at the maxillary right first molar. (B) Overlying flap and microsurfaced acellular dermal matrix (mADM) were sutured dependently using 5-0 polyglycolic acid (PGA) sling suture. (C) Healing at 4 weeks demonstrates good increases in tissue thickness and root coverage with minimal inflammation. (D) One year postoperatively: the crown on tooth #4 was changed during the course of treatment. Root coverage and tissue thickness gains appear stable with natural soft tissue appearance.

TABLE 3 Clinical outcomes at 12 months.

Outcome (mean ± SD)	Baseline	12 months	Baseline–12 months	*p*-Value
REC (mm)	3.64 ± 0.50	0.73 ± 0.79	2.91 ± 1.04	0.00000327*
PD (mm)	1.45 ± 0.52	1.91 ± 0.30	0.45 ± 0.69	0.0531
KTW (mm)	2.32 ± 0.81	3.36 ± 0.92	1.00 ± 0.45	0.0000227*
CAL (mm)	5.00 ± 0.63	3.00 ± 0.77	2.00 ± 0.77	0.00000646*
CRC (*n*/%)		5/45.5		
RC (%)		80		
Phenotype	Thick	Thick		

Abbreviations: CAL, clinical attachment level; CRC (*n*/%), complete root coverage (number/percentage); KTW, keratinized tissue width; PD, probing depth; RC (%), root coverage percentage; REC, recession depth; SD, standard deviation.
*p-Value < 0.05, statistically significant difference.

unaddressed NCCL. A major challenge in root coverage procedures is accurately identifying the CEJ, particularly when it is obscured by a NCCL. In this study, we utilized the clinical CEJ predetermination method described by Zucchelli et al.[18] to estimate the soft tissue margin after healing. This approach relies on the measurement of ideal papilla height as a reference point, allowing for a predictable assessment of root coverage outcomes. However, the methods to determine the level of the lost CEJ are relatively subjective; therefore, the final result may be compromised in cases where the estimated CEJ is placed more coronally than the previously destroyed CEJ. Second, residual cervical abrasion lesions were not treated in all cases, which may have influenced the final outcomes. Surgical root coverage procedures are less likely to achieve full coverage[25,26] and may have an increased risk of gingival recession recurrence[27] when performed at sites where gingival recession is associated with NCCL. However, studies by Santamaria et al.[26,28] showed treating recession defects with NCCL using restoration materials with SCTG does not alter the root coverage outcome. Notably, the use of resin composite with SCTG resulted in improved gingival contour and greater resolution of dentin hypersensitivity.[26] Third, patient-reported outcome measures were not available due to the retrospective nature of this case series. As a result, we were unable to provide quantitative records assessing esthetic outcomes and dentin hypersensitivity. Fourth, all surgical procedures and clinical assessments were performed by the

same examiner, who was not blinded. This introduces a potential bias that may influence the objectivity of the clinical measurements. Fifth, due to the retrospective nature of the study, examiner calibration was not performed, which may have affected the consistency and reliability of clinical assessments. Sixth, the recipient site preparations across the five cases were not standardized, introducing potential variability in the results. Last, the small sample size limits the generalizability of these findings.

However, the treatment resulted in excellent root coverage without complications such as graft exposure or infection. Additionally, it is worth noting that all patients reported minimal postoperative discomfort and were satisfied with the esthetic outcome. Nonetheless, future randomized clinical trials research with larger sample sizes, standardized protocols, and longer follow-up periods will be essential to compare the initial healing and long-term outcomes of this innovative matrix with other treatment modalities for recession defects.

CONCLUSION

Within the limits of this retrospective case series, our findings indicate that mADM may offer a viable treatment alternative for RT1 gingival recession defects for 12-month period. Future randomized clinical trials are necessary to compare mADM with other options to treat recession defects.

AUTHOR CONTRIBUTIONS

Yu-Chang Wu contributed to data analysis, data interpretation, manuscript preparation, and final approval of the manuscript. Guo-Liang Cheng contributed to data interpretation, manuscript preparation, and final approval of the manuscript. Shaun Rotenberg contributed to the concept of the work, data collection, data interpretation, manuscript preparation, and final approval of the manuscript. Figure 1a,b was provided by Osteogenics Biomedical.

CONFLICT OF INTEREST STATEMENT

This case series did not receive any grant from any funding agency in the public, commercial, or not-for-profit sectors. Dr. Shaun Rotenberg has previously received consulting and lecture fees from Osteogenics Biomedical. However, the surgeries included in this study were performed prior to any consulting he did on soft tissue for Osteogenics. Furthermore, he did not receive any financial compensation related to the cases presented in this study. The authors declare no other conflicts of interest and no financial interests in the companies whose materials were included in this article.

DATA AVAILABILITY STATEMENT

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

PATIENT CONSENT STATEMENT

The authors received verbal and written consent for treatment from all five patients.

ORCID

Yu-Chang Wu https://orcid.org/0009-0003-9847-9434
Guo-Liang Cheng https://orcid.org/0000-0002-3752-986X
Shaun Rotenberg https://orcid.org/0000-0002-8684-1948

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