

Comparative Evaluation of Interdental Papilla Reconstruction Using Modified Beagle's Surgical Technique Versus Injectable Hyaluronic Acid: A Randomized Controlled Clinical Trial

T. Praveen Kumar¹, Neetha Bhargava^{2*}, Nancy Srivastava³, Rachna Kulshreshtha⁴, B. Roshan Arbaaz,⁵ G. Harini⁶

¹Postgraduate Student, Department of Periodontology, NIMS Dental College & Hospital, NIMS University Rajasthan, Jaipur, India

^{2*}Professor and Head, Department of Periodontology, NIMS Dental College & Hospital, NIMS University Rajasthan, Jaipur, India

³Professor, Department of Periodontology, NIMS Dental College & Hospital, NIMS University Rajasthan, Jaipur, India

⁴Reader, Department of Periodontology, NIMS Dental College & Hospital, NIMS University Rajasthan, Jaipur, India

⁵Postgraduate Student, Department of Periodontology, Sri Venkateshwaraa Dental College, Ariyur, Pondicherry, India

⁶Postgraduate Student, Department of Periodontology, Sri Venkateshwaraa Dental College, Ariyur, Pondicherry, India

***Corresponding Author:**

Dr. Neetha Bhargava

Professor and Head, Department of Periodontology, NIMS Dental College & Hospital, NIMS University Rajasthan, Jaipur, India

Email: veekshya@gmail.com

ABSTRACT

Background

Interdental papillary deficiency is one of the most challenging esthetic problems encountered in periodontal practice. Loss of the interdental papilla results in unaesthetic open gingival embrasures, commonly referred to as black triangles, which may impair smile esthetics, phonetics, and oral hygiene maintenance. Surgical papilla reconstruction has traditionally been regarded as the treatment of choice; however, minimally invasive techniques using injectable hyaluronic acid have recently gained considerable attention. The present randomized controlled clinical trial was undertaken to compare the clinical outcomes of Modified Beagle's surgical technique and injectable hyaluronic acid in the reconstruction of deficient interdental papillae.

Materials and Methods

Forty-eight participants presenting with Nordland and Tarnow Class I or Class II interdental papillary deficiency were randomly allocated into two equal groups. Group I received injectable 0.8% hyaluronic acid gel, whereas Group II underwent reconstruction using the Modified Beagle's surgical technique. Clinical parameters including Plaque Index (PI), Gingival Index (GI), Papillary Deficient Height (PDH), Papillary Width (PW), and Papillary Deficient Area (PDA) were recorded at baseline, 3 weeks, 6 weeks, and 12 weeks. Standardized photographs were analyzed using Digimizer software, and statistical analysis was performed using SPSS version 21.0 with a significance level of $P < 0.05$.

Results

Both treatment modalities demonstrated significant improvement in interdental papillary reconstruction during the study period. The surgical group exhibited rapid improvement in papillary height, width, and deficient area by the third postoperative week, followed by stable clinical outcomes through the 12-week evaluation. The hyaluronic acid group showed progressive improvement throughout the observation period. Intergroup comparisons demonstrated significantly greater improvement in the surgical group for papillary deficient height, papillary width, and papillary deficient area ($P < 0.05$). Plaque and gingival indices remained stable in both groups.

Conclusion

Both Modified Beagle's surgical technique and injectable hyaluronic acid were effective in reconstructing deficient interdental papillae. Although hyaluronic acid provided gradual clinical improvement through a minimally invasive approach, the Modified Beagle's surgical technique produced earlier and superior esthetic outcomes, suggesting that it remains the more predictable treatment modality for appropriately selected cases.

Keywords: Interdental Papilla; Black Triangle; Modified Beagle's Technique; Hyaluronic Acid; Periodontal Plastic Surgery; Randomized Controlled Clinical Trial.

How to cite this article: Kumar TP, Bhargava N, Srivastava N, Kulshreshtha R, Arbaaz BR, Harini G., Comparative Evaluation of Interdental Papilla Reconstruction Using Modified Beagle's Surgical Technique Versus Injectable Hyaluronic Acid: A Randomized Controlled Clinical Trial. *Int J Drug Deliv Technol.* 2026;16(83s): 793-816; DOI: 10.25258/ijddt.16.83s.73

INTRODUCTION

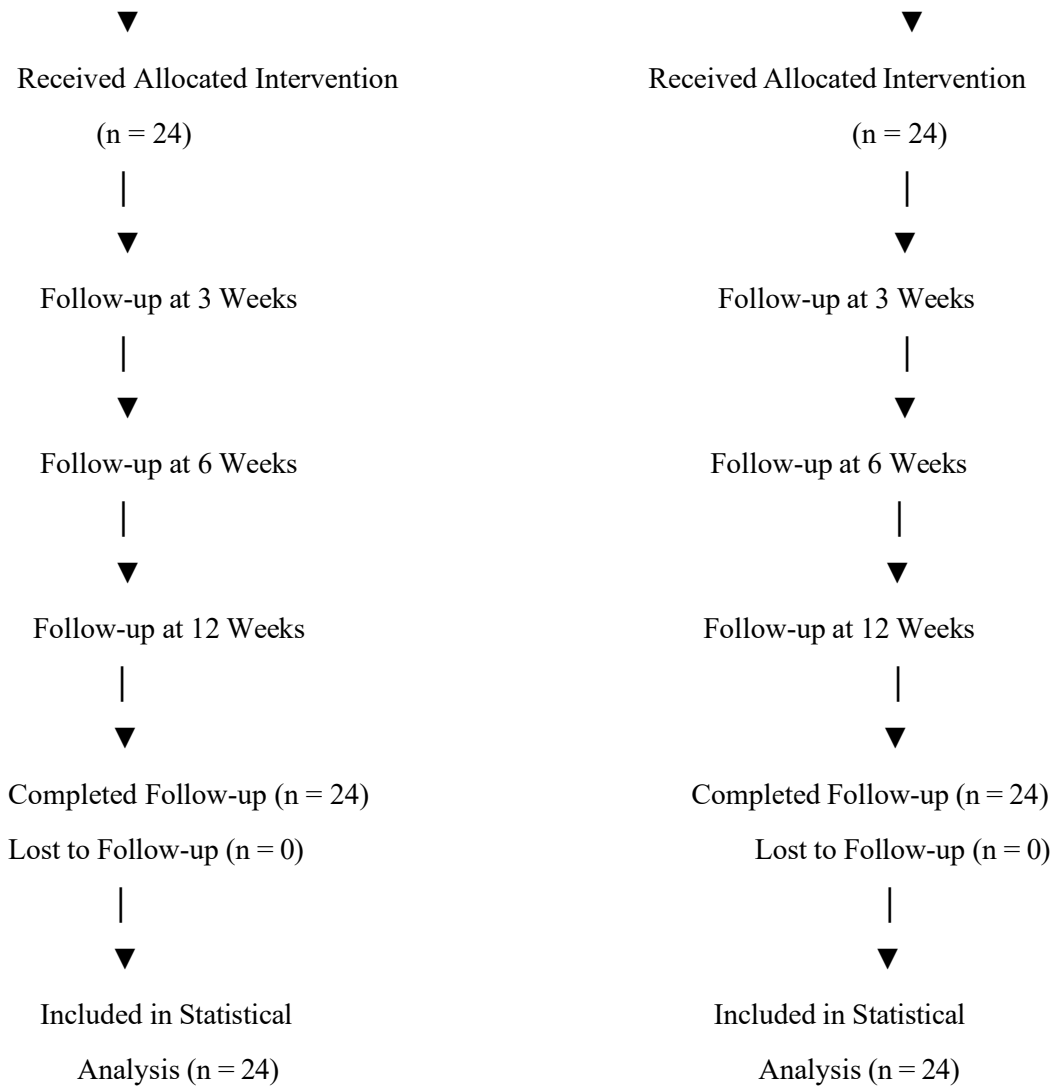
The interdental papilla is a vital component of periodontal esthetics, contributing to harmonious gingival architecture, functional support, and an attractive smile. Deficiency of the interdental papilla creates open gingival embrasures, commonly known as black triangles, which adversely affect facial esthetics and may lead to food impaction, speech difficulties, and plaque retention. As patient awareness of dental esthetics continues to increase, management of interdental papillary defects has become an important objective in contemporary periodontal therapy. ¹

The integrity of the interdental papilla depends on several anatomical and biological determinants, including the position of the interproximal contact point, the height of the interdental alveolar bone, tooth morphology, and gingival tissue characteristics. Alteration of any of these factors due to periodontal disease, traumatic oral hygiene practices, orthodontic tooth movement, or age-related tissue changes can result in loss of papillary volume. Successful treatment therefore requires careful evaluation of both the hard and soft tissue components before selecting an appropriate therapeutic approach. ⁴

Reconstruction of the interdental papilla remains one of the most demanding procedures in periodontal plastic surgery because of the limited vascular supply and the small volume of available soft tissue. Several surgical techniques have been introduced to improve papillary form by repositioning or augmenting soft tissues. Although these procedures can achieve favorable esthetic outcomes, they require advanced surgical skill, are technique-sensitive, and may be associated with postoperative discomfort. ⁵

The development of minimally invasive procedures has provided alternative treatment options for papillary reconstruction. Hyaluronic acid is a naturally occurring glycosaminoglycan present within the extracellular matrix and plays an essential role in tissue hydration, cellular migration, angiogenesis, and wound healing. Owing to its excellent biocompatibility and regenerative properties, injectable hyaluronic acid has been increasingly investigated as a non-surgical method for soft tissue augmentation in the esthetic zone. ¹⁰

Despite encouraging clinical outcomes reported for both surgical and non-surgical techniques, evidence directly comparing these treatment modalities remains limited. Comparative clinical studies are essential to determine their relative effectiveness and to assist clinicians in selecting predictable treatment strategies for patients presenting with interdental papillary deficiencies. Therefore, the present randomized controlled clinical trial was designed to compare the clinical outcomes of the Modified Beagle's surgical technique and injectable hyaluronic acid in the management of interdental papillary defects by evaluating papillary



Inclusion Criteria

Participants fulfilling the following criteria were included:

- Age between 18 and 40 years.
- Presence of Nordland and Tarnow Class I or Class II interdental papillary deficiency. **3**
- Systemically healthy individuals.
- Full-mouth plaque score and gingival score within acceptable limits following phase I periodontal therapy.
- Patients willing to participate and comply with the follow-up schedule.

Exclusion Criteria

The following patients were excluded:

- Smokers and tobacco users.
- Pregnant or lactating women.
- Patients with uncontrolled systemic diseases.
- History of periodontal surgery in the study area.
- Active periodontal disease or untreated carious lesions.
- Patients receiving medications known to influence periodontal wound healing.
- Patients with poor oral hygiene compliance.

Randomization

Forty-eight eligible participants were randomly assigned into two equal treatment groups using a simple random allocation method. Allocation was performed after completion of Phase I periodontal therapy to minimize selection bias.

Initial Periodontal Therapy

Before commencement of the study, all participants underwent Phase I periodontal therapy, including oral hygiene instructions, supragingival and subgingival scaling, and root planing where required. Oral hygiene was reinforced throughout the study period. Clinical measurements were recorded only after resolution of gingival inflammation.

Clinical Parameters

The following clinical parameters were recorded at **baseline, 3 weeks, 6 weeks, and 12 weeks**:

- Plaque Index (Silness and Loe)
- Gingival Index (Loe and Silness)
- Papillary Deficient Height (PDH)
- Papillary Width (PW)
- Papillary Deficient Area (PDA)

Standardized intraoral photographs were obtained using a **Canon EOS 5D Mark III digital camera equipped with a 100-mm macro lens** under standardized photographic conditions. Linear and area measurements were analyzed using **Digimizer image analysis software**.

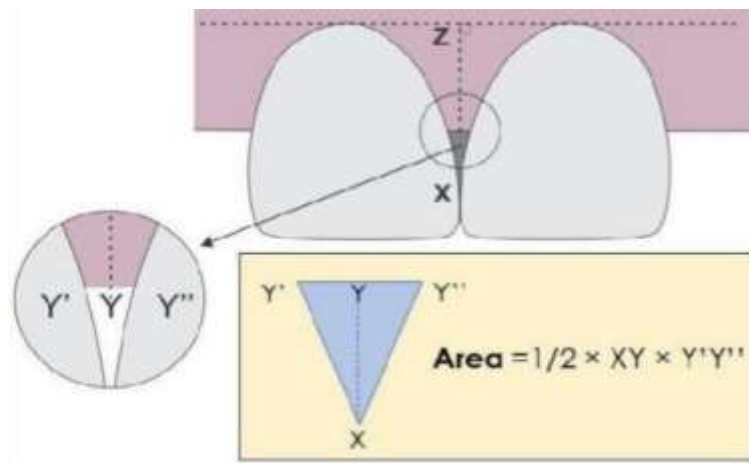


Figure 1 . Schematic representation of the reference points. Point X = Interdentary Contact Point; Point Y = Crest of the Interdentary Papilla; Point Z = Point perpendicular to the imaginary line joining the facial CEJ of adjacent teeth; Y'Y'' = Papillary Width; XY = Papillary Deficient Height; YZ = Papillary Height; XZ = Expected Papillary Height.

Group I – Injectable Hyaluronic Acid(GENGIGEL)

Participants allocated to Group I received **0.8% injectable hyaluronic acid gel** for reconstruction of the deficient interdentary papilla.

Following local antisepsis, approximately **0.2 mL** of hyaluronic acid gel was injected using a **30-gauge insulin syringe**. The needle was inserted approximately **2–3 mm apical to the papillary tip** at an angle of approximately **45° to the long axis of the tooth**, with the bevel directed apically. Following injection, gentle digital massage was performed for approximately one minute to facilitate uniform distribution of the material within the papillary tissue. **FIGURE :2**

Group II – Modified Beagle's Surgical Technique

Patients assigned to Group II underwent papillary reconstruction using the **Modified Beagle's surgical technique** under local anesthesia containing **2% lignocaine with 1:80,000 epinephrine**.

Vertical releasing incisions were placed at the line angles of the adjacent teeth and connected with a horizontal incision apical to the papillary defect. A partial-thickness pedicle flap was carefully elevated while preserving tissue vascularity. The papillary tissue was mobilized coronally to completely cover the interdentary embrasure and stabilized using **3-0 silk sutures**. Periodontal dressing was placed whenever required.

Postoperative Care

Participants in the surgical group received postoperative medications consisting of:

- Amoxicillin 500 mg three times daily for five days.
- Diclofenac sodium 50 mg with Paracetamol 500 mg twice daily for three days.

Patients in both groups were instructed to avoid flossing or traumatic cleaning of the treated area during the healing period. Chlorhexidine mouth rinse (0.12% or 0.2%) was advised twice daily for two weeks, and oral hygiene instructions were reinforced at each follow-up visit.**FIGURE :2**

Follow-up Evaluation

Clinical evaluation was performed at **3 weeks, 6 weeks, and 12 weeks** after treatment. At each visit, Plaque Index, Gingival Index, Papillary Deficient Height, Papillary Width, and Papillary Deficient Area were recorded using standardized clinical photographs and image analysis. The same examiner performed all clinical measurements to minimize examiner variability.

Statistical Analysis

All clinical data were entered into Microsoft Excel and analyzed using **Statistical Package for the Social Sciences (SPSS) software version 21.0 (IBM Corp., Armonk, NY, USA)**.

Descriptive statistics were expressed as **mean ± standard deviation**. Normality of the data was assessed using the **Kolmogorov–Smirnov test**. Intragroup comparisons among different time intervals were performed using **Repeated Measures Analysis of Variance (ANOVA)**, followed by appropriate post hoc analysis where indicated. Intergroup comparisons were performed using the **Independent Student's t-test**. A value of **P < 0.05** was considered statistically significant.

RESULTS

Demographic characteristics of the study participants

A total of 48 participants were enrolled and completed the study, with 24 participants in each treatment group. The mean age was 24.83 ± 1.10 years in the hyaluronic acid group and 23.63 ± 0.34 years in the Modified Beagle's surgical group. The hyaluronic acid group comprised 14 males (58.3%) and 10 females (41.7%), whereas the Modified Beagle's surgical group included 11 males (45.8%) and 13 females (54.2%). No statistically significant differences were observed between the groups with respect to age or gender distribution ($P > 0.05$), indicating comparable baseline characteristics.

2. Comparison of Plaque Index between groups

Plaque Index and Gingival Index remained stable throughout the 12-week follow-up period in both groups. No statistically significant intra- or intergroup differences were observed at baseline, 3 weeks, 6 weeks, or 12 weeks ($P > 0.05$), indicating that satisfactory oral hygiene and gingival health were maintained throughout the study

PAPILLARY DEFICIENT HEIGHT

Table 1. Intragroup and Pairwise Comparison of Papillary Deficient Height

Group	Timeline / Comparison	Mean (mm)	SD	Mean Difference (mm)	F value	P value
Group I	Baseline	2.03	0.50	—	2.434	0.04*
	3 weeks	1.60	0.60	0.43		
	6 weeks	1.23	1.10	0.80		
	12 weeks	0.64	0.20	1.39		
	3W vs 6W	1.60	0.60	0.37		0.04*
	3W vs 12W	1.60	0.60	0.96		0.01*
	6W vs 12W	1.23	1.10	0.59		0.03*
Group II	Baseline	2.60	1.40	—	1.349	0.03*
	3 weeks	0.30	0.10	2.30		
	6 weeks	0.28	0.02	2.32		
	12 weeks	0.24	0.01	2.36		

Group	Timeline / Comparison	Mean (mm)	SD	Mean Difference (mm)	F value	P value
	3W vs 6W	0.30	0.10	0.02		0.02*
	3W vs 12W	0.30	0.10	0.06		0.01*
	6W vs 12W	0.28	0.02	0.04		0.03*

*Repeated measures ANOVA; $p < 0.05$ indicates statistical significance.

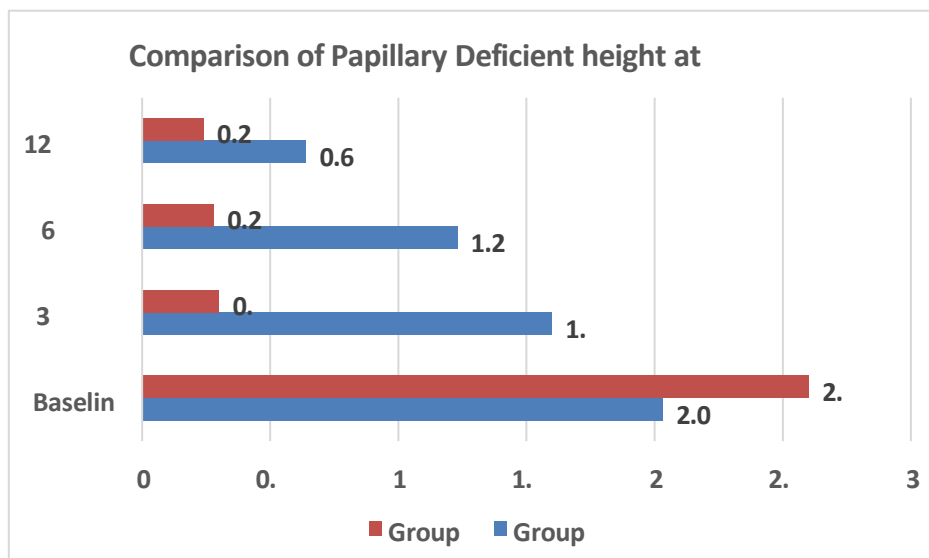
Table 2. Intergroup Comparison of Papillary Deficient Height

Group	Time Interval	Mean (mm)	Std. (mm)	Error t value	95% Confidence Interval	P value
Group I (Hyaluronic Acid)	Baseline	2.03	0.136	2.274	1.07–5.08	<0.01*
	3 weeks	1.60	0.471	1.349	0.86–3.26	
	6 weeks	1.23	0.707	3.034	0.42–2.19	
	12 weeks	0.64	0.597	–1.055	0.11–1.31	
Group II (Modified Beagle 's Technique)	Baseline	2.60	0.358	0.067	1.01–4.31	
	3 weeks	0.30	0.454	25.80	0.12–0.61	
	6 weeks	0.28	0.278	5.124	0.12–0.57	
	12 weeks	0.24	0.465	–2.04	0.10–0.57	

*Independent sample t-test; $p < 0.05$ indicates statistical significance

Both treatment groups demonstrated a significant reduction in Papillary Deficient Height (PDH) over the 12-week follow-up period. In the hyaluronic acid group, the mean PDH decreased progressively from 2.03 ± 0.50 mm at baseline to 0.64 ± 0.20 mm at 12 weeks. In contrast, the Modified Beagle's surgical group showed a rapid reduction from 2.60 ± 1.40 mm at baseline to 0.24 ± 0.01 mm at 12 weeks, with most of the improvement observed by the third postoperative week. Intragroup analysis demonstrated statistically significant reductions in PDH in both groups over time ($P < 0.05$). Intergroup comparison showed significantly greater improvement in the Modified Beagle's surgical group than in the hyaluronic acid group throughout the follow-up period (Tables 1 and 2; Figure 1)Figure 4.

Comparison of Papillary Deficient Height between groups



PAPILLARY DEFICIENT AREA

Table 3. Intragroup and Pairwise Comparison of Papillary Deficient Area

Group	Timeline Comparison	Mean (mm²)	SD	Mean (mm²)	Difference	F value	P value
Group I	Baseline	1.02	0.40	—		144.97	0.03*
	3 weeks	0.65	0.40	0.37			
	6 weeks	0.38	0.01	0.64			
	12 weeks	0.14	0.02	0.88			
	3W vs 6W	0.65	0.40	0.27			0.04*
	3W vs 12W	0.65	0.40	0.51			0.01*
	6W vs 12W	0.38	0.02	0.24			0.03*
Group II	Baseline	1.82	2.02	—		162.85	<0.01*

Group	Timeline Comparison	Mean (mm ²)	SD	Mean (mm ²)	Difference	F value	P value
	3 weeks	0.021	5.12	1.799			
	6 weeks	0.018	1.29	1.802			
	12 weeks	0.012	1.33	1.808			
	3W vs 6W	0.021	3.74	0.003			0.02*
	3W vs 12W	0.021	3.81	0.009			0.01*
	6W vs 12W	0.018	1.31	0.006			0.03*

Repeated measures ANOVA; $p < 0.05$ was considered statistically significant.

Table 4. Intergroup Comparison of Papillary Deficient Area

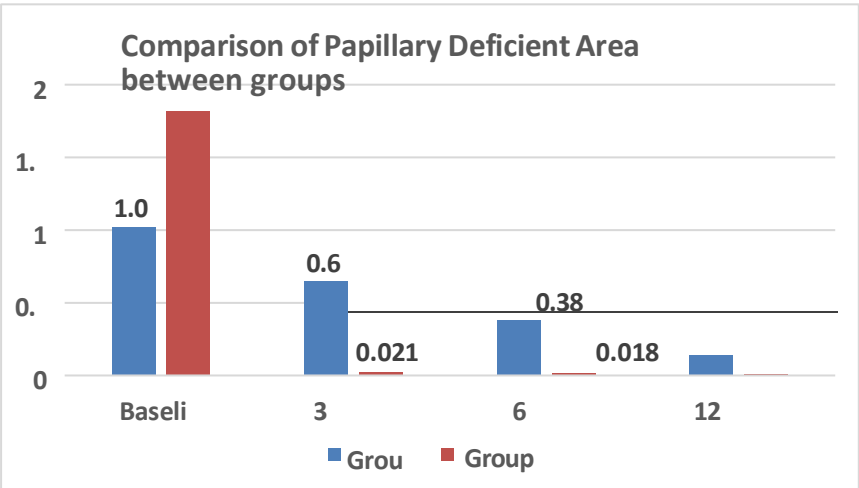
Group	Time Interval	Mean (mm ²)	Std. Error	t value	95% Interval	Confidence P value
Group I (Hyaluronic Acid)	Baseline	1.02	8.23	1.528	0.17–5.19	<0.01*
	3 weeks	0.65	1.63	3.486	0.11–1.80	
	6 weeks	0.38	3.23	0.216	0.04–0.93	
	12 weeks	0.14	2.93	4.17	0.00–0.79	
Group II (Modified Beagle's Technique)	Baseline	1.82	2.02	1.392	0.19–4.33	
	3 weeks	0.021	5.12	0.584	0.00–0.10	
	6 weeks	0.018	1.29	5.163	0.00–0.08	
	12 weeks	0.012	1.33	6.004	0.00–0.03	

Independent sample t-test; $p < 0.05$ was considered statistically significant.

Both treatment modalities produced a significant reduction in Papillary Deficient Area (PDA) during the 12-week follow-up. In the hyaluronic acid group, the mean PDA decreased from **1.02 ± 0.40 mm²** at baseline to **0.14 ± 0.02 mm²** at 12 weeks. The Modified Beagle's surgical group demonstrated a greater

reduction, with PDA decreasing from $1.82 \pm 2.02 \text{ mm}^2$ at baseline to $0.012 \pm 1.33 \text{ mm}^2$ at 12 weeks. Intragroup analysis showed statistically significant improvement in both groups ($P < 0.05$), while intergroup comparison demonstrated significantly greater reduction in PDA in the Modified Beagle's surgical group throughout the study period (Tables 3 and 4; Figure 5)

Comparison of Papillary Deficient Area between groups



PAPILLARY DEFICIENT WIDTH

Table 5 :Intragroup and Pairwise Comparison of Papillary Width

Group	Timeline / Comparison	Mean (mm)	SD	Mean Difference (mm)	F value	P value
Group I	Baseline	0.918	0.013	—	298.34	0.03*
	3 weeks	0.730	1.47	0.188		
	6 weeks	0.526	0.21	0.392		
	12 weeks	0.358	0.79	0.560		
	3W vs 6W	0.730	1.47	0.204		0.04*
	3W vs 12W	0.730	1.47	0.372		0.01*
	6W vs 12W	0.526	0.21	0.168		0.03*
Group II	Baseline	1.447	0.417	—	391.34	0.04*

Group	Timeline / Comparison	Mean (mm)	SD	Mean Difference (mm)	F value	P value
	3 weeks	0.251	1.212	1.196		
	6 weeks	0.157	0.320	1.290		
	12 weeks	0.141	2.850	1.306		
	3W vs 6W	0.251	1.212	0.094		0.02*
	3W vs 12W	0.251	1.212	0.110		0.01*
	6W vs 12W	0.157	0.320	0.016		0.03*

Repeated measures ANOVA; $p < 0.05$ was considered statistically significant.

Table 6. Intergroup Comparison of Papillary Width

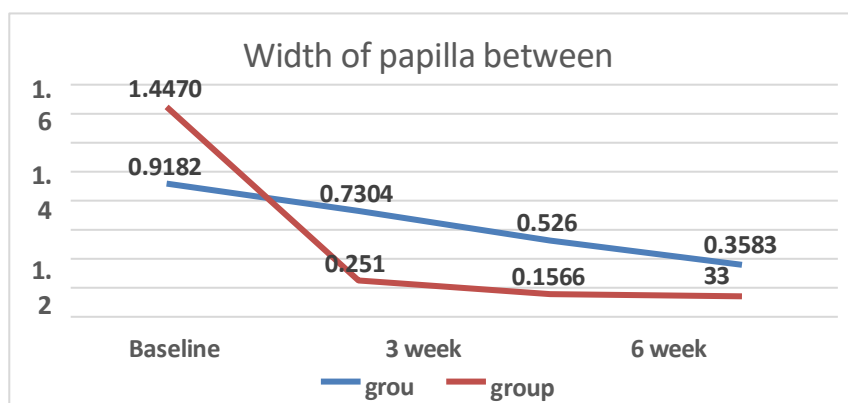
Group	Time Interval	Mean (mm)	Std. Error (mm)	t value	95% Confidence Interval	P value
Group I (Hyaluronic Acid)	Baseline	0.918	233.541	49.094	0.50–2.04	<0.01*
	3 weeks	0.730	489.507	46.052	0.25–1.14	
	6 weeks	0.526	107.830	29.410	0.16–1.08	
	12 weeks	0.358	112.624	72.170	0.01–2.82	
Group II (Modified Beagle's Technique)	Baseline	1.447	268.437	51.930	0.37–7.20	
	3 weeks	0.251	23.670	21.540	0.04–1.90	
	6 weeks	0.157	243.926	89.210	0.06–0.70	
	12 weeks	0.141	104.307	28.390	0.06–0.62	

Independent sample t-test; $p < 0.05$ was considered statistically significant.

A significant reduction in Papillary Deficient Width (PW) was observed in both treatment groups throughout the study period. In the hyaluronic acid group, the mean PW decreased from 0.918 ± 0.013 mm at baseline to 0.358 ± 0.79 mm at 12 weeks. The Modified Beagle's surgical group demonstrated a greater reduction, with PW decreasing from 1.447 ± 0.417 mm at baseline to 0.141 ± 2.850 mm at 12 weeks.

Intragroup analysis revealed statistically significant reductions in PW over time in both groups ($P < 0.05$). Intergroup comparison demonstrated significantly greater improvement in the Modified Beagle's surgical group compared with the hyaluronic acid group during the 12-week follow-up (Tables 5 and 6; Figure 6).

Comparison of Papillary width between groups



DISCUSSION

The present randomized controlled clinical trial was conducted to evaluate and compare the clinical effectiveness of non-surgical injectable hyaluronic acid and the modified Beagle's surgical technique for the reconstruction of interdental papilla in patients presenting with Nordland and Tarnow Class I and Class II papillary deficiencies. Loss of the interdental papilla, clinically manifested as black triangles, is one of the most challenging esthetic concerns encountered in periodontal practice. In addition to compromising smile esthetics, papillary loss may result in food impaction, phonetic disturbances, and reduced patient satisfaction, thereby affecting oral health-related quality of life. Therefore, predictable reconstruction of the interdental papilla continues to be an important objective of periodontal plastic surgery.^{1–3}

The baseline demographic characteristics demonstrated no statistically significant differences between the two treatment groups with respect to age and gender distribution, confirming successful randomization and homogeneity of the study population. This minimizes the influence of confounding variables and strengthens the internal validity of the present study. Similar baseline comparability has been reported in previous clinical trials evaluating various treatment modalities for interdental papilla reconstruction.⁴

The gingival index and plaque index remained stable throughout the study period, with no statistically significant differences between the two groups. These findings indicate that all participants maintained satisfactory plaque control and periodontal health during the follow-up period. Maintenance of optimal oral hygiene is considered essential for successful periodontal wound healing and soft tissue reconstruction. Awartani and Tatakis¹¹ emphasized that meticulous plaque control and patient compliance are critical determinants for achieving predictable outcomes following periodontal plastic surgery. The stability of

these indices in the present study suggests that the improvements observed were attributable to the treatment modalities rather than changes in periodontal health.

A statistically significant reduction in papillary deficient height was observed in both treatment groups. In the non-surgical group, papillary deficient height gradually decreased from **2.03 mm at baseline** to **1.60 mm at 3 weeks**, **1.23 mm at 6 weeks**, and **0.64 mm at 12 weeks**, indicating progressive soft tissue regeneration. This gradual improvement may be explained by the biological properties of hyaluronic acid, which promotes fibroblast proliferation, angiogenesis, extracellular matrix formation, and collagen synthesis, thereby facilitating tissue repair and regeneration. Becker et al.⁵ reported significant papillary fill following hyaluronic acid injections, while Lee et al.⁶ demonstrated that hyaluronic acid is particularly effective in the management of small papillary defects. These findings support the gradual improvement observed in the present investigation.

In contrast, the modified Beagle's surgical technique demonstrated a rapid reduction in papillary deficient height, with the greatest improvement occurring during the first three weeks after surgery. This rapid clinical response may be attributed to immediate coronal repositioning of the papillary tissue together with preservation of vascularity through the pedicle flap design. Cortellini et al.³ reported that papilla preservation techniques improve flap stability and vascular supply, thereby enhancing wound healing. Similarly, Azzi et al.¹⁷ demonstrated that connective tissue grafting provides increased tissue thickness and long-term papillary stability. The findings of the present study are consistent with these reports, as the surgical group exhibited early stabilization with minimal additional changes during subsequent follow-up.

A significant reduction in papillary deficient area was also observed in both treatment groups. However, the reduction was substantially greater in the surgical group. The papillary deficient area decreased from **1.02 mm² to 0.14 mm²** in the non-surgical group, whereas it decreased from **1.82 mm² to 0.012 mm²** in the surgical group. These findings indicate that the modified Beagle's technique provides more effective closure of black triangle defects by immediately restoring papillary architecture. Abdelraouf et al.¹¹ reported significant reduction in black triangle dimensions following hyaluronic acid therapy, whereas Chaulkar et al.⁹ demonstrated superior outcomes with modified surgical techniques for papillary reconstruction. The present findings are in agreement with these studies and further support the superiority of the surgical approach in achieving predictable papillary fill.

Papillary width demonstrated a similar pattern of improvement. Although both treatment modalities significantly reduced papillary width, the surgical group exhibited greater and earlier improvement than the non-surgical group. Restoration of papillary width is clinically important because it contributes to the elimination of black triangles and improves gingival contour and smile esthetics. Pitale et al.¹⁴ also reported improvement in papillary width following hyaluronic acid injections; however, the response was gradual and less predictable than that observed with surgical intervention. These findings suggest that while injectable hyaluronic acid is capable of improving papillary contour, the modified Beagle's technique provides superior clinical predictability.

The differences in treatment outcomes observed in the present study may be explained by the distinct mechanisms of action of the two treatment modalities. Hyaluronic acid acts as a biologically active extracellular matrix component that enhances tissue hydration, promotes fibroblast migration, stimulates collagen synthesis, and accelerates wound healing.^{12,27} Hyaluronic acid has shown promising results in achieving papillary fill, even in HIV patients with severe periodontitis and papillary recession, supporting its regenerative potential in compromised periodontal conditions.⁴⁸

Full-mouth disinfection is a proven treatment modality for severe periodontitis and provides a healthy periodontal environment before papillary reconstruction.⁴⁹ Furthermore, personalized treatment planning based on individual patient needs and risk factors improves clinical decision-making and treatment outcomes in periodontics.⁵⁰

Consequently, tissue regeneration occurs gradually and depends largely on the patient's intrinsic healing capacity. In contrast, the modified Beagle's surgical technique provides immediate anatomical correction through coronal repositioning of the papillary tissue while maintaining an adequate vascular supply. This results in rapid tissue adaptation, improved flap stability, and predictable long-term clinical outcomes.

Despite the favorable outcomes observed with hyaluronic acid therapy, variability has been reported in the literature. Bertl et al.⁸ found no statistically significant difference between hyaluronic acid and saline injections, suggesting that treatment outcomes may be influenced by defect morphology, gingival biotype, bone support, injection protocol, and patient-related factors. Furthermore, systematic reviews by Castro-Calderón et al.¹⁵ and Patel et al.¹⁶ concluded that although hyaluronic acid shows promising clinical potential, additional well-designed randomized clinical trials with standardized treatment protocols and longer follow-up periods are required before definitive clinical recommendations can be established.

Another important determinant of successful papillary reconstruction is the distance between the contact point and the alveolar bone crest. Tarnow et al.¹ demonstrated that complete papillary fill is highly predictable when this distance is **5 mm or less**, whereas the probability of complete reconstruction decreases significantly as the distance increases. Similarly, gingival biotype plays an important role in treatment outcomes, with thicker biotypes demonstrating more favorable healing and improved soft tissue stability than thin biotypes, as reported by Ni et al.¹⁰. These anatomical considerations should therefore be carefully evaluated during case selection to maximize the predictability of both surgical and non-surgical treatment modalities.

The findings of the present study clearly demonstrate that the modified Beagle's surgical technique provides earlier, more predictable, and clinically superior outcomes than injectable hyaluronic acid for the reconstruction of interdental papilla. Although injectable hyaluronic acid represents a promising minimally invasive treatment option that produced gradual and statistically significant improvement, the surgical approach achieved more rapid papillary fill, greater reduction in papillary deficient height, width, and area, and superior soft tissue stability throughout the 12-week follow-up period. These findings suggest that the modified Beagle's surgical technique should be considered the preferred treatment modality for patients requiring predictable esthetic reconstruction of interdental papillary deficiencies, while injectable hyaluronic acid may serve as an effective alternative in carefully selected cases

ILLUSTRATION
NON SURGICAL TECHNIQUE

Figure 2 : Clinical images showing non-surgical management of interdental papillary deficiency using hyaluronic acid gel at different time intervals.

Fig 2 A : Baseline



Fig 2 B : HA Injection at Baseline



Fig 2 C : 3 WEEK



Fig 2 D : 6 WEEK



Fig 2 : 12 WEEK



SURGICAL TECHNIQUE

Fig.3 : Clinical images showing surgical management of interdental papillary deficiency using modified beagles technique at different time intervals

Fig 3 A: Baseline



Fig 3 B : Incision given



Fig 3 C : partial thickness flap



Fig 3 D :suturing done



Fig 3 D : 3 week



Fig 3 E: 6 week



Fig 2 F : 12 WEEK



REFERENCE

1. Singh VP, Upoor AS, Nayak DG, Shah D. Black triangle dilemma and its management in esthetic dentistry. *Dent Res J*. 2013;10(3):296-301.
2. Takei HH, Han TJ, Carranza FA Jr, Kenney EB, Lekovic V. Flap technique for papilla preservation. *J Periodontol*. 1985
3. Nordland WP, Tarnow DP. A classification system for loss of papillary height. *J Periodontol*. 1998;69(10):1124-1126.
4. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interdental papilla. *J Periodontol*. 1992.
5. Cortellini P, Pini-Prato G, Tonetti MS. Modified papilla preservation technique for interproximal regenerative procedures. *J Periodontol*. 1999.
6. Pilloni A, Rojas MA. Connective tissue graft for interdental papilla reconstruction. *Int J Periodontics Restorative Dent*. 2008.
7. Becker BE, Becker W. Predictable papilla reconstruction procedures in esthetic dentistry. *Compend Contin Educ Dent*. 2005;26(10):653-660.
8. Pilloni A, et al. Clinical application of hyaluronic acid in periodontal therapy. *J Clin Periodontol*. 2011

9. Awartani FA, Tatakis DN. Interdental papilla loss: treatment by hyaluronic acid gel injection. *Clin Oral Investig*. 2015;20(7):1775-1780.
10. Becker W, Gabitov I, Stepanov M, Kojs J, Smidt A, Becker BE. Minimally invasive treatment for papilla deficiencies in the esthetic zone: a pilot study. *Clin Implant Dent Relat Res*. 2010;12(1):1-8.
11. Lee WP, Kim HJ, Yu SJ, Kim BO. Six-month clinical evaluation of interdental papilla reconstruction with injectable hyaluronic acid gel. *J Esthet Restor Dent*. 2016;28(4):221-230
12. Al-Khateeb R, Olszewska-Czyz I. HA as biomaterial in dentistry. *Heliyon*. 2020;6:e03722
13. Pirnazar P, Wolinsky L, Nachnani S, Haake S, Piloni A, Bernard GW. Bacteriostatic effects of hyaluronic acid. *J Periodontol*. 1999.
14. Singh S, Vandana KL. Use of different concentrations of hyaluronic acid in papillary deficiency treatment. *J Indian Soc Periodontol*. 2019;23(1):35-41.
15. Ficho AC, de Souza Faloni AP, et al. HA for papilla reconstruction: systematic review. *J Esthet Restor Dent*. 2020;32:1-8.
16. Alsharif SB, Aljahdali B. HA injection for black triangle: systematic review. *Acta Odontol Scand*. 2024;83:371-391.
17. Azzi R, Etienne D, Carranza FA. Surgical reconstruction of the interdental papilla. *Int J Periodontics Restorative Dent*. 1998.
18. Wang HL, et al. Surgical techniques for papilla reconstruction. *J Periodontol*. 2009.
19. Sawai ML, Kohad RM. An evaluation of a periodontal plastic surgical procedure for the reconstruction of interdental papillae in the maxillary anterior region: A clinical study. *Journal of Indian Society of Periodontology*. 2012;16(4):533–538.
20. Awartani FA, Tatakis DN. Interdental papilla loss: Etiology, classification, and

management. *Journal of Periodontology*. 2016;87(6):e92–e103.

21. Bertl K, Gotfredsen K, Jensen SS, Bruckmann C, Stavropoulos A. Hyaluronan injections for papilla augmentation. *Clin Oral Implants Res*. 2017;28(9):1054–1061.
22. Chaulkar PP, Mali RS, Mali AM, Lele PA, Patil PA. Comparative evaluation of papillary reconstruction by modified Beagle's technique. *J Indian Soc Periodontol*. 2017;21(3):218–223.
23. i J, Shu R, Li C. Efficacy of HA gel for gingival papilla defects. *J Oral Maxillofac Surg*. 2019;77(12):2467–2474.
24. Singh S, Vandana KL. Use of different concentrations of hyaluronic acid in the treatment of interdental papillary deficiency: A clinical study. *Journal of Indian Society of Periodontology*. 2019;23(1):35–41.
25. Abdelraouf SA, Aboul Dahab O, Elbarbary A, El-Din AM, Mostafa B. Assessment of hyaluronic acid gel injection in the reconstruction of interdental papilla: A randomized clinical trial. *Open Access Maced J Med Sci*. 2019;7(11):1834–1840.
26. Alhabashneh R, Alomari S, Khaleel B, Qinawi H, Alzaubi M. HA injection for papilla reconstruction: 6-month study. *J Esthet Restor Dent*. 2020;33(3):531–537.
27. Al-Khateeb R, Olszewska-Czyz I. Biological molecules in dental applications: hyaluronic acid as a companion biomaterial for diverse dental applications. *Clin Oral Investig*. 2020;24(6):1–12.
28. Kim SB, Cho J, Jue SS, Park JH, Kim JY. HA filler effect on interdental papilla: animal study. *Int J Environ Res Public Health*. 2020;17(14):4956.
29. Shenoy BS, Punj A, Ramesh A, Talwar A. Papilla reconstruction: case series. *Case Rep Dent*. 2020.
30. Pitale U, Pal PC, Thakare G, et al. Minimally invasive HA therapy for papilla reconstruction. *J Indian Soc Periodontol*. 2021;25(1):22–28.

31. Castro-Calderón A, et al. HA injection for papilla reconstruction: systematic review. *Acta Odontol Scand*. 2022;80(4):295–307.
32. Bal A, Panda S, Mohanty R, Satpathy A. HA with PRGF for papilla loss: RCT. *J Funct Biomater*. 2023.
33. Urgiles Espinoza KA, Rosales Calderón JA, et al. Injectable hyaluronic acid for interdental papilla reconstruction: A clinical study. *International Journal of Dentistry*. 2023;2023:1–8.
34. Patel M, Guni A, Nibali L, Garcia-Sanchez R. Interdental papilla reconstruction: systematic review. *Clin Oral Investig*. 2024;28(1):101.
35. Hamadeh W, Alhabashneh R, Abdelhafez R, Khader Y. HA injection overlay technique: clinical study. *Quintessence Int*. 2024;55(3):180–189.
36. Kaur A, Waghmare PW, Dodwad V, et al. HA for papilla regeneration: clinical study. *Cureus*. 2024;16(7):e64510.
37. Saberi BV, Khalighi Sigaroudi A, Kamani M, Rafiei E. Alb-PRF vs HA for papilla reconstruction: RCT. *J Adv Periodontol Implant Dent*. 2024.
38. Kapoor S, Bhardwaj A. Evaluation of 2% hyaluronic acid gel for interdental papilla reconstruction in the esthetic zone: A clinical prospective study. *Journal of Pharmaceutical Research International*. 2024;34:43–58.
39. El Mobadder M, Nammour S. Photobiomodulation therapy for the management of interdental papilla loss (“black triangles”): A case report. *Photodiagnosis and Photodynamic Therapy*. 2024;45:103902.
40. Jamjoom AG, Bakhshwain MA. Injectable hyaluronic acid versus surgical and non-surgical approaches for interdental papilla reconstruction: A systematic review. *J Periodontol*. 2025;96(1):45–56.
41. Kazarian E, Inozemtseva K, Lebedeva E. 3D tunneling technique for papilla reconstruction. *Int J Periodontics Restorative Dent*. 2025;45(1):31–45.

42. Larderet A, Petit C, Huck O, Gegout PY. HA injection for papilla reconstruction: systematic review. *Oral Health Prev Dent.* 2025;23:279–290.
43. Nemcovsky CE. Interproximal papilla augmentation procedure: a novel surgical approach and clinical evaluation. *Int J Periodontics Restorative Dent.* 2001;21(6):553–559.
44. Zucchelli G, De Sanctis M. Surgical treatment of multiple gingival recessions with coronally advanced flap. *J Periodontol.* 2004.
45. Pilloni A, Paolantonio M, Camargo PM. Root coverage with connective tissue graft associated with papilla reconstruction. *Int J Periodontics Restorative Dent.* 2006;26(4):363–369.
46. Lokhande Sawai M, Kohad R. An evaluation of a periodontal plastic surgical procedure for reconstruction of interdental papillae. *J Indian Soc Periodontol.* 2012;16(4):533–538.
47. Kapoor S, Bhardwaj A. HA gel for papilla reconstruction: clinical study. *J Pharm Res Int.* 2022;34:43–58.
48. Research Society and Development. Injectable HA for papilla regeneration: review. *Res Soc Dev.* 2024;13(5):e5213545816.
49. Rohit Sharma, Akshay Bhargava, Neetha Bhargava, HB passi, N Barala, P Gumber. Journal of pharmaceutical Negative Results 2022;13
50. MA Razi, R Sharma, SK Koppula, N Bhargava, M Khalid .IP International Journal of Periodontology and Implantology 2025;10(4):181-187.
51. Mohammed Ahsan Razi, Manoj Kumar Singh, Neetha Bhargava. IP International Journal of Periodontology and Implantology 2026;11(1):3-9.