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Minimally invasive therapy for papillary reconstruction using injectable hyaluronic acid - a case report

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Abstract
Introduction: Interdental papillary deficiency, commonly referred to as "black triangles," is a major aesthetic and functional concern for both patients and clinicians. The absence of interdental papilla can lead to cosmetic deformities and chronic food impaction. Numerous surgical and non-surgical techniques have been proposed for the reconstruction of lost papillae. Although autogenous subepithelial connective tissue grafting remains the gold standard, it involves surgical morbidity and patient discomfort. Hence, minimally invasive approaches using bioactive agents such as hyaluronic acid (HA) have emerged as effective alternatives. HA is a naturally occurring glycosaminoglycan that plays an important role in tissue repair, cell proliferation, and wound healing. Its hygroscopic and viscoelastic properties make it suitable for volumizing deficient interdental papillae.
Aim and Objective: To evaluate the efficacy of injectable hyaluronic acid for the reconstruction of interdental papilla.
Materials and Methods: Patients presenting with Nordland and Tarnow (1998) Class I and II papillary recession were selected. A volume of 0.2 ml of HA filler (20 mg/ml) was injected 2-3 mm apical to the coronal tip of the papilla. Clinical parameters, including the distance from the contact point to the gingival margin (CP-GM) and interproximal width (IPW), were assessed at baseline, 3 weeks, and 5 weeks. The data were statistically analyzed using analysis of variance (ANOVA).
Results: Injectable HA showed promising outcomes in papillary reconstruction within 5 weeks. Both CP-GM and IPW exhibited statistically significant reductions from baseline to 5 weeks.
Conclusion: Injectable hyaluronic acid represents a safe, predictable, and minimally invasive approach for the reconstruction of interdental papillae. It provides significant esthetic enhancement, promotes tissue regeneration, and ensures greater patient comfort, thereby serving as an effective nonsurgical alternative to conventional surgical procedures

Keywords: Minimally invasive therapy, injectable hyaluronic acid, interdental papillary reconstruction

Introduction

The interdental papilla is the gingival tissue that occupies the space between adjacent teeth, playing a crucial role in maintaining esthetics, phonetics, and periodontal health. The loss or reduction of this papilla, often visible as "black triangles," can occur due to gingival recession, alveolar bone loss, or improper dental procedures. Such deficiencies not only compromise esthetics but can also lead to food impaction and patient discomfort [1].

The etiology of interdental papilla loss is multifactorial and includes abnormal tooth morphology, thin gingival biotype, diverging roots, overhanging restorations, traumatic interdental cleaning habits, periodontal disease, orthodontic tooth movement, and surgical procedures [2-3].

Treatment strategies vary depending on the underlying cause. Non-surgical management includes improving oral hygiene practices and modifying traumatic cleaning techniques. Orthodontic closure of diastemas and prosthetic corrections can help reestablish proper contact points, facilitating spontaneous papillary regeneration [4-5].

Various surgical techniques have been proposed for papillary reconstruction, but their results

are often unpredictable because of the limited blood supply in the interdental area and the delicate tissue architecture. Recently, minimally invasive approaches such as the use of injectable biomaterials have gained popularity. Among these, hyaluronic acid (HA) has shown significant promise in soft tissue augmentation due to its regenerative, biocompatible, and hydrating properties [6].

To overcome these limitations, bioactive and minimally invasive methods using injectable agents like hyaluronic acid (HA) have been proposed. HA, a natural component of the extracellular matrix, plays a vital role in maintaining tissue integrity and promoting wound healing. It is a high molecular weight, non-sulfated glycosaminoglycan known for its biocompatibility, non-immunogenicity, and biodegradability. Cross-linking of HA molecules enhances their mechanical stability and longevity, making them suitable for soft tissue augmentation and papillary reconstruction [7].

Materials and Methods

This *in vivo* clinical study was conducted to evaluate the effect of injectable hyaluronic acid on Class I and II papillary recessions (Nordland & Tarnow classification).

Inclusion Criteria

- Medically healthy patients with Class I or II papillary recession
- No radiographic evidence of interdental bone loss
- Probing pocket depth ≤4 mm
- Good plaque control
- Tooth mobility score 0

Exclusion Criteria

- Systemic diseases or blood disorders
- Pregnancy or lactation
- Tobacco use

Written informed consent was obtained from all participants after explaining the nature, risks, and benefits of the procedure. A plaque control regimen was initiated three weeks before treatment, including oral hygiene instruction and motivation.

Clinical parameters assessed were:

1. **CP-GM (Contact Point-Gingival Margin):** Vertical distance from the contact point to the gingival margin.
2. **IPW (Interproximal Width):** Horizontal width of the papillary recession at the gingival margin.

A 2% cross-linked hyaluronic acid filler (20 mg/ml) was utilized in the present study. Approximately 0.2 ml of the material was injected using a 23G × 25 mm needle at a 45° angle, positioned 2-3 mm apical to the papillary tip. The procedure was performed at baseline and repeated after three weeks. After each injection, the treated site was gently massaged for about 2-3 minutes to ensure even distribution of the filler.

Postoperative instructions included advising patients to maintain a soft diet and avoid using anterior teeth for biting to prevent mechanical irritation at the injection site. Periodontal maintenance was scheduled weekly during the first month and monthly thereafter. Clinical measurements were taken at baseline, at 3 weeks, and again at 5 weeks to evaluate tissue changes.

Statistical Analysis

All data were analyzed using SPSS software. Analysis of variance (ANOVA) was applied to compare mean values across the three different time intervals to determine statistical significance.

Fig 1: At baseline

Fig 2: application of HA

Fig 3: Measurement of CP-GM

Fig 4: measurement of IPW

Fig 5: After 5 weeks

Results

A progressive improvement in papillary height and width was observed at 3 and 5 weeks. Both CP-GM and IPW values decreased significantly over time, indicating papillary regeneration.

Patient	Parameters	Time Interval	Value
1	CP-GM	BASELINE	1.8
		3 WEEKS	1.0
		5 WEEKS	0.0
	IPW	BASELINE	1.7
		3 WEEKS	0.8
		5 WEEKS	0.0

Patient	Parameters	Time Interval	Value
2	CP-GM	BASELINE	0.9
		3 WEEKS	0.6
		5 WEEKS	0.0
	IPW	BASELINE	0.9
		3 WEEKS	0.5
.5		5 WEEKS	0.0

Discussion

The main aim of this study was to evaluate the clinical performance of injectable HA in reconstructing interdental papillae. HA, a naturally occurring glycosaminoglycan present in the extracellular matrix, is known for its viscoelasticity, hydrophilicity, and ability to promote cell proliferation. When injected into gingival tissues, HA integrates well with the surrounding connective tissue, improves local microcirculation, and provides immediate volume enhancement.

Its strong hydrophilic nature allows it to bind up to 1,000 times its molecular weight in water, resulting in soft tissue expansion. HA also stimulates fibroblast proliferation and collagen synthesis, leading to long-term volumetric stability even after gradual degradation of the filler. The high degree of cross-linking increases HA's resistance to enzymatic breakdown, ensuring prolonged tissue lift and firmness. Furthermore, HA acts as a scaffold for essential growth factors such as platelet-derived growth factor (PDGF) and bone morphogenetic protein-2 (BMP-2), which enhance tissue regeneration and angiogenesis [12, 13].

In the current study, all participants showed uneventful healing with no allergic or inflammatory reactions during the 5-week observation period. These findings are consistent with prior research by Becker *et al*. (2010), Mansouri *et al*. (2013), Lee *et al*. (2016), Pi *et al*. (2017), Habashneh and Khaleel (2018), and Singh and Vandana (2018), all of which demonstrated significant esthetic improvement after HA injection [1-6].

Becker *et al*. reported that repeated HA applications maintained papillary volume for up to 25 months, though follow-up intervals varied [1]. Similarly, Mansouri *et al*. found progressive improvement over time, with 10% of sites showing 50% improvement at 3 months and 43% at 6 months ($P<0.05$) [2]. Abdelraouf *et al*. (2019) demonstrated a significant reduction in black triangle height and area compared to controls [7].

Although Bertl *et al*. (2017) reported a mean reduction in black triangle height (0.23 mm at 3 months and 0.09 mm at 6 months), these results were less than the present findings possibly due to differences in HA formulations and dosage [8]. Habashneh and Khaleel (2018) found significant papillary improvement ($P<0.001$), aligning with this study ($P<0.01$) [5]. Singh and Vandana (2018) reported that different HA concentrations (1%, 2%, and 5%) produced variable regenerative responses, confirming that higher concentrations yield better stability [6].

In the present study, sites with complete papillary coverage maintained results throughout the 5-week period. In contrast, partially filled sites showed a tendency for relapse due to plaque accumulation and food impaction. These findings underscore the importance of meticulous oral hygiene and regular maintenance after HA therapy.

Sin *et al*. and Kerner *et al*. emphasized the need for consistent imaging angles for reliable photographic assessment of papillary changes [9, 10]. Furthermore, Ricci *et al*. validated digital imaging as an accurate tool for quantitative evaluation of gingival soft-tissue volume [11].

Additional studies by Gontiya and Galgali (2012), Naik *et al*. (2020), Kumar *et al*. (2021), and Gümüş *et al*. (2020) also demonstrated the positive role of HA in enhancing papillary fill, collagen maturation, and tissue resilience [12-15]. Their findings further reinforce the potential of HA as a regenerative biomaterial for non-surgical papilla reconstruction and esthetic enhancement.

Conclusion

Within the limitations of this study, injectable hyaluronic acid proved to be a safe, predictable, and minimally invasive option for the reconstruction of interdental papillae. The technique provided significant esthetic enhancement, improved soft tissue volume, and offered excellent patient comfort without surgical intervention.

The ease of application, reduced postoperative morbidity, and rapid healing make HA injection a valuable nonsurgical alternative to conventional papillary reconstruction techniques. Hence, HA can be considered a promising biomaterial for regenerating lost papillae and improving the esthetic harmony of the anterior dentition.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

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