



Claire Burgess



Dominic Hassall

An Introduction to a Modern Procedure for Anterior Composite Restorations and Black Triangle Closure Using a Novel Matrix System: Part 1

Abstract: The Bioclear Method is a modern approach to direct composite restorations that gives both patients and dentists the longevity, both cosmetically and functionally, that they desire. This article explains the principles of the Bioclear Method and presents clinical cases where the Bioclear Method has been used. The article also includes examples of black triangle closure, a patient concern that practitioners have been reluctant to treat in the past using traditional composite methods.

CPD/Clinical Relevance: This article highlights a clinically relevant and modern method that can be used for placing all direct composite restorations.

Dent Update 2023; 50: 117–125

Patients and dentists look to direct composite restorations as a way for replacing existing stained or metallic restorations, repairing chipped or fractured teeth, correcting the shape of teeth, and correcting spaces (including black triangles) between teeth. Issues that both patients and dentists have with traditional layered composite restorations is the high level of chipping and staining that can occur, often within a short period of time.¹ The Bioclear Method (Bioclear,

Tacoma, WA, USA) is a modern approach to direct composite restorations that potentially gives both patients and dentists a systematic set of procedures that simplify composite techniques to create predictable patient-centred outcomes.

Composite resin materials

Composite resins, a combination of monomers and filler particles, were first

introduced to dentistry in the 1960s. Over time there have been advances with both the composite materials and their ability to bond to tooth structure. Development of the acid-etch technique by Buonocore, and the Bis-GMA resin by Bowen, transformed composite restorations.^{2–5} Bonding to enamel is highly predictable as it consists of 96% inorganic apatite.⁶ Bonding to dentine, however, still remains less predictable because it consists of an inorganic apatite within a collagen and water matrix.⁷ The bond with dentine, especially secondary dentine, degenerates over time, resulting in reduced long-term stability. The development of the total etch technique helped to compensate

Claire Burgess, BDS (Birm), MFGDP (RCS Eng), MSc Restorative + Cosmetic Dentistry (UCLan), Smile Concepts, Solihull. **Dominic Hassall**, BDS, MSc (Manc), FDS RCPS (Glasg), MRD RCS (Edin), FDS (Rest Dent), RCS (Eng), Restorative, Prosthodontic and Periodontal Specialist, Training Institute, Solihull.
email: claire.burgess@burgess-dental.co.uk

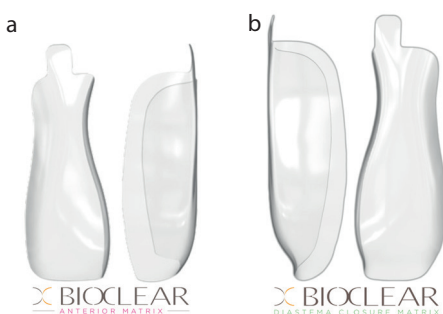


Figure 1. (a) Anterior and (b) diastema closure Bioclear matrices.

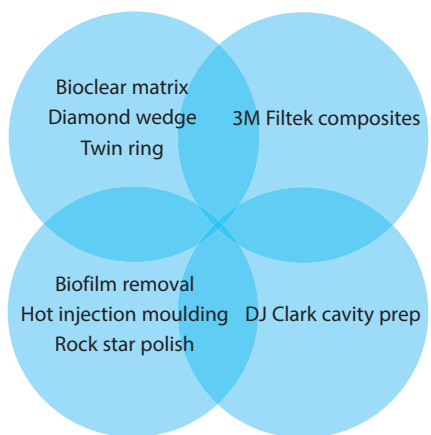


Figure 2. Venn diagram showing the components of the Bioclear Method (courtesy of Dr David Clark).

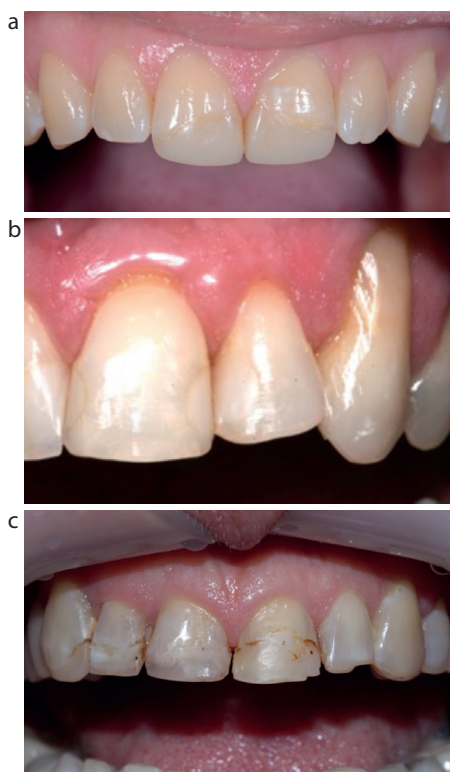


Figure 3. (a–c) Traditional layered composite restorations showing staining, greyness and chipping (courtesy of Dr Claire Burgess and Dr David Clark).

for this by increasing the bonding strength of the composite to the dentine. Through the application of 37% phosphoric acid to the dentine for a maximum of 15 seconds, the total etch technique removes the smear layer, opens the tubules and decalcifies the coronal intertubular dentine. This results in a dense collagen network that can then be penetrated by resin.^{8–10}

The method of traditional direct composite restorations involves incrementally layering composite as close to a finished contour of the restoration as possible, with shaping of the composite, once cured, being kept to a minimum. Finishing routinely involves a combination of discs/burs/polishing cups and pastes.

The longevity of an amalgam restoration may be up to 30 years if all clinical stages are optimised.^{11–13} Traditional layered anterior composite restorations in general dental practice have an annual failure rate of 4.6% at 5 years.¹⁴ This is influenced by the position of the tooth being restored, the type of restoration, patient age, and operator skill.¹⁴ Issues with composites include chipping, especially of incisal edge areas, rough surface texture, and staining developing at the margins of the restorations.¹⁵ The existing approach of the combination of the amalgam material, cavity design, material placement technique and finishing is predictable for amalgam restorations. Unfortunately, this is not true for composite restorations.^{11,12} The same predictability from composite restorations as for amalgam restorations would be desirable.

The following properties for composite materials would be ideal: smooth non-sticky handling, easy to sculpt/contour, moisture tolerant, non-shrinkage, lack of water absorption post-cure and good long-term polish.

The Bioclear Method

The development of the Bioclear Method dates to 2007, when Dr David Clark introduced the anterior Bioclear matrices. These are patented clear cellulose acetate anatomical matrices that can be used to form the interdental shape of anterior restorations (Figure 1). They were invented to replace non-anatomical clear Mylar strips, used by most dentists to recreate the interdental anatomy of the restoration. The Bioclear matrices became available in the UK in 2012 and can improve the emergence profile and shape of anterior composite restorations.

Developing on from these, matrices for the placement of all direct composite restorations – anterior Class III, diastema closure, posterior Class II, direct composite overlay or direct composite veneer were introduced.

The five pillars of the Bioclear method

The method encompasses five pillars: biofilm removal; composite materials; cavity design; composite placement and finishing methods; and anatomical matrices (Figure 2). The aim is to combine all elements of composite restorations to produce predictable long-lasting outcomes.

It can be difficult to simultaneously master marginal adaption, form and shade.¹⁶ Traditional layered placed composite restorations require a high-skill level to produce predictable long-term results. The restorations can have flat emergence profiles, textured surfaces, and appear greyer due to increased translucency (Figure 3). The aim for the development of the Bioclear Method was to provide all dentists with a systematic set of steps and tools/techniques that simplified composite procedures to create predictable outcomes. If followed, these steps may allow for longer-lasting and aesthetically superior composite restorations.

The aims of the Bioclear Method are to:

- Preserve and respect the biomechanics of the natural tooth;
- Replace deficient, missing and diseased tooth structure;
- Thicken and opacify the aged and translucent tooth.

The majority of anterior composite systems use a standard three-layer technique to achieve biomimetics. These three layers often consist of a dentine anatomical-like core, a translucent enamel-like outer layer, and a translucent/transparent incisal edge material. The result of the restorations can be an increased level of greyness or translucency.

Bioclear restorations incorporate a single 'body' shade of 3M Filtek Supreme XTE restorative (3M, MN, USA), which helps to mask translucency while providing a natural appearance. With the Bioclear Method a single shade of paste and flowable are used for the restorations. Therefore, it is important that there is a good shade match between the flowable and corresponding paste composites. This is the case for 3M Filtek dental restoratives,

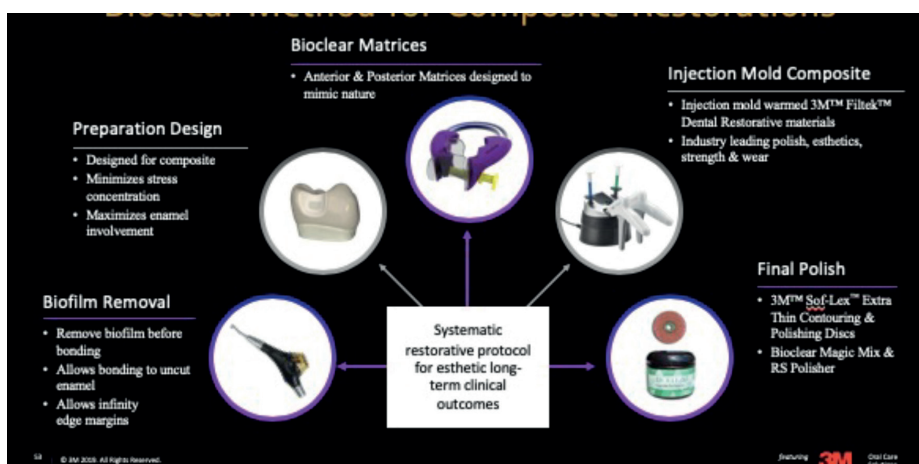


Figure 4. The five pillars of the Bioclear Method (courtesy of 3M and Dr David Clark).

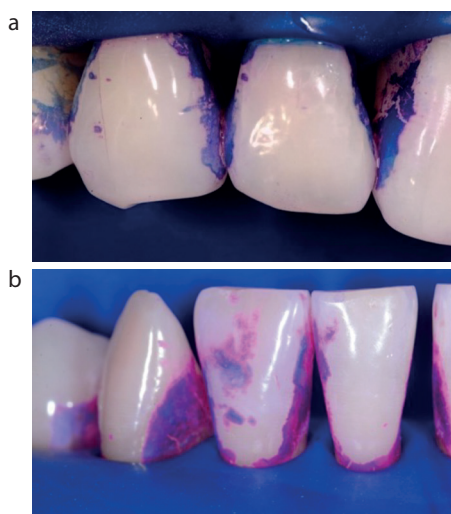


Figure 5. (a,b) Teeth disclosed showing biofilm (courtesy of Dr David Clark).

and is one of the reasons they work well with the Bioclear Method.

Each of the Bioclear Method's five core pillars is mandatory for producing a predictable result (Figure 4):

- Biofilm removal;
- Modern composite cavity design;
- Anatomically shaped matrices;
- Warm injection moulding of composite, preferably 3M Filtek Supreme XTE restorative;¹⁷
- Two-step 'rock star' (high surface) polish.

Biofilm removal

It is well reported that biofilm removal in relation to indirect dentistry can result in increased bond strengths.^{13,18,19} Biofilm removal should also form an essential part of any form of modern direct dentistry. If the biofilm is not physically removed, it can result in cosmetic failure of restorations

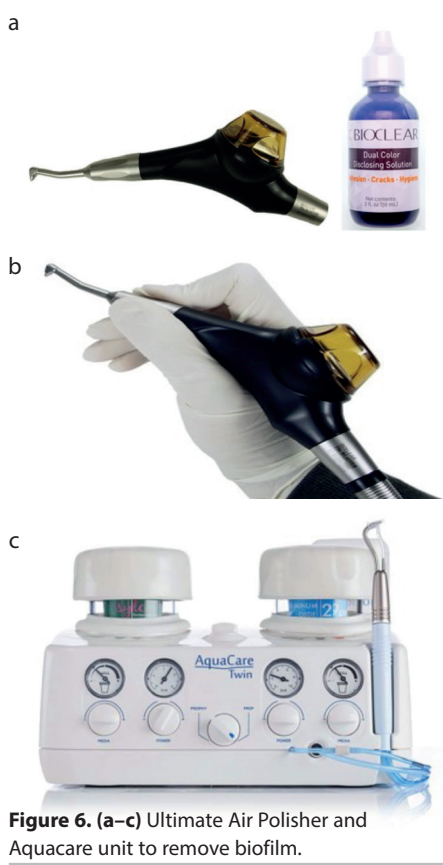


Figure 6. (a-c) Ultimate Air Polisher and Aquacare unit to remove biofilm.

owing to microleakage, chipping and staining. Biofilm may not be predictably removed by the action of etch alone (37% phosphoric acid). It needs to be physically removed, but because it is invisible to the naked eye, it needs to first be disclosed (Figure 5). Removal of biofilm is straightforward and involves particle abrasion of the tooth with powder and water at pressure.^{13,20} The particle size and pressure vary depending on the recommendations of the unit manufacturer.

Units suitable for this include the BA Ultimate Air Polisher (NSK, Stevenage, UK) (Figure 6), Aquacare Unit (Velopex International, London, UK), Dentoprep Microblaster (RONVIG Dental, Denmark) and EMS (EMS, Switzerland) units.

Different units use a variety of powders with different hardness measurements. Aluminium trihydroxide powder has a similar hardness to dentine and is therefore safe to be used on dentine. It also lightly abrades the enamel, which aids enamel bonding. It is therefore ideal for biofilm removal.

The biofilm removal protocol is as follows:

- Dry the whole tooth;
- Disclose the tooth with two-tone disclosing solution;
- Abrade the tooth with a combination of water and aluminium trihydroxide.

Modern cavity design

A full consideration is beyond the scope of this introductory article and is covered in more detail within the Syllabus on Learning Centre Courses (www.dominic-hassall-training.co.uk/bioclear-courses). It involves the modern radius wall/bevel, which allows for a gradual transition of the composite from thick to thin. This is discussed further in the Part 2 of the present series. This produces a polychromatic effect and allows for a warmer/higher chroma neck shade and a more natural appearance. When the composite is thicker, it then masks the underlying colour of the tooth. The gradual transition allows for the use of a single shade of composite, as the colour blend with the tooth is better. The radius bevel also allows for the composite to be in compression, and for an increase in the enamel surface area available for bonding because of the preparation shape, and it aims to be additive.²⁰

Anatomical Bioclear matrices

All Bioclear matrices are anatomical and consist of cellulose acetate. They are available in two thicknesses – 50 or 75 microns. The aim is for all matrices to seat subgingivally for approximately 2–3 mm and form the shape interdentially (Figure 7). Thus, after injection moulding, no finishing is required between the teeth – an area that all dentists struggle to refine and polish.

The patented anatomical matrices allow control over both the interproximal shape, and the gingival emergence profile

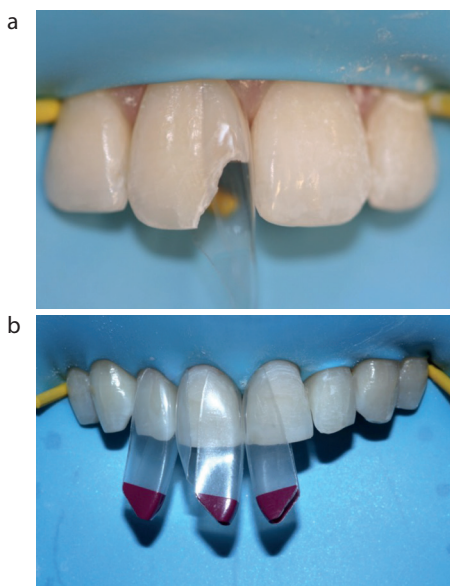


Figure 7. (a,b) Bioclear matrix *in situ* seating subgingivally.

of the restoration. There are three main families of Bioclear matrices (Figure 8):

- Anterior and diastema closure matrices;
- 360° veneer matrices;
- Black triangle closure matrices.

Anterior and diastema closure matrices

These matrices are the traditional Bioclear matrices and can be used in all situations. They are made from Mylar and so produce a smooth hygienic surface between teeth. They can be used for routine Class III and IV restorations, as well as for closing diastemas, triangles and reshaping peg laterals. If contacts are present, then the heavy duty 75-micron matrices are preferable to the 50-micron matrices. If diastemas are present, then the 50-micron matrices are preferable because there is less matrix thickness to overcome on closure of the diastema.

360° veneer matrices

These matrices, if placed mesially and distally on a tooth, will wrap around the tooth completely, by 360 degrees. They are 75 microns thick, making them more rigid and thus, ideal for rebuilding fractured teeth, increasing the lengths of teeth vertically and for veneering.

Black triangle matrices

These are ideal for closure of black triangles following orthodontics, where the teeth are aligned with contacts.

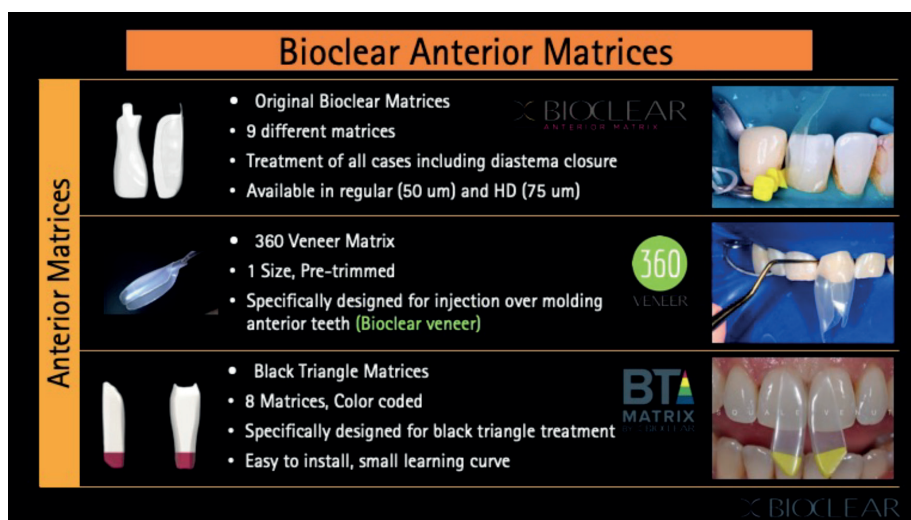


Figure 8. Classification of Bioclear matrices: anterior/diastema closure matrices, 360° veneer matrices, black triangle matrices. (Courtesy of 3M and Dr David Clark).

Warm injection moulding of composite

Warm injection moulding of composite, preferably using 3M Filtek Supreme XTE restorative composite, is gaining popularity.^{21–23}

The HeatSync heater heats the entirety of several compules of composite to a constant temperature of 68°C (Figure 9).^{24–26} It is important to always heat more compules of composite than thought required because injection moulding requires overfilling. Compules that have not been used can be stored and reheated for the next patient of that shade. Composite has a very poor thermal conductivity, so within 10–15 seconds of removal from the heater, the composite temperature drops close to 25°C (Figure 10).²⁷ Therefore, a high degree of warming is necessary. The subsequent flowability of the composite also drops with temperature. The warmer the composite, the better it flows and adapts to the tooth/matrix, and the easier it is to inject. 3M studies support and show that there is no change to the colour or chemical stability/properties of warmed 3M composite capsules (including 3M Filtek Supreme XTE, 3M Filtek Universal, and 3M Filtek One Bulk Fill restorative) when warmed up to 70°C (158°F) for up to 1 hour. 3M Filtek Supreme Flowable restorative and 3M Filtek Bulk Fill Flowable restorative syringes may be warmed up to 70°C for up to 1 hour, up to 25 at a time.

Advantages of using heated composite include:^{28,29}

- Material flows better allowing superior adaption to the tooth;

- Improved marginal integrity – resulting in a reduction in microleakage, secondary caries, and post-operative sensitivity;³⁰
- Decreased voids within the material – nearing monolithic composite;^{31,32}
- Stronger restorations with less chipping or fewer fractures;^{31,32}
- Improved cure rates and depths^{33–36}
- Single increment placement, reduction in layers;
- Easier manipulation and less technique sensitive method for the operator;
- Quicker restorative placement.

When undertaking the Bioclear Method, total etch is advised for anterior composite restorations. If required, a standard bonding protocol would be followed for sealing exposed dentinal tubules prior to injection moulding. When using 3M Scotchbond Universal Plus adhesive, this would involve agitation of the adhesive over the open dentinal tubules for 20 seconds before air drying for 5 seconds (or until there is no more visible fluid movement), then light curing for 10 seconds.^{37,38} Injection moulding (as patented by Bioclear) is the combination of 3M Scotchbond Universal Plus adhesive, Filtek Supreme Flowable restorative and Filtek Supreme XTE restorative.

Specifically, Scotchbond Universal Plus adhesive is applied and air thinned, Filtek Supreme Flowable restorative is then applied to gingival and line angle areas, followed immediately with Filtek Supreme XTE restorative which is immediately



Figure 9. (a,b) Bioclear HeatSync heater.

and directly injected into the flowable restorative using a composite compule. Only after the cavity/matrix has been overfilled and massaged is the composite complex light cured. It is always important to follow the composite manufacturer's curing recommendations. The injection of the paste composite displaces the Scotchbond adhesive and flowable composite. The aim of Bioclear injection moulding is to achieve a final restoration that consists of approximately 80% paste composite. This is beneficial for both functional strength and polish retention. The final monolithic mass is stronger than traditionally layered composites.^{31,32}

After removal of the matrices, the gross excess is removed with diamond burs, and shaped with discs. The systematic shaping is the same for

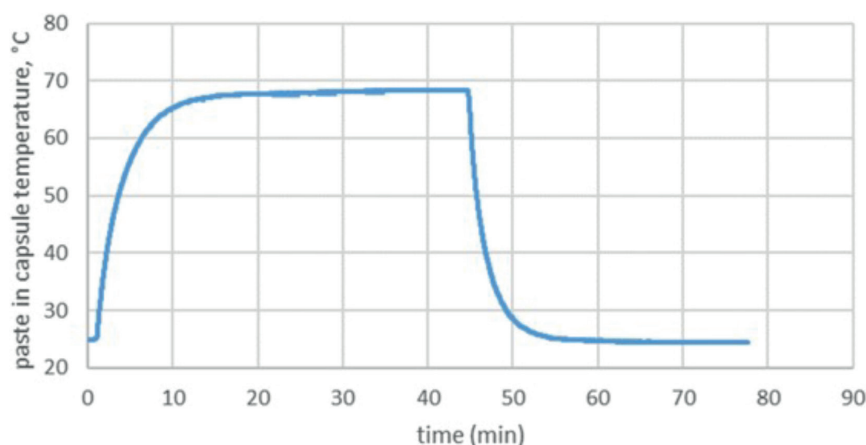


Figure 10. The heating and cooling curve of composite materials (courtesy of 3M and Dr David Clark).

all restorations.

Three-step 'Rock Star' polish

There are many techniques for polishing composite. The Bioclear Method follows the same protocol for all composite restorations. There are three stages:

1. Shofu Brownies (Shofu Dental, Germany) with water to finally marginate the restoration and the tooth palatally.
2. Magic Mix (Bioclear) with a prophyl cup at medium speed. Magic Mix is a mixture of varying size particles of aluminium oxide within a green gel suspension. The result of this should leave a very smooth surface to the composite – to almost have the appearance of etched enamel.
3. 'Bioclear rock star polish' – involves the use of a diamond impregnated cup (SS White Jazz polisher, SS White, NJ, USA). This is used with light and heavy pressure with water coolant. Once complete the composite should appear shiny, whether wet or dry.

The polish of the composite can rival porcelain. Attentive use of finishing methods is still necessary for surface quality and natural appearance of the final restoration. One must also appreciate the angles of the teeth and their surface shape so as to form specular highlights.

The anterior Bioclear Method is taught using 3M Filtek Supreme XTE restorative (body shades). The body shades are used as they allow for a better polychromaticity (colour blend) than enamel shades, which have a higher translucency and less polychromaticity.

3M nanocomposites use a patented process that creates unique clusters of

nanometer-sized particles. The nanoclusters wear at a similar rate to the surrounding resin matrix during abrasion, which results in longer lasting strength and shine of this material.³⁹

Black triangle closure

This is a concern of patients that is often misunderstood and underestimated by dentists. Black triangles have been ranked as the third most upsetting cosmetic feature behind visible caries and visible crown margins. They were ranked as worse than dark colour and crowded teeth.⁴² This is especially important regarding adult orthodontics where black triangles will occur for an estimated 65% of patients undergoing orthodontics to straighten their teeth.⁴⁰

In the past, the treatment for black triangles has been traditional layered composite restorations, which can be prone to staining, chipping and overhangs, or more biologically aggressive indirect procedures, such as indirect veneers (Figure 11).

The Bioclear Method is a preparation-free treatment for black triangles.^{41–45} and uses a custom black triangle kit (Figure 12). It uses a gauge, which measures the triangle, and colour codes the size of the triangle to the colour of the matrix (removing the need for the practitioner to customize the size of the emergence of the matrix, which would be required using the anterior/diastema closure matrices). The black triangle matrices are scalloped to reduce the amount of shaping and finishing after injection moulding. These matrices are ideal for well-aligned teeth,



Figure 11. (a,b) Traditional layered composite restorations for black triangle closure showing overhangs and gingival inflammation.



Figure 12. Bioclear black triangle kit containing black triangle measuring gauge and assorted black triangle matrices.

but may not be ideal for the treatment of diastemas or misaligned teeth where the misalignment is to be corrected.

The following case is a patient who had upper black triangles following orthodontics (Figure 13).

The black triangle gauge measured the size of the triangles, and the corresponding coloured small black triangle matrices were selected and tried in to confirm the emergence profiles and complete triangle closure. Contacts were lightened where necessary with Tru-Contact Saws (Bioclear) to allow seating of the matrices (if the contacts are too tight, the matrix deforms on seating). The teeth were isolated with heavy-duty latex-free rubber dam (UnoDent, UK) and the biofilm removal protocol was followed. The matrices were inserted, and the teeth injection moulded.



Figure 13. Clinical black triangle. (a) Pre-treatment smile. (b) Pre-treatment upper anterior black triangle. (c) Black triangle gauge measuring the size of the triangles. (d) Try-in upper black triangle matrices matching gauge size. (e) Rubber dam isolation and biofilm removal. (f) Matrices *in situ* for injection over-moulding of first tooth, UR1. (g) Injection over-mould of second tooth, UL1. (h) After sculpting of the upper centrals. (i) Injection over-mould of third tooth, UL2. (j) Post-sculpting, pre-polish of the front four teeth. (k) Immediately following rubber dam removal. (l) Immediately post-treatment. (m) The upper teeth at the 1-week review. (n) After upper and lower Bioclear black triangle closures. (o) Post-treatment smile.

Once a tooth had been injection moulded, the matrices were removed from that tooth, and the tooth finished with burs and discs before proceeding with the next tooth to be injection moulded. The process was repeated until all teeth had been injection moulded. All teeth were then finished to 'grade' together with discs and finally polished using the three-step polishing protocol. The occlusion was confirmed, and if any adjustments were required, the teeth were re-polished afterwards.

The patient was provided with a new fixed and removable retainer.

Ideally, 12–18-month maintenance appointments are advised, at which time restorations may need re-polishing with the SS White polishing cup. Figure 14 is a 6-year post-treatment photo of a black triangle case treated using the Bioclear Method.

Black triangles are also often a post-treatment concern for periodontal patients. Treatment for these triangles has been avoided in the past owing to concerns about creating ledges/overhangs/plaque traps, thus potentially worsening periodontal health. With the Bioclear Method, emergence profiles are smooth and overhangs are not present. Therefore, providing patients are periodontally stable with excellent oral hygiene, treatment to close black triangles is possible. Figure 15 shows a case where Bioclear Method restorations were undertaken to close the triangle. The 4-year post photo shows gingival health with fully formed papilla and pink healthy stippling.

The Bioclear Method can also be used for many anterior treatments. These include standard and deep Class III and IV restorations, replacing chipped/stained old composite restorations, closing diastemas, aesthetic building of peg laterals, and overmoulding small teeth. Figures 16–19 show other cases treated with the Bioclear Method:

Conclusion

In conclusion, direct composite restorations can satisfy most aesthetic demands and offer an affordable alternative to more invasive indirect procedures. It is therefore essential that dentists understand the principles and handling characteristics of the composite system they use to gain the maximum benefit from the material and technique. The Bioclear Method offers a contemporary approach to composites which provides several advantages over traditional composites.

As with any restorative technique, dentists should have thorough understanding of all treatment aspects including functional occlusion and the periodontal-restorative interface, to prevent premature failure either restoratively, functionally, or aesthetically.

Author's view

My experience of the longevity of Bioclear Method restorations is that they are superior to traditional layered composites. Having solely undertaken Bioclear Method-style composite restoration since May 2015, I have only experienced three restoration failures out of over 1000 completed Bioclear restorations.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

Informed Consent: Informed consent was obtained from all individual participants included in the article.

References

1. Kwon SR, Oyoyo U, Li Y. Influence of application techniques on contact formation and voids in anterior resin composite restorations. *Oper Dent* 2014; **39**: 213–220. <https://doi.org/10.2341/13-060-L>
2. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *J Dent Res* 1955; **34**: 849–853. <https://doi.org/10.1177/00220345550340060801>
3. Bowen R. Development of a silica resin direct filling material. Report 6333. *Washington: National bureau of standards* 1958.
4. Phillips RW. Bonding agents and adhesives. *Adv Dent Res* 1988; **2**: 150–154. <https://doi.org/10.1177/08959374880020010801>
5. Burke FJ, Palin WM, James A *et al*. The current status of materials for posterior composite restorations: the advent of low shrink. *Dent Update* 2009; **36**: 401–409. <https://doi.org/10.12968/denu.2009.36.7.401>
6. Swift EJ Jr, Perdigão J, Heymann HO. Bonding to enamel and dentin: a brief history and state of the art, 1995. *Quintessence Int* 1995; **26**: 95–110.
7. Gwinnett A. Bonding basics: What every clinician should know. *Esth Dent Update* 1994; **5(2)**:35-41
8. Nakabayashi N, Kojima K, Masuhara E. The promotion of adhesion by the infiltration of monomers into tooth substrates. *J Biomed Mater Res* 1982; **16**: 265–273. <https://doi.org/10.1002/jbm.820160307>
9. Fusayama T. Total etch technique and cavity isolation. *J Esthet Dent* 1992; **4**: 105–109. <https://doi.org/10.1111/j.1708-8240.1992.tb00674.x>
10. Kanca J. A method for bonding to tooth structure. *J Dent Res* 1990; **69**: 231.
11. Overton JD, Sullivan DJ. Early failure of Class



Figure 14. Upper anterior black triangle closure case (courtesy of Dr David Clark). (a) Pre-treatment; (b) immediately after treatment; (c) 6 years and 4 months after treatment.



Figure 15. Black triangle closure after periodontal disease. (a) Pre-treatment; (b) 4 years after treatment.



Figure 16. (a) Pre-treatment diastema following orthodontic treatment. (b) After a full diastema closure using the Bioclear Method.

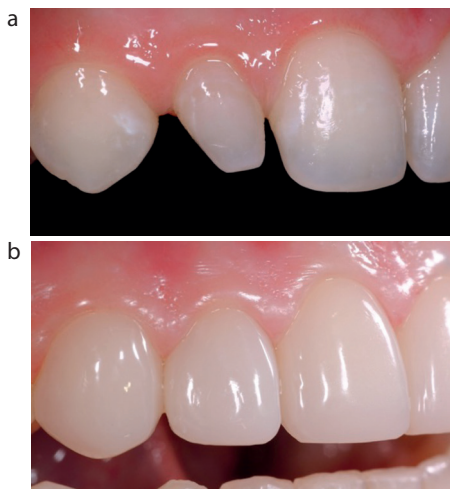


Figure 17. (a) Lateral peg and undersized central and canine. (b) After Bioclear treatment with over-mould on the lateral peg. (Courtesy of Dr David Clark.)



Figure 18. (a) Old stained and chipped composites on smiling. (b) Old stained and chipped composites. (c) On smiling after Bioclear restorations. (d) After Bioclear restorations.



Figure 19. (a) A traumatic fracture of incisors. (b) 6.5 years following Bioclear restorations. (c) Smile at 6.5 years after the Bioclear treatment.

II resin composite versus Class II amalgam restorations placed by dental students. *J Dent Educ* 2012; **76**: 338–340.

12. Bohaty BS, Ye Q, Misra A et al. Posterior composite restoration update: focus on factors influencing form and function. *Clin Cosmet Investig Dent* 2013; **5**: 33–42. <https://doi.org/10.2147/CCIDE.S42044>
13. Chaiyabutr Y, Kois JC. The effects of tooth preparation cleansing protocols on the bond strength of self-adhesive resin luting cement to contaminated dentin. *Oper Dent* 2008; **33**: 556–563. <https://doi.org/10.2341/07-141>
14. Collares K, Opdam NJM, Laske M et al. Longevity of anterior composite restorations in a general dental practice-based network. *J Dent Res* 2017; **96**: 1092–1099. <https://doi.org/10.1177/0022034517717681>
15. Demarco FF, Collares K, Coelho-de-Souza

- FH et al. Anterior composite restorations: a systematic review on long-term survival and reasons for failure. *Dent Mater* 2015; **31**: 1214–1224. <https://doi.org/10.1016/j.dental.2015.07.005gg>
16. Magne P, Douglas WH. Cumulative effects of successive restorative procedures on anterior crown flexure: intact versus veneered incisors. *Quintessence Int* 2000; **31**: 5–18.
17. Opdam NJ, Roeters FJ. Preparatievorm en vultechnieken bij posterieure composietrestauraties [Preparation forms and filling techniques for posterior composite restorations]. *Ned Tijdschr Tandheelkd* 1996; **103**: 461–463.
18. Mujdeci A, Gokay O. The effect of airborne-particle abrasion on the shear bond strength of four restorative materials to enamel and dentin. *J Prosthet Dent* 2004; **92**: 245–249. <https://doi.org/10.1016/j.prosdent.2004.05.007>
19. Manhart J, Mehl A, Schroeter R et al. Bond strength of composite to dentin treated by air abrasion. *Oper Dent* 1999; **24**: 223–232.
20. Hess TA, Wadhvani CP. The Tucker technique: conservative molar inlays preserving the transverse ridge. *Oper Dent*

- 2012; **37**: 93–97. <https://doi.org/10.2341/11-048-T>
21. Freedman G, Krejci I. Warming up to composites. *Compend Contin Educ Dent* 2004; **25**: 371–376.
22. Nada K, El-Mowafy O. Effect of precuring warming on mechanical properties of restorative composites. *Int J Dent* 2011; **2011**: 536212. <https://doi.org/10.1155/2011/536212>
23. Daronch M, Rueggeberg FA, Moss L, de Goes MF. Clinically relevant issues related to preheating composites. *J Esthet Restor Dent* 2006; **18**: 340–350. <https://doi.org/10.1111/j.1708-8240.2006.00046.x>
24. Rees JS, Jagger DC, Williams DR et al. A reappraisal of the incremental packing technique for light cured composite resins. *J Oral Rehabil* 2004; **31**: 81–84. <https://doi.org/10.1046/j.0305-182x.2003.01073.x>
25. Daronch M, Rueggeberg FA, Hall G, De Goes MF. Effect of composite temperature on in vitro intrapulpal temperature rise. *Dent Mater* 2007; **23**: 1283–1288. <https://doi.org/10.1016/j.dental.2006.11.024>
26. Campbell I, Kang J, Hyde TP. Randomized controlled trial of postoperative sensitivity with warm and room

- temperature composite. *JDR Clin Trans Res* 2017; **2**: 295–303. <https://doi.org/10.1177/2380084416682934>
27. Kampanas NS. Resin composite pre-heating. a review of the laboratory results. *Int J Oral Dent Health* 2018; **4**: 1–5.
 28. Hassall D, Burgess C. Developments in bonding and composite technology and it's clinical implications. Part II: developments in composite materials and clinical techniques. *Dentistry* 2020; 24-27.
 29. Hassall D. Cosmetic, aesthetic or restorative? *The Dentist* 2014; **4**: 68–70.
 30. Wagner WC, Aksu MN, Neme AM et al. Effect of pre-heating resin composite on restoration microleakage. *Oper Dent* 2008; **33**: 72–78. <https://doi.org/10.2341/07-41>
 31. Opdam NJ, Roeters JJ, Peters TC et al. Cavity wall adaptation and voids in adhesive Class I resin composite restorations. *Dent Mater* 1996; **12**: 230–235. [https://doi.org/10.1016/s0109-5641\(96\)80028-5](https://doi.org/10.1016/s0109-5641(96)80028-5)
 32. Opdam NJ, Roeters JJ, Joosten M, Veeke Ov. Porosities and voids in Class I restorations placed by six operators using a packable or syringable composite. *Dent Mater* 2002; **18**: 58–63. [https://doi.org/10.1016/s0109-5641\(01\)00020-3](https://doi.org/10.1016/s0109-5641(01)00020-3)
 33. Muñoz CA, Bond PR, Sy-Muñoz J et al. Effect of pre-heating on depth of cure and surface hardness of light-polymerized resin composites. *Am J Dent* 2008; **21**: 215–222.
 34. Trujillo M, Newman SM, Stansbury JW. Use of near-IR to monitor the influence of external heating on dental composite photopolymerization. *Dent Mater* 2004; **20**: 766–777. <https://doi.org/10.1016/j.dental.2004.02.003>
 35. Daronch M, Rueggeberg FA, De Goes MF. Monomer conversion of pre-heated composite. *J Dent Res* 2005; **84**: 663–667. <https://doi.org/10.1177/154405910508400716>
 36. Conditt M, Leinfelder K. Improving the polymerization of composite resins. *Pract Proced Aesthet Dent* 2006; **18**: 169–171.
 37. Moritake N, Takamizawa T, Ishii R et al. Effect of active application on bond durability of universal adhesives. *Oper Dent* 2019; **44**: 188–199. <https://doi.org/10.2341/17-384-L>
 38. Saikaew P, Matsumoto M, Chowdhury A et al. Does shortened application time affect long-term bond strength of universal adhesives to dentin? *Oper Dent* 2018; **43**: 549–558. <https://doi.org/10.2341/17-205-L>
 40. McConnell RJ, Sabbagh J, de la Macorra JC et al. Frequently asked questions in composite restorative dentistry. *Dent Update* 2011; **38**: 549–556. <https://doi.org/10.12968/denu.2011.38.8.549>
 41. Cunliffe J, Pretty I. Patients' ranking of interdental 'black triangles' against other common aesthetic problems. *Eur J Prosthodont Restor Dent* 2009; **17**: 177–181.
 42. Clark D. Restoratively driven papilla regeneration: correcting the dreaded 'black triangle'. *Tex Dent J* 2008; **125**: 1112–1115.
 43. Clark D. A restorative option for the dreaded black triangle. *Inside Dentistry* 2014; **10(4)**
 44. Clark D. Injection overmoulding for aesthetics and strength, part 1. *Dentistry Today* 2014; 86–89
 45. Clark D. Injection overmolding for aesthetics and strength, part 2. *Dentistry Today* 2014; 108–112.
 46. Clark D, Kim J. Full-mouth black triangle treatment protocol. *Dentistry Today* 2017, 72–77.

Reach for the stars plan for your future

wealthwide
Life Unboxed

With specialist financial planning you'll know exactly what you can afford now and in the future.

Our bespoke service gives dentists the confidence to make important, life changing decisions with clarity and peace of mind.

We've been helping dentists with their finances for more than 20 years.

To talk to one of our specialist financial planners, please get in touch:

team@wealthwide.co.uk | 0121 685 5060
www.wealthwide.co.uk

