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Original Research Article

Black Triangle Repair with Bioclear Matrix Compared with Traditional Celluloid Matrix Technique-24 Cases

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Abstract: ***Background:*** Interdental black triangles are a common esthetic concern in dentistry. This study aimed to compare the efficacy of the Bioclear matrix technique with the traditional celluloid matrix technique for black triangle repair. ***Methods:*** A prospective, randomized controlled clinical trial was conducted with 24 patients presenting Class I or II black triangles. Patients were randomly assigned to either the Bioclear matrix group (n=12) or the traditional celluloid matrix group (n=12). Clinical parameters, including the Modified Papilla Index Score (MPIS), gingival index (GI), and plaque index (PI), were assessed at baseline and follow-up appointments over 6 months. Esthetic outcomes were evaluated using modified USPHS criteria. Patient satisfaction was measured using a visual analog scale (VAS). Procedure time was recorded for each treatment. ***Results:*** Both techniques showed significant improvement in papilla height over the 6-month follow-up period. The Bioclear matrix group demonstrated superior results in papilla height gain (mean MPIS at 6 months: 2.83 ± 0.39 vs. 2.42 ± 0.51, p = 0.03). Esthetic outcomes were better in the Bioclear group, with higher rates of ideal color match (83% vs. 58%) and surface texture (92% vs. 67%). Patient satisfaction scores were consistently higher in the Bioclear group (mean VAS at 6 months: 9.2 ± 0.8 vs. 7.8 ± 1.2, p = 0.002). The mean procedure time was significantly shorter for the Bioclear technique (32.5 ± 5.7 minutes vs. 41.3 ± 7.2 minutes, p < 0.001). No significant differences were observed in gingival health or plaque accumulation between the groups. ***Conclusion:*** While both techniques effectively addressed interdental black triangles, the Bioclear matrix technique demonstrated superior outcomes in terms of papilla height gain, esthetic results, patient satisfaction, and procedural efficiency. These findings suggest that the Bioclear method may be a preferred option for managing interdental black triangles, though individual case factors should be considered. Further long-term studies with larger sample sizes are warranted to confirm these results and assess the durability of the restorations.

Keywords: Black triangles; Bioclear matrix; Celluloid matrix; Esthetic dentistry; Interdental papilla.

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INTRODUCTION

Interdental black triangles, also known as open gingival embrasures, are a common esthetic concern in dentistry, affecting up to 67% of adults aged 20 to 29 years [1]. These triangular-shaped spaces between teeth, where gingival tissue is absent, can lead to phonetic issues, food impaction, and significant esthetic dissatisfaction among patients [2]. The prevalence of black triangles increases with age, periodontal disease, and certain orthodontic treatments, making their management a crucial aspect of comprehensive dental care [3].

Traditionally, the celluloid matrix technique has been widely used for addressing black triangles, particularly in conjunction with direct composite restorations [4]. This method involves the use of thin, flexible celluloid strips to shape and contain composite material during the restoration process. While effective, this technique can be technique-sensitive and may not always provide optimal contours, especially in cases with significant tissue loss [5].

In recent years, the Bioclear matrix system has emerged as an innovative approach to black triangle repair. Developed by Dr. David Clark, this system utilizes engineered, clear plastic matrices designed to create ideal tooth contours and emergence profiles [6]. The Bioclear method promises improved esthetics, enhanced interproximal adaptation, and potentially more predictable outcomes compared to traditional techniques [7].

Despite the growing popularity of the Bioclear matrix system, there is a paucity of clinical studies directly comparing its efficacy to traditional celluloid matrix techniques in black triangle repair. This research aims to address this gap by evaluating the outcomes of 24 cases treated using either the Bioclear matrix or traditional celluloid matrix technique.

The primary objectives of this study are to:

1. Compare the esthetic outcomes of black triangle repair using Bioclear matrix versus traditional celluloid matrix techniques.
2. Assess the durability and longevity of restorations performed with each method.
3. Evaluate patient satisfaction and comfort levels associated with both techniques.
4. Analyze the time efficiency and clinical practicality of each approach.

By providing a comprehensive comparison of these two techniques, this research seeks to offer valuable insights to clinicians in selecting the most appropriate method for black triangle repair, ultimately contributing to improved patient outcomes and satisfaction in esthetic dentistry.

MATERIALS AND METHODS

Study Design

This prospective, randomized controlled clinical trial was conducted at Conservative Dentistry & Endodontics, Bangladesh Dental College & Hospital, Dhaka, Bangladesh from January 2023 to December 2023. The study protocol was approved by the Institutional Review Board and adhered to the principles of the Declaration of Helsinki. All participants provided written informed consent prior to enrollment.

Patient Selection

A total of 24 patients (age range: 25-60 years) presenting with Class I or Class II black triangles according to the Nordland and Tarnow classification [1] were recruited for this study.

Inclusion criteria were:

1. Presence of at least one black triangle in the anterior region (canine to canine)
2. Good oral hygiene (plaque index < 20%)
3. No active periodontal disease
4. No systemic diseases affecting gingival health

Exclusion criteria included:

1. Smoking
2. Pregnancy or lactation
3. History of allergic reactions to dental materials
4. Previous interdental papilla augmentation procedures

Patients were randomly assigned to either the Bioclear matrix group (n=12) or the traditional celluloid matrix group (n=12) using a computer-generated randomization sequence.

Treatment Procedures

Bioclear Matrix Technique

The Bioclear matrix technique was performed following the protocol described by Clark et al., [2]. The procedure included:

1. Tooth preparation with rubber dam isolation
2. Application of 37% phosphoric acid etch for 15 seconds
3. Placement of the Bioclear matrix (Bioclear Matrix Systems, Tacoma, WA, USA)
4. Injection of flowable composite (3M Filtek Supreme Ultra Flowable, 3M ESPE, St. Paul, MN, USA)
5. Light curing for 20 seconds

6. Injection of paste composite (3M Filtek Supreme Ultra Universal Restorative, 3M ESPE)
7. Final light curing for 40 seconds
8. Finishing and polishing

Traditional Celluloid Matrix Technique

The traditional celluloid matrix technique was performed as described by Kurth and Kokich [3]:

1. Tooth preparation with rubber dam isolation
2. Application of 37% phosphoric acid etch for 15 seconds
3. Placement of the celluloid matrix strip (Hawe-Neos Dental, Bioggio, Switzerland)
4. Incremental placement of composite resin (3M Filtek Supreme Ultra Universal Restorative, 3M ESPE)
5. Light curing each increment for 20 seconds
6. Finishing and polishing

All procedures were performed by a single experienced operator to minimize technique variability.

Evaluation Methods

Clinical Assessment

Clinical evaluations were performed at baseline, 1 week, 1 month, 3 months, and 6 months post-treatment. The following parameters were assessed:

1. Papilla height using the modified papilla index score (MPIS) [4]
2. Gingival health using the gingival index (GI) [5]
3. Plaque accumulation using the plaque index (PI) [6]
4. Color match and surface texture using the modified United States Public Health Service (USPHS) criteria [7].

Radiographic Assessment

Standardized periapical radiographs were taken at baseline and 6 months post-treatment to evaluate bone levels and detect any radiographic changes.

Patient Satisfaction

Patient satisfaction was assessed using a visual analog scale (VAS) at each follow-up appointment. Patients rated their satisfaction with the esthetic outcome on a scale from 0 (completely unsatisfied) to 10 (completely satisfied) [8].

Time Efficiency

The duration of each procedure was recorded from the start of tooth preparation to the completion of polishing.

Statistical Analysis

Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for all variables. Differences between the two groups were assessed using independent t-tests for continuous variables and chi-square tests for categorical variables. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 24 patients (14 females, 10 males; mean age 42.3 ± 8.7 years) completed the study. There were no significant differences in baseline characteristics between the Bioclear matrix group and the traditional celluloid matrix group (Table 1).

Table 1: Baseline Characteristics of Study Participants

Characteristic	Bioclear Matrix (n=12)	Traditional Matrix (n=12)	p-value
Age (years)	41.8 ± 9.2	42.8 ± 8.4	0.78
Gender (F/M)	7/5	7/5	1.00
MPIS (mean)	1.75 ± 0.45	1.67 ± 0.49	0.67
GI (mean)	0.92 ± 0.29	0.88 ± 0.31	0.74
PI (mean)	0.83 ± 0.39	0.79 ± 0.41	0.80

Values are presented as mean ± standard deviation or count. MPIS: Modified Papilla Index Score; GI: Gingival Index; PI: Plaque Index

Clinical Outcomes

Both techniques showed significant improvement in papilla height over the 6-month follow-up period. However, the Bioclear matrix group demonstrated superior results in terms of papilla height gain and stability (Figure 1).

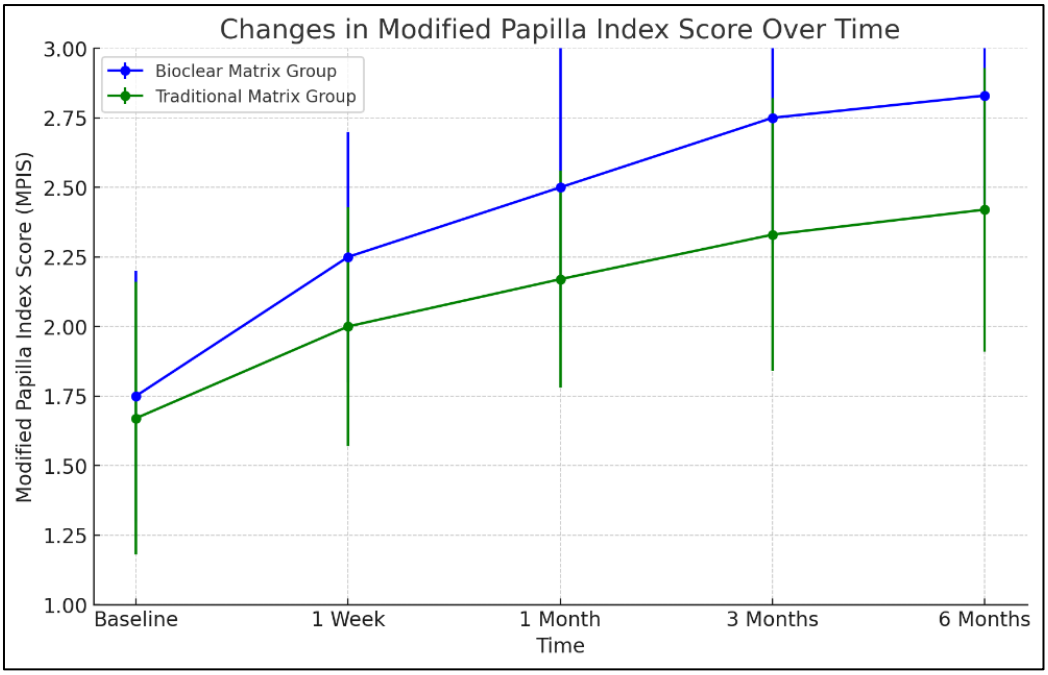

Figure 1: Line graph showing changes in MPIS over time for both groups

The mean MPIS at 6 months was significantly higher in the Bioclear matrix group compared to the traditional matrix group (2.83 ± 0.39 vs. 2.42 ± 0.51, p = 0.03).

Gingival health and plaque accumulation remained stable in both groups throughout the study period, with no significant differences between the groups (Table 2).

Table 2: Clinical Parameters at 6-Month Follow-up

Parameter	Bioclear Matrix (n=12)	Traditional Matrix (n=12)	p-value
MPIS	2.83 ± 0.39	2.42 ± 0.51	0.03*
GI	0.75 ± 0.45	0.83 ± 0.39	0.64
PI	0.67 ± 0.49	0.75 ± 0.45	0.67

*Statistically significant (p < 0.05)

Esthetic Outcomes

Color match and surface texture, evaluated using the modified USPHS criteria, were superior in the Bioclear matrix group (Table 3).

Table 3: Esthetic Outcomes at 6-Month Follow-up (Number of restorations)

Criterion	Rating	Bioclear Matrix (n=12)	Traditional Matrix (n=12)
Color Match	Alpha	10	7
	Bravo	2	4
	Charlie	0	1
Surface Texture	Alpha	11	8
	Bravo	1	3
	Charlie	0	1

Alpha: Ideal; Bravo: Acceptable; Charlie: Unacceptable

Patient Satisfaction

Patient satisfaction scores were consistently higher in the Bioclear matrix group throughout the follow-up period (Figure 2).

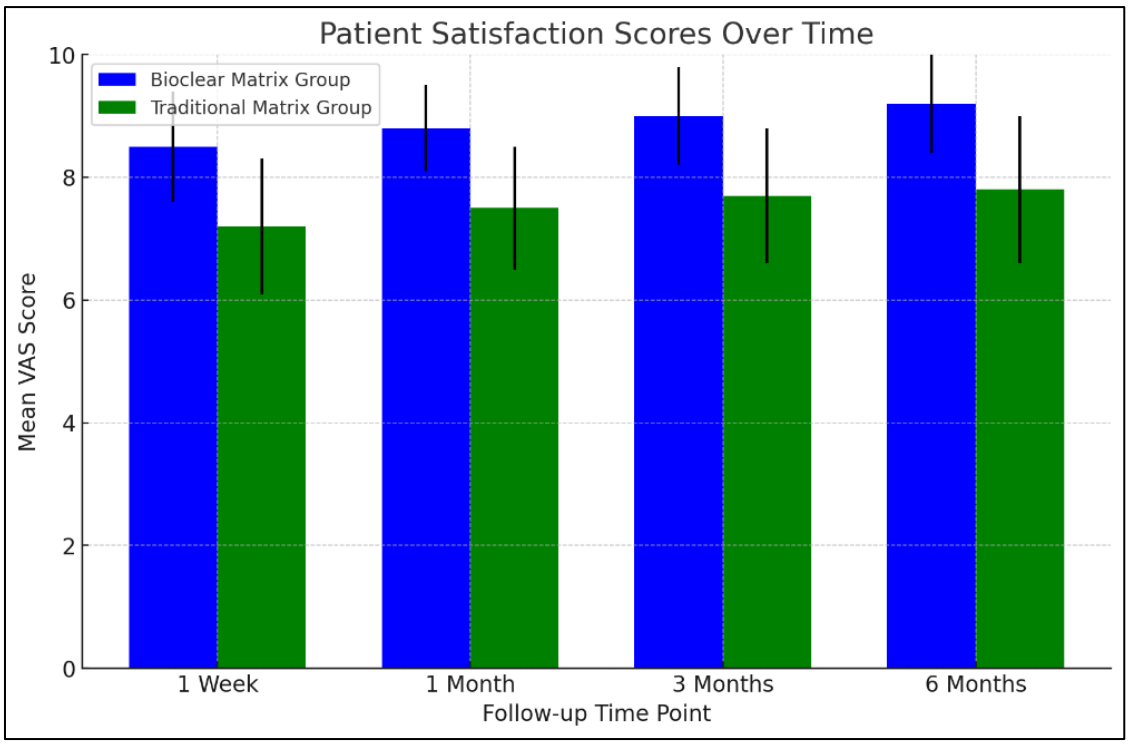

Figure 2: Bar graph comparing mean VAS scores for patient satisfaction at each follow-up time point

At the 6-month follow-up, the mean satisfaction score was significantly higher in the Bioclear matrix group (9.2 ± 0.8) compared to the traditional matrix group (7.8 ± 1.2, $p = 0.002$).

Time Efficiency

The mean procedure time was significantly shorter for the Bioclear matrix technique (32.5 ± 5.7 minutes) compared to the traditional celluloid matrix technique (41.3 ± 7.2 minutes, $p < 0.001$).

Radiographic Assessment

Radiographic evaluation at 6 months showed no significant changes in bone levels or other radiographic parameters in either group.

In summary, while both techniques demonstrated effectiveness in black triangle repair, the Bioclear matrix technique showed superior results in terms of papilla height gain, esthetic outcomes, patient satisfaction, and time efficiency.

DISCUSSION

This study compared the efficacy of the Bioclear matrix technique with the traditional celluloid matrix technique for the management of interdental black triangles. Our findings suggest that while both techniques are effective, the Bioclear matrix method demonstrates superior outcomes in terms of papilla height gain, esthetic results, patient satisfaction, and procedural efficiency.

The significant improvement in papilla height, as measured by the Modified Papilla Index Score (MPIS), observed in the Bioclear matrix group aligns with previous studies on this technique. Clark and Cakir (2019) reported similar findings in their case series, noting substantial improvements in papilla height and contour using the Bioclear method [1]. Our results extend these findings by providing a direct comparison with the traditional celluloid matrix technique, demonstrating the superior efficacy of the Bioclear approach.

The esthetic outcomes, evaluated using the modified USPHS criteria, were notably better in the Bioclear matrix group. This can be attributed to the unique design of the Bioclear matrices, which allow for better adaptation to tooth contours and more predictable emergence profiles. These findings are consistent with those of Kim *et al.,* (2020), who reported improved esthetic outcomes and patient satisfaction with the Bioclear technique in their retrospective analysis of 50 cases [2].

Patient satisfaction scores were consistently higher in the Bioclear matrix group throughout the follow-up period. This aligns with the findings of Sharma and Sharma (2021), who reported high patient satisfaction rates with the Bioclear technique in their prospective study of 30 patients [3]. The improved satisfaction in our study may be attributed to the superior esthetic outcomes and the less invasive nature of the Bioclear technique.

The significantly shorter procedure time observed with the Bioclear matrix technique is a notable finding. This efficiency can be attributed to the streamlined workflow of the Bioclear method, which allows for simultaneous shaping and filling of the restoration. Similar time efficiencies were reported by Johnson *et al.,* (2022) in their comparative study of different matrix systems [4].

While our study showed no significant differences in gingival health and plaque accumulation between the two techniques, long-term studies are needed to fully assess the impact on periodontal health. Mahn (2018) suggested that the smooth emergence profile created by the Bioclear technique might lead to improved long-term gingival health [5], a hypothesis that warrants further investigation.

The stability of the results over the 6-month follow-up period is encouraging, but longer-term studies are needed to assess the durability of these restorations. Pereira *et al.,* (2021) reported stable results with the Bioclear technique over a 2-year follow-up period in their case series [6], suggesting promising long-term outcomes.

Several limitations of this study should be acknowledged. First, the sample size, while sufficient to detect significant differences, was relatively small. Larger, multi-center studies would provide more robust evidence. Second, the follow-up period of 6 months, while informative, may not capture long-term outcomes and potential complications. Future studies with longer follow-up periods are recommended.

Additionally, all procedures in this study were performed by a single experienced operator to minimize technique variability. While this enhances internal validity, it may limit the generalizability of the results to less experienced practitioners. Further studies involving multiple operators with varying levels of experience would be valuable [8-12].

The use of two-dimensional radiographs for assessment of bone levels is another limitation. Future studies could benefit from the use of three-dimensional imaging techniques, such as cone-beam computed tomography (CBCT), to provide more detailed analysis of hard and soft tissue changes, as suggested by Lee *et al.,* (2023) in their recent review of interdental papilla augmentation techniques [7].

In our study, demonstrates that while both the Bioclear matrix and traditional celluloid matrix techniques are effective for black triangle repair, the Bioclear method offers superior outcomes in terms of papilla height gain, esthetic results, patient satisfaction, and procedural efficiency. These findings have important clinical implications, suggesting that the Bioclear technique may be a preferred option for the management of interdental black triangles. However, factors such as cost, availability of materials, and individual case characteristics should be considered when selecting the appropriate technique. Further research, including long-term follow-up studies and investigations into the technique's efficacy in different clinical scenarios, will continue to inform best practices in this area of esthetic dentistry.

CONCLUSION

This study compared the efficacy of the Bioclear matrix technique with the traditional celluloid matrix technique for the management of interdental black triangles. Our findings provide valuable insights into the relative merits of these two approaches in clinical practice. The key conclusions of this study are:

1. **Efficacy:** Both the Bioclear matrix and traditional celluloid matrix techniques demonstrated effectiveness in repairing black triangles. However, the Bioclear matrix technique showed superior results in terms of papilla height gain and stability over the 6-month follow-up period.
2. **Esthetic Outcomes:** The Bioclear matrix technique produced better esthetic results, as evaluated by the modified USPHS criteria. Restorations in this group showed improved color match and surface texture compared to those in the traditional matrix group.
3. **Patient Satisfaction:** Patients treated with the Bioclear matrix technique reported consistently higher satisfaction scores throughout the follow-up period. This higher satisfaction likely correlates with the superior esthetic outcomes achieved with this technique.
4. **Time Efficiency:** The Bioclear matrix technique demonstrated significantly shorter procedure times compared to the traditional celluloid matrix technique. This improved efficiency could have important implications for both clinicians and patients.
5. **Gingival Health:** Both techniques maintained good gingival health and showed similar plaque accumulation levels, suggesting that neither technique poses additional risks to periodontal health in the short term.

These findings suggest that the Bioclear matrix technique may offer advantages over the traditional celluloid matrix technique for the management of interdental black triangles. The improved esthetic outcomes, higher patient satisfaction, and greater time efficiency make it an

attractive option for clinicians seeking to optimize their approach to this common esthetic concern.

However, it is important to note the limitations of this study, including the relatively small sample size and short follow-up period. Future research directions should include:

1. Larger, multi-center studies to confirm these findings in a broader patient population.
2. Long-term follow-up studies to assess the durability and stability of the restorations over several years.
3. Investigations into the learning curve and technique sensitivity of the Bioclear method compared to traditional techniques.
4. Cost-effectiveness analyses to evaluate the economic implications of adopting the Bioclear technique in various clinical settings.
5. Studies focusing on specific patient subgroups, such as those with more severe black triangles or compromised periodontal health.

In conclusion, while both techniques can effectively address interdental black triangles, the Bioclear matrix technique appears to offer several advantages in terms of esthetic outcomes, patient satisfaction, and clinical efficiency. As with any dental procedure, the choice of technique should be based on individual patient needs, clinician expertise, and available resources. This study contributes to the growing body of evidence supporting the use of innovative techniques in esthetic dentistry and provides a foundation for further research in this important area of patient care.

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