

A Clinical Study of Direct Composite Full-Coverage Crowns: Long-Term Results

复合树脂直接全冠修复的临床研究：长期疗效观察

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Clinical Relevance

Composite full-coverage crowns are a viable option for teeth with amelogenesis or microdonts and are especially suitable for patients still undergoing growth.

SUMMARY

Objective: Long-term assessment of the clinical behavior of direct composite full-coverage crowns using transparent strip crowns as a matrix.

Method: A retrospective observational study without controls of 21 restorations was performed: nine teeth with hypoplasia, six conoid teeth, and six with microdontia. The mean patient age was 22.5 ± 8.2 years. The clinical procedure consisted of cleaning the tooth, acid etching and application of adhesive, after which a transparent strip crown was filled with composite and placed on the tooth. The gingival contour was polished using multifluted burs and interproximal spaces polished with polishing strips. Patients were examined

after a period of $12.5 (\pm 4.6)$ years by two observers who recorded the plaque index and evaluated the restorations in accordance with the modified U. S. Public Health Service (USPHS) criteria.

Results: Except for one case, all the scores obtained on the basis of the USPHS criteria were within the acceptable range. There were no cases of secondary caries. The statistically significant variations were anatomical form, marginal adaptation, marginal discoloration, and surface roughness.

Discussion: This technique is simple and noninvasive. It is a viable long-term treatment option for teeth with amelogenesis or microdonts and is especially suitable for patients still undergoing growth.

INTRODUCTION

The dental anomalies that most commonly affect the upper lateral incisors are microdontia, conoidism, or a combination of both.¹ Microdontia affects 1.5% to 2% of the population.²

临床意义

复合树脂全冠是修复牙发育不全或过小牙的方案之一，尤其适用于仍处于生长发育期的患者。

摘要

目的：通过Strip透明成形冠作为骨架，对复合树脂直接全冠修复的临床行为进行长期评价。

方法：对21个修复体进行回顾性观察研究（不干预）：9颗牙齿发育不良，6颗锥形牙，6颗过小牙。患者的平均年龄 22.5 ± 8.2 岁。临床操作流程包括清洁患牙、酸蚀、涂布粘结剂、选择合适的Strip透明成形冠后填入复合树脂、置入患牙。Strip透明成形冠的龈缘使用多凹槽车针抛光、邻间隙使用抛光碟抛光。复合树脂修复 12.5 ± 4.6 年后，2名观察者

根据改良美国公共卫生服务（USPHS）标准对患者的菌斑指数及复合树脂修复体进行检查评价。

结论：除一个病例外，所有基于USPHS标准的得分均在允许范围内。所有病例均未发生继发龋。患牙解剖学形态、修复体边缘适合性、边缘变色及修复体表面粗糙度差异均有显著统计学意义。

讨论：本方法简单、无创伤性。对于发育不全或过小牙的长期修复治疗切实有效，尤其适用于仍处于生长发育期的患者。

前言

牙形态异常，包括过小牙、锥形牙或者二者混合发生，多见于上颌侧切牙¹。过小牙发生率约1.5%-2%²。

The term “amelogenesis imperfecta” covers a clinically and genetically heterogeneous group of hereditary disorders. Epidemiological studies of differing populations have shown prevalence to range widely, from one in 700 to one in 14,000. It is classified into three groups — hypoplasia, hypomaturation, and hypocalcification³ — and affects the enamel of both deciduous and permanent dentitions. More rarely, amelogenesis imperfecta is associated with other dental and oral disorders, such as taurodontism, and predominantly extraoral systemic syndromes, such as cone-rod dystrophy, oculodentodigital syndrome, tricho-dentosseous syndrome, nephrocalcinosis, or Usher's syndrome.⁴ Hypoplastic teeth exhibit a varying decrease in the enamel thickness, along with pitting and other irregularities. However, their hardness and transparency are preserved.

Histological alterations are seen in the enamel of teeth affected by amelogenesis imperfecta. Such alterations may affect the quality of the adhesive bond that may be achieved. In particular, hypocalcification reduces the quality of the bond because of the lack of mineralized structure. Some authors consider that deproteinization, through application of sodium hypochlorite a minute after acid etching, can improve enamel bonding in primary teeth,^{5,6} while others prefer to limit the application of orthophosphoric acid to a maximum of 30 seconds in order to prevent further demineralization.⁷

These histological alterations affect the esthetics of the anterior sector. Such teeth are typically restored by indirect

methods, using veneers,⁸⁻¹⁰ porcelain,¹¹⁻¹³ or metal-ceramic¹⁴ crowns. Another option is composite reconstruction,¹⁵⁻²⁰ indicated in growing patients and as a transitional restoration in readiness for future prosthetic rehabilitation.

Strip crowns have been used successfully for many years for restoring carious deciduous anterior teeth,²¹⁻²⁸ serving in the anterior sector as a matrix for a composite reconstruction. Little has been published on their use in permanent teeth.^{29,30} There are very few long-term studies on direct composite restorations that modified the size and form of affected teeth in adult patients. In fact, strip crowns^{31,32} were not used in any study.

The aim of this work was to study the long-term clinical outcome of direct composite complete crowns fabricated using transparent strip crown matrices on caries-free permanent teeth with microdontia, conoidism, or hypoplasia.

MATERIALS AND METHODS

This observational retrospective study without controls assessed a total of 21 restorations provided between 1992 and 2006: 14 in men and seven in women with a mean age of 22.5 ± 8.2 years. All restorations were in the anterior sector, 16 upper and five lower, and without endodontic treatment. There were six conoid teeth, six with microdontia (all upper lateral incisors), and nine with hypoplasia. At the time of the restoration, five patients were receiving orthodontic treatment, none had bruxism, and only one was a smoker (Table 1).

“牙釉质发育不全”包括临床及基因的遗传异质群体。流行病学调查表明不同人群中的“牙釉质发育不全”差别极大：从1/700到1/14000；其可以分为3组—牙釉质发育不良、牙釉质成熟不良、牙釉质矿化不良³—可同时影响乳牙列及恒牙列牙釉质。个别情况下，牙釉质发育不全与其他口腔或牙列疾病（如牛牙症）及口外系统性疾病（如椎体杆体营养不良、眼牙指发育不良综合症、毛发-牙齿-骨综合症、肾钙质沉着症或Usher's综合症）有关⁴。釉质发育不全的患牙釉质厚度有不同程度降低，并伴有窝状缺陷及其他异常。然而患牙的釉质硬度及透明度无改变。

釉质发育不全患牙的釉质可观察到组织学改变，而这种组织学改变可能会影响粘结剂的粘结效能：特别是釉质矿化不良的患牙，由于缺乏矿化结构，粘结剂的粘结效能会降低。一些学者认为乳牙酸蚀后使用次氯酸钠一分钟，可去除乳牙釉质表面的蛋白，从而提高釉质的粘结性能^{5,6}。其他学者提出，使用正畸磷酸酸蚀时不应超过30秒，以避免进一步的

脱矿化⁷。

釉质发育不全的组织学改变同样可影响前牙区的美观。前牙区的患牙通常是通过间接途径，如贴面⁸⁻¹⁰，瓷修复体¹¹⁻¹³或烤瓷冠¹⁴修复。另一种选择是通过复合树脂重建患牙的生理形态及功能¹⁵⁻²⁰，此方法适用于处于生长发育期的患者，同时也可作为后期义齿修复前的临时修复。

Strip透明成形冠已经应用于修复乳前牙龋坏²¹⁻²⁸、作为支架行复合树脂修复中数年，并取得良好的疗效。但Strip透明成形冠应用于恒牙的相关报道较少^{29,30}，关于恢复成人患者患牙大小及形态的复合树脂直接修复体的长期研究报道也较少。事实上，Strip透明成形冠^{31,32}之前并未应用于任何研究中。

本研究的目的是：通过Strip透明成形冠，研究复合树脂直接修复全冠修复恒牙牙体非龋性疾病（过小牙、锥形牙或釉质发育不全）的长期临床疗效。

材料与方法

本回顾性观察研究（不干预）评估1992-2006年间共21个修复体：其中男性患者14个修复体、女性患者7个修复体，平均年龄 22.5 ± 8.2 岁。所有修复体位于前牙区：16个修复体位于上

牙弓、5个位于下牙弓，患牙均未行牙髓治疗。21颗患牙中6颗为锥形牙、6颗为过小牙（以上均为上颌侧切牙）、9颗为釉质发育不全牙。5名患者于修复治疗间同时接受正畸治疗，无人罹患磨牙症，只有1名患者吸烟（表1）。

Table 1: Teeth Included in the Study / 表1：本研究纳入患牙

Age 年龄	Sex 性别	Tooth 牙位	Anomaly 诊断	Year of Treatment 治疗时间	Adhesive 粘结剂	Composite 复合树脂	Plaque Index 菌斑指数	Restorations Years 修复年限
47	F / 女	22	Conoid / 锥形牙	1992	Scotchbond 2	XRV	0	18
31	M / 男	12	Microdontia / 过小牙	1992	Scotchbond 2	XRV	2	18
32	M / 男	22	Microdontia / 过小牙	1993	Scotchbond 2	XRV	2	17
16	M / 男	21	Hypoplasia / 牙发育不全	1994	Scotchbond 2	TPH	0	16
16	M / 男	11	Hypoplasia / 牙发育不全	1994	Scotchbond 2	TPH	0	16
16	M / 男	31	Hypoplasia / 牙发育不全	1994	Scotchbond 2	TPH	1	16
16	M / 男	41	Hypoplasia / 牙发育不全	1994	Scotchbond 2	TPH	1	16
22	F / 女	22	Conoid / 锥形牙	1994	Scotchbond 2	TPH	1	16
17	M / 男	22	Hypoplasia / 牙发育不全	1995	Prime&Bond 2.0	TPH	0	15
17	M / 男	12	Hypoplasia / 牙发育不全	1995	Prime&Bond 2.0	TPH	0	15
17	M / 男	32	Hypoplasia / 牙发育不全	1995	Prime&Bond 2.0	TPH	1	15
17	M / 男	42	Hypoplasia / 牙发育不全	1995	Prime&Bond 2.0	TPH	1	15
23	F / 女	12	Microdontia / 过小牙	1997	Prime&Bond 2.1	XRV	0	11
23	F / 女	22	Microdontia / 过小牙	1997	Prime&Bond 2.1	XRV	0	11
32	F / 女	12	Microdontia / 过小牙	2000	Prime&Bond NT	TPH	0	10
33	F / 女	22	Microdontia / 过小牙	2001	Prime&Bond NT	TPH	0	9
26	F / 女	12	Conoid / 锥形牙	2001	Prime&Bond NT	A110	0	9
19	M / 男	43	Hypoplasia / 牙发育不全	2002	Prime&Bond NT	TPH	1	8
13	M / 男	22	Conoid / 锥形牙	2001	Prime&Bond NT	A110	2	4
16	M / 男	22	Conoid / 锥形牙	2006	Prime&Bond NT	XRV	2	4
16	M / 男	12	Conoid / 锥形牙	2006	Prime&Bond NT	XRV	2	4

All participating patients signed an informed consent form. The study was approved by the Ethics Committee of the Faculty of Medicine and Dentistry of the University of Santiago de Compostela.

The restorations in this study were performed at a private clinic by the same operator. The clinical procedure used was as follows. Infiltration anesthesia was administered. A mouth opener was applied and gauze placed on the tongue. Nonimpregnated retraction cord was introduced in the gingival sulcus to improve access to this area. Wedges were placed in cases where interproximal contacts could interfere with the gingival adjustment of the crown. Additionally, it was necessary to separate adjacent teeth with wedges to compensate for the thickness of the matrix and avoid diastemas. The choice of crown was made according to form and size, aiming for a mesiodistal diameter that matched as closely as possible the tooth's gingival contour. The crown should normally be of a slightly larger size to compensate for the thickness of the matrix and the removal of material during polishing and esthetic recontouring. The crown was then trimmed back gingivally to obtain the correct height, and a hole was made in the palatal area of the matrix to allow any excess resin to escape when placing the crown on the tooth. The tooth was subsequently cleaned with pumice powder, taking care not to cause the gums to bleed. This was followed by etching with 37% orthophosphoric acid for 20 seconds, rinsing, and drying. Before curing the adhesive, it was verified

that there was no contact with adjacent teeth. The adhesives used were Scotchbond 2 in eight cases, Prime & Bond 2.0 in four cases, Prime & Bond 2.1 in two cases, and Prime & Bond NT in seven cases.

The composites used were TPH Spectrum (Dentsply- Detrey, Konstanz, Germany) in 12 cases, Herculite XRV (Kerr, Orange, CA, United States) in seven cases, and Filtek A110 (3M ESPE, Seefeld Germany) in two cases. Medium or "body" opacity and a single color were used for all teeth. Frasaco® strip crowns (Franz Sachs & Co, Tettngang, Germany) were used in all cases. They have a thickness of 0.20 to 0.30 mm. Six different sizes are available for the upper incisors and three for the lower incisors. When filling the strip crown forms, it was important to avoid the formation of pores, especially in the corners of the incisal edge. Deformation of the crown by pressing too hard with the fingers was avoided. Any excess material escaping from the gingival area and palatal opening was removed with an explorer. The vestibular and palatal surfaces were light cured, and the crown was finally removed by breaking it with an explorer.

The gingival area was polished with multifluted tungsten burs, and an explorer was subsequently used to verify the uniformity of the surface and the absence of ridges. Strips were used in the interproximal area, and vestibular and incisal areas were finished and recontoured with discs. Occasionally, occlusal adjustment required removal of composite resin from the palatal area, possibly exposing the tooth surface.

所有纳入患者签署知情同意书。本研究经圣地亚哥口腔医学院伦理委员会批准后进行。

本研究中所使用的修复体均来自一私人诊所的同一技工。临床流程如下：局部浸润麻醉、应用开口器并于舌侧垫以纱布、未浸湿的退缩绳置入龈沟以暴露牙颈部、对于邻面接触可能影响Strip透明成形冠龈缘调改的患牙需置入楔子。除此之外，楔子可分开相邻牙，以补偿成形片的厚度，避免间隙的形成。透明成形冠的选择取决于其大小及形态，选择合适成形冠的标准是成形冠的近远中径尽可能接近于患牙的牙龈轮廓。成形冠常规应略大于患牙大小，以补偿Strip骨架的厚度及抛光、美学重建中所磨除的材料。修剪成形冠龈缘以得到合适的高度，在透明成形冠的腭侧穿一个孔，作为填入复合树脂的透明成形冠就位时多余材料的排溢孔。然后以浮石粉清洁患牙，注意勿使牙龈出血。以37%正畸磷酸蚀20秒，清水冲洗后吹干。在光固化粘结剂前，需保证患牙与邻牙无接触。8个病例使用的粘结剂为 Scotchbond 2，4个病例使用的则为Prime & Bond 2.0，2个病例为Prime & Bond 2.1，剩余7个病例为Prime & Bond NT。

12个病例使用的复合树脂为TPH Spectrum（登士柏，康斯坦茨，德国）、7个病例使用的是Herculite XRV（科尔，橘城，加州，美国）、2个病例为Filtek A110（3M ESPE，泽费尔德，德国）。所有牙齿使用中度或“体部”透明度及单色复合树脂。所有病例使用 Frasacot Strip 透明成形冠（Franz Sachs & Co，泰特南，德国）；其厚度约0.20-0.30mm；上颌切牙共用6种规格的成形冠，下颌切牙使用3种。成形冠填入复合树脂时，需避免气泡的产生，尤其是切嵴处。同样要避免手指用力过度致成形冠变形。用探针去除颈缘及排溢孔溢出的多余材料。患牙唇颊侧光固化，最后用探针破坏成形冠并去除。

复合树脂修复体龈缘以多凹槽钨钢车针抛光，然后使用探针检查修复体表面是否均匀一致、是否存在悬突。修复体邻面接触区以抛光条抛光，唇颊侧则以抛光碟修整。从腭侧去除牙合面多余的复合树脂，以暴露牙体组织。

使用医用尼康120mm镜头拍摄治疗前、治疗中、治疗后及检查过程中的口内像（图1）。2名经过专门训练的口腔研究生



Fig. 1: (A) Tooth 12 with microdontia; the only procedure required is cleaning of the tooth with pumice powder. (B) The strip crown with composite filling is placed on the tooth; excess material is removed prior to polymerization. (C) Restoration is complete after one week.

图1: (A) 12过小牙; 所需治疗仅为浮石粉清洁患牙12 (B) 填入复合树脂的Strip成形冠戴入患牙; 固化前去除溢出的材料 (C) 修复体完成一周后

Photographs were taken pre-, intra-, and postoperatively and during the examinations using a Medical Nikkor 120-mm lens (Fig. 1). The examinations were conducted by two external evaluators, postgraduate dental students specifically trained for this study. The postoperative evaluation was based on photographs taken seven days after completion of the restoration.

Restorations were assessed clinically in 2008 and 2010 (after 12.5 ± 4.6 years). The mean patient age was 35.0 ± 10.2 years. Dental health was evaluated by means of the Silness and Loe³³ plaque index in accordance with U.S. Public Health Service (USPHS) criteria modified by van Dijken^{34,35} (Table 2). The SPSS

(version 17, IBM, New York, USA) software was used for the statistical analysis and the Kaplan-Meier analysis for estimating survival curves.

RESULTS

Based on the analysis of the immediate postoperative photographs, the examiners gave a score of 0 in all categories of the USPHS criteria. In the examinations, the criteria obtaining statistically significant ($p < 0.05$) values were anatomical form, surface roughness, marginal discoloration, and marginal adaptation (Table 3), with the greatest changes being found in the last three (43%, 62%, and 43%, respectively). However, all scores were in the “acceptable” range except for one case.

对患者进行检查。治疗后的评价基于复合树脂修复体完成后7天所拍摄的口内像。

复合树脂修复体的临床评价分别于2008年及2010年进行（修复后 12.5 ± 4.6 年），此时患者的平均年龄为 35.0 ± 10.2 岁。采用与美国公立健康服务标准（USPHS，经van Dijken^{34,35}改良）相一致的 Silness and Loe 菌斑指数评估患者口腔卫生（表2）。使用SPSS软件（version 17, IBM, 纽约, 美国）进行统计学分析；使用卡普兰-迈耶分析估算生存率。

结果

基于术后即刻口内像，检查者依据USPHS标准给予各检查内容0分作为基准。检查结果显示，复合树脂修复体的解剖形态、边缘变色及边缘适合性差异有统计学意义（ $p < 0.05$, 表3），其变化最大（分别为43%、62%、43%）。然而，除一个病例外，其余的得分均处于“可接受”的范围内。

根据USPHS标准，仅于1例修复体色泽发生改变，但所有病例均无继发龋发生。6例修复体的解剖学形态发生改变：其中4例因殆面局部减小所致，1例外形凸度过小，最后1例（图2）的原因是牙本质暴露区修复体折裂，因此只得2分（不可接受）。

关于边缘适合性，9例可通过探针检查出修复体边缘，表明存在隐蔽的间隙（得分：1）。边缘变色方面，11例轻度染色，但可以通过抛光去除（得分：1）；2例则无法通过抛光去除（得分：2）。而对于修复体表面粗糙度而言，9例存在微小凹坑（得分：1，图3、4）。

21个复合树脂冠中，只有1例10年后因部分折裂需修补。3个病例在经过4及11年的正畸治疗后考虑更换为瓷修复体（图5）。

2年随访的生存率分析为95.2%，10年的生存率为88.9%，11年后为75.2%。11年之后的生存率保持稳定。

Table 2: Modified USPHS Criteria for Direct Clinical Evaluation of the Restorations / 表2: 依据改良USPHS标准对修复体进行临床评价

Category 检查内容	Score 得分		Criteria 标准
	Acceptable 可接受	Unacceptable 不可接受	
Anatomical form 解剖形态	0		The restoration is continuous with tooth anatomy 修复体与牙体外形连续一致
	1		Slightly under- or overcontoured restoration; marginal ridges slightly undercontoured; contact slightly open (may be self-correcting); occlusal height reduced locally 修复体外形凸度过小或过大; 边缘嵴外形凸度恢复过小; 无邻面接触(轻度, 可自我调整); 局部咬合高度降低
		2	Restoration is undercontoured, dentin or base exposed; contact is faulty, not self-correcting; occlusal height reduced, occlusion affected 修复体外形凸度过小, 牙本质或基质暴露; 邻面接触异常, 无法自我调整; 咬合高度降低, 影响咬合
		3	Restoration is missing or traumatic occlusion; restoration causes pain in tooth or adjacent tissue 修复体脱落或创伤殆; 修复体致牙齿或相邻组织疼痛
Marginal adaptation 边缘适合性	0		Restoration is continuous with existing anatomic form; explorer does not catch 修复体外形与显存解剖形态相一致; 探针检查无勾住感
	1		Explorer catches, no crevice is visible into which explorer will penetrate 探针检查有勾住感, 但无可见的间隙, 探针不可穿入
	2		Crevice at margin, enamel exposed 龈缘间隙存在, 牙釉质暴露
		3	Obvious crevice at margin, dentin or base exposed 龈缘明显的间隙, 牙本质或基质暴露
		4	Restoration mobile, fractured, or missing 修复体松动、折裂或脱落
Color match 色泽匹配性	0		Very good color match 极佳的色泽匹配
	1		Good color match 良好的色泽匹配
	2		Slight mismatch in color, shade, or translucency 色泽匹配、渐变或透明性轻度不佳
		3	Obvious mismatch, outside the normal range 色泽明显的 mismatch, 超出正常范围
		4	Gross mismatch 色泽显著的不匹配
Marginal discoloration 边缘变色	0		No discoloration evident 无明显的变色
	1		Slight staining, can be polished away 轻度着色, 可通过抛光去除
	2		Obvious staining can not be polished away 明显着色, 不可通过抛光去除
		3	Gross staining 显著着色
Surface roughness 表面粗糙度	0		Smooth surface 表面光滑
	1		Slightly rough or pitted 轻度粗糙或小凹坑
	2		Rough, cannot be refinished 粗糙, 无法返工修光
	3		Surface deeply pitted, irregular grooves 深凹坑, 不规则的沟裂
Secondary caries 继发龋	0		No evidence of caries contiguous with the margin of the restoration 未发现龋坏, 牙体与修复体边缘连续一致
		1	Caries is evident contiguous with the margin of the restoration 修复体边缘可检出龋坏

Table 3: USPHS Criteria Values at Follow-Up^a / 表3: 依据USPHS标准对随访结果评分

USPHS Criteria Value USPHS标准得分	Anatomical Form 解剖形态	Marginal Adaptation 边缘适合性	Color Match 色泽匹配性	Marginal Discoloration 边缘变色	Surface Roughness 表面粗糙度	Secondary Caries 继发龋
0	15	12	20	8	12	21
1	5	9	1	11	9	0
2	1	0	0	2	0	-
3	0	0	0	0	0	-
4	-	0	0	-	-	-
	<i>p</i> =0.031*	<i>p</i> =0.004*	<i>p</i> =1.000	<i>p</i> =0.000*	<i>p</i> =0.004*	<i>p</i> =1.000*

a. USPHS标准对所有检查项目均予0分作为基准, n=21

* 显著统计学意义, *p*<0.05



Fig. 2: (A) 47-year-old woman with conoid tooth 22. (B) Completed restoration; an indentation on the buccal surface can be observed, caused by excessive pressure exerted with the fingernail when placing the transparent strip crown. Composite used: Herculite XRV (Kerr). (C and D) State of the restoration after 18 years; this was the only case included in the study where an unacceptable score was obtained (anatomical form) due to fracturing of the restoration.

图2: (A) 女, 47岁, 22锥形牙 (B) 复合树脂全冠; 22唇面可见压痕, 戴入Strip透明成形冠是指甲施力过度所致。复合树脂: 钢化玻璃XRV (科尔) (C、D) 修复18个月后的修复体; 此为本研究唯一得分为“不可接受”的病例(解剖形态): 修复体折裂



Fig. 3: (A) 23-year-old woman with microdontia in both upper lateral incisors. At the time of the restoration, the subject was undergoing orthodontic treatment. (B) Restoration is complete after one week. The composite used was Prodigy (Kerr). (C) Appearance of the restoration after 11 years.

图3: (A) 女, 23岁, 12、22过小牙。修复治疗阶段同时接受正畸治疗 (B) 一周后修复体完成。所使用的复合树脂为Prodigy (科尔) (C) 11年后修复体外观

According to the USPHS criteria, a color change was observed in only one restoration, but there were no cases of secondary caries. The anatomical form of the crowns varied in six cases. Of these, four were due to locally reduced occlusal surface, one was due to slight undercontouring, and the last, which obtained a score of 2 (not acceptable), was due to fracturing where the dentin was exposed (Fig. 2).

Regarding marginal adaptation, in nine cases the margin was detectable with the explorer, showing an invisible gap (score of 1). As for marginal discoloration, in 11 cases there was slight staining that was removable by polishing, obtaining a score of 1, and two cases showed a stain that could not be polished out (score of 2). Nine restorations presented small pores and obtained a score of 1 for surface roughness (Fig. 3 and 4).

Of the 21 composite crowns, only one had to be repaired after 10 years because of partial fracture. In three cases, the patients decided to change them for ceramic crowns at the end of the orthodontic treatment after four and 11 years (Fig. 5).

DISCUSSION

The crowns were chosen according to size and shape, with a mesiodistal diameter that fitted as well as possible to the gingival contour of the tooth. Crowns should be slightly longer than the tooth to compensate for the thickness of the matrix and material removal during polishing and esthetic recontouring. Pore formation should be avoided, especially in the incisal angles, when filling the transparent crown. During insertion onto the tooth, distortion of the crown due to excessive finger pressure should also be avoided.

Survival analysis after two years of follow-up was 95.2%, 88.9% after 10 years, and 75.2% after 11 years. From 11 years on, the survival rate remained constant.



Fig. 4: Conoid tooth 12 restored with composite A110 (3M ESPE); appearance after 9 years. Observe the healthy gingival margin and the long-term esthetic behavior of the composite

图4: 以复合树脂A110 (3M ESPE) 修复12锥形牙; 9年后修复体外观。可观察到健康的游离龈缘及复合树脂长期的美学性能

This procedure simplifies the fabrication of the restoration. No composite modeling or layering is required, just recontouring and polishing. A full coverage crown is completed in a single step. In orthodontic treatment where microdontia is very marked or associated with conoidism, applying this clinical procedure provides a greater facial surface for bracket adhesion³⁶ and simultaneously improves tooth esthetics. Therefore, in such cases a tooth cannot be treated when a bracket has already been attached.



Fig. 5: (A) A 16-year-old male with microdontia of the upper right lateral incisor that will be orthodontically treated. (B) Try-in of the strip crown to evaluate the gingival fit, the mesiodistal diameter, and its size. (C) Insertion of the strip crown with composite, excess composite exits through the hole previously made in the palatal region of the matrix. (D) The strip crown is removed by breaking it through forcing a probe up from the gingival margin. (E and F) Gingival polishing with multifluted tungsten burs with non cutting tips. (G and H) Revision after seven days. The bracket is later placed. (I) Evaluation after four years.

图3: (A) 男, 16岁, 12过小牙, 将接受正畸治疗 (B) 试戴Strip透明成形冠以评估其龈缘适合性、近远中径及其大小 (C) Strip成形冠填入复合树脂, 戴入后多余的复合树脂从成形冠腭侧排溢孔排出 (D) 用探针从龈缘楔入Strip成形冠并翘除 (E、F) 使用多凹槽钨钢车针 (不使用切割车针) 抛光修复体龈缘 (G、H) 7天后调改, 稍后粘结托槽 (I) 4年后再评价

讨论

透明成形冠的选择取决于其大小及形态, 选择标准是成形冠的近远中径尽可能适合患牙的牙龈轮廓。成形冠应略大于患牙大小, 以补偿Strip骨架的厚度及抛光、美学重建中所磨除的材料。成形冠填入复合树脂时, 需避免气泡的产生, 尤其是切嵴处。戴入成形冠时, 同样要避免手指用力过度所致的成形冠变形。

该治疗简化了修复体的制作流程: 无需塑形及分层固化, 修整轮廓及抛光即可; 全冠仅需一步即可完成。正畸治疗中, 若过小牙十分明显或伴有锥形牙, 通过该治疗可为托槽粘结提供更好的粘结表面 (唇面)³⁶, 同时可提高牙齿美观性。若患牙已经粘结有托槽, 则无法行该治疗方法。

本文中, 所有的修复体均为复合树脂全冠 (肉眼不可见修复

体-牙界面), 这点可能会提高修复体长期的美观性。12.5 ± 4.6年后, 所有21例复合树脂全冠中有20例具有良好的色泽匹配性、15例维持其解剖形态。本研究中, 52%的复合树脂修复体应用于小于19岁的年轻患者。作者认为, 该技术对于仍处于生长发育期的患者是可供选择的治疗方案。

Peumans及其他学者^{31,32}评价矫正前牙区牙体形态及位置的复合树脂修复体: 5年后, 约56%的修复体仍保持其美观的色泽, 但由于修复材料的损失, 只有20%的修复体可维持其解剖形态。Peumans认为修复体的大小是其美观性能的决定因素。除此之外, 他们发现中切牙的美观性最佳, 依次为尖牙、侧切牙。Peumans报道约89%的修复体因碎片折裂致颈区变色, 同样可致边缘适合性的丧失及微渗漏; 除此之外, 他们未发现继发龋, 但只有5%的修复体具有理想的边缘。

In this work, all the restorations were full coverage composite crowns with no restoration-tooth interface on the visible surfaces, a fact that possibly enhanced the long-term esthetic results. Of the 21 composite crowns, 20 showed a good color match, and 15 preserved well their anatomical shape after 12.5 ± 4.6 years. In this study, 52% of the restorations were carried out in patients younger than 19 years of age. In the view of the authors, this technique could be the treatment of choice in patients still undergoing growth.

Peumans and others^{31,32} studied direct composite restorations correcting form and position in the anterior sector. They reported that after five years, these restorations maintained a perfect color in 56% of cases, but only 20% retained their anatomical form as a result of restoration material loss. They considered that the size of the restoration was a determining factor for esthetics. Moreover, they found that central incisors performed best, followed by canines and then lateral incisors. In 89% of their cases, they reported cervical region discoloration due to chip fractures, leading to loss of adaptation and consequent microfiltration. Additionally, they found no recurrence of caries, and only 5% of their restorations presented perfect margins.

No cases of secondary caries were observed in this study. An influencing factor could be that decayed teeth were not restored without prior cavity preparation. Marginal adaptation obtained scores of zero in 12 cases (57%) and one in the remainder. Marginal discoloration scored zero in eight cases (38%) and one in 11 cases (52%).

In a study comparing metal-ceramic crowns with composite reconstructions, it was concluded that while composites suffered more fractures, they were at least reparable, especially in the anterior sector. However, failures in metal-ceramic crowns tended to involve root-canal treatments and extractions. They also reported that there were no statistically significant differences in durability between the two types of restorations over a 10-year period.³⁷ In this study, only one fracture occurred and was easily reparable, requiring only composite to be added to the existing

restoration. Endodontic therapy was not required later in any case.

Little exists in the literature regarding composite reconstruction of permanent teeth using a strip crown as a matrix.^{29,30} However, there are several studies analyzing their performance in carious deciduous teeth²¹⁻²⁸ and teeth with amelogenesis imperfecta.³⁸ A review of the literature²⁴ concluded that while esthetic results are satisfactory, more prospective studies are needed to validate the technique. Kupietzky and others²² used this technique on 112 carious deciduous incisors in 40 children and found none had lost the complete restoration after assessment at 18 months, the retention rate being 88%. Another study by the same authors²⁵ examined 145 restorations of deciduous upper incisors with caries. After three years, not a single restoration had been lost, and only two of them showed radiographic evidence of pulpal pathology. In another study, Ram and others²³ concluded that more than 80% survived successfully for at least two years and reported that the retention rate was lower in teeth with caries affecting three or more surfaces.

In some studies, hypoplasia in the anterior sector was treated using porcelain veneers,¹⁰ porcelain crowns,¹² or metal ceramic crowns.¹⁴ Others, on the other hand, opted for composite restorations¹⁵⁻¹⁸ but without the use of strip crowns.

This clinical procedure does not require any preparatory tooth drilling, and there is therefore no biological cost attached to it, and the adhesion is entirely on the enamel. It is a reversible, reparable, and modifiable treatment and moreover does not preclude the use of a different technique in the future. Because it is performed in a single clinical session, it could be considered a technique with hardly any contraindications.³⁰

The authors believe that the long-term outcomes in the cases performed using this clinical technique are satisfactory. However, further studies with a larger sample size are needed in order to assess the longevity of these restorations for the indications described.

本研究中未发现继发龋，一个影响因素可能为龋坏牙若未经去腐则不充填。12个病例（57%）中的边缘适合性得分为0，其余9例得分为1。对于边缘变色而言，8例（38%）修复体得分为0，11例（52%）得分为1。

某比较烤瓷冠与复合树脂冠的研究报道显示，当发生折裂时，复合树脂至少是可以修补的，尤其对于前牙区而言。然而，失败的烤瓷冠病例往往需要进行根管治疗或拔除。该文还报道超过10年的观察显示，两种类型修复体的使用年限无

显著统计学意义³⁷。本研究中，只有1例修复体发生折裂且易于修补（仅需于现有充填体上行复合树脂修补），所有病例均无需行牙髓治疗。

现有文献关于使用Strip透明冠以复合树脂冠修复恒牙的相关报道较少^{29,30}。然而仍有其在乳牙龋坏²¹⁻²⁸及釉质发育不全³⁸中应用的相关报道。某综述²⁴认为，虽然该技术的美观性比较理想，但仍需更多的前瞻性研究以明确该方法的疗效。Kupietzky及其他学者²²应用该技术于40名儿童的112颗乳

切牙龋坏的修复治疗中, 18个月后评估发现无一修复体脱落, 保留率为88%。Kupietzky的另一项研究²⁵检查145例上颌乳切牙龋坏的复合树脂修复体, 3年后复查发现无一修复体脱落、只有2例通过影像学检查出牙髓病变。另一项研究中, Ram及其他学者²³证实复合树脂冠2年后的保留率超过80%, 且对于龋损涉及3面或多面的患牙, 复合树脂冠的保留率降低。

某些研究中, 前牙区的牙发育不全是以瓷贴面¹⁰、全瓷冠¹²或烤瓷冠¹⁴修复; 另一方面, 有些则选用复合树脂进行修复¹⁵⁻¹⁸,

但未使用Strip成形冠。

该临床操作流程无需任何牙齿预备, 因此无任何牙体损失, 冠粘结面均为牙釉质。复合树脂冠可逆、可修补、可调改, 更重要的是不影响后期其他修复体的制备。因为该技术在一次临床会议上介绍并演示, 所以应视为一项无任何禁忌的修复技术³⁰。

作者认为本技术的远期疗效理想。然而, 后期仍需加大样本量以评估复合树脂冠寿命及其适应症。

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