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The Effect of Hyaluronic Acid Gel Injection on The Reconstruction of Deficient Interdental Papilla

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Abstract

Background and objectives: The use of hyaluronic acid as injectable gel into gaps where interdental papillae are absent can refill black triangles. This study aims to evaluate the effects of two concentrations of hyaluronic acid on papilla regeneration by measuring the black triangle height.

Methods: This prospective interventional study carried out in Khanzad specialized dental center in Erbil city-Kurdistan region/Iraq through the period of 6 months from 1st of March 2023, to 1st of September 2023 on a sample of 20 patients with deficient tissue between their central and lateral incisors. A split-mouth technique was employed for the administration of hyaluronic acid with concentrations of 22mg/ml and 20mg/ml. Each region received three injections each three weeks. Participants were re-evaluated after three and six months. An ANOVA test was used to compare mean values.

Results: There was a statistically significant disparity in black triangle height between the groups ($p = 0.013$) after three months. Later, after a duration of six months, there was compelling evidence of a distinction between the two groups ($p = 0.004$). For the 22mg\ml group, full coverage was achieved in six months by 60% (12 out of 20) while for the 20mg\ml group it was only 40% (8 out of 20).

Conclusions: Both concentrations showed significant effect on reconstruction of missing interdental papilla with more effect in the 22 mg\ml group ($p < 0.01$).

Keywords: Black triangle, Hyaluronic acid, Inadequate interdental papilla, Reconstruction.

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Introduction

"Interdental papilla" describes the narrow strip of free gingiva that is between teeth and below the point of contact between them.[1] On a functional and aesthetic level, it is crucial.[2] Individuals with broad smiles often find the absence of the papilla, which can result in "black triangles," to be particularly undesirable. This insufficiency can lead to problems such as food entrapment, difficulties in articulation, tooth hypersensitivity, root decay, abrasion, erosion, and accumulation of plaque.[3] Interdental papilla loss can have many different and complicated causes. One of the main causes is gingival recession, a periodontal disease in which the gum line shifts downwards, revealing the tooth root.[4,5] Inadequate dental care, rough brushing, misaligned teeth, loss of bone, improper tooth location, tight frenulum, smoking, and occlusal trauma are all potential causes of gingival recession.[6] On top of that, gingival recession might be an unintended side effect of orthodontic and prosthetic procedures.[7,8] Furthermore, the deficiency of interdental papilla may be worsened by the constriction of oral soft tissue that takes place during the healing process following periodontal surgery.[9] Various methods can be employed to substitute missing gingival papillae, such as restorative procedures, orthodontic treatments, interdisciplinary approaches, and various surgical enhancement techniques.[10,11] The surgical methods used to improve the appearance of both hard and soft tissues in areas with black triangles are invasive and can result in unforeseen results. The initial three options are both time-consuming and expensive.[12] Periodontal plastic surgeons have a formidable challenge with interdental papilla repair due to the lack of reliability and limited success of various flap designs and surgical methods.[13] Non-invasive methods to treat papillary deficits involve using orthodontic and restorative techniques, either separately or together. Nevertheless, these procedures, albeit being less intrusive, require a significant amount of time.[1] A linear polymer called hyaluronic acid (HA) is present in the extracellular matrix of connective tissue, especially in synovial fluid. The physiological structure of the organism plays a key role in maintaining tissue consistency and possesses qualities that combat bacterial infections and reduce inflammation.[14] Hyaluronic acid (HA) has diverse therapeutic uses, including its ability to minimize scar formation after surgery and its effectiveness in treating orthopedic disorders such as osteoarthritis and rheumatoid arthritis.[15,16] Additionally, it shows potential in tissue engineering because of its involvement in cell motility, organogenesis, and development.[17] Binding water is one of its primary roles in preserving tissue structure. Cosmetic dermatology and skincare products benefit greatly from its use as a moisturizer due to its hydrophilicity, biocompatibility, and consistency. Reducing wrinkles and improving facial features have been demonstrated to be successful outcomes of injectable HA gel.[18] Research on the use of HA in dentistry has focused on its ability to lessen the severity of gingivitis and periodontitis by reducing the depth of probing and localized bleeding that occurs during probing.[19] The goal of this research is to find out how well a new concentration of HA gel—20mg/ml—replaces the conventional 22mg/ml concentration in replacing lost interdental papilla.

Patients and methods

This prospective interventional study carried out in Khanzad specialized dental center in Erbil city-Kurdistan region/Iraq through the period of 6 months from 1st of March 2023, to 1st of September 2023 on a sample of 20 patients with deficient tissue between their central and lateral incisors. This clinical experiment aimed to treat Nordland's Class I and II papillary recession in the maxillary

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anterior teeth using injectable hyaluronic acid (HA) fillers with concentrations of 20mg/ml and 22mg/ml. The treatment was conducted using a split mouth approach. The 20mg/ml hyaluronic acid gel was injected on the right side, whereas the 22mg/ml gel was administered on the left side. A total of 20 patients, consisting of 11 males and 9 females, were chosen from the diagnosis department of Khanzad specialized dentistry center in Erbil city. These patients had a total of 40 problems. Participants' ages ranged from twenty-five to forty. Everyone who participated in the study did not smoke, and their teeth were in good condition; six front teeth were noted. Following a comprehensive explanation of the process and the anticipated consequences following treatment, the patient signed an informed consent document written in Kurdish and Arabic language. In the four weeks leading up to the treatment, the patient was required to adhere to a thorough plaque management regimen that included ultrasonic scaler tips for supragingival and subgingival scaling, as well as instructions for proper dental hygiene, information about the procedure, and motivation to follow the plan. For clinical purposes, we measured the distance from contact point to the gingival margin (CP-GM) using a standardized acrylic stent and the University of North Carolina-15 probe. At each site, digital pictures were taken with the probe in place four weeks after phase I and just before HA injection. Five minutes before to the treatment, a 30-gauge needle was inserted into the mucogingival junction to provide local anesthetic in order to reduce pain from many punctures and pressure during the injection of HA. One visit was sufficient to treat every site with papilla recession in every quadrant. At each location, a new needle was used for the injection of HA. The procedure involved injecting 0.2 ml of HA gel, which had a concentration of 20 mg/ml, using a 23-gauge, 25 mm intraoral injection needle. The injection was done at a 45° angle and targeted specific locations located 2-3 mm below the top of the papillae. The area was delicately massaged for a period of 2-3 minutes to guarantee even distribution of the material. The afterwards recommendations consisted of following a diet that primarily consists of soft foods and refraining from utilizing the front teeth for cutting or biting. Participants were instructed to uphold optimal oral hygiene by consistently cleaning their teeth with a gentle toothbrush and utilizing an antimicrobial mouthwash twice a day for the entire duration of the trial. Quantitative data were collected during the third and sixth months for assessment purposes. Ethics approval has been obtained from Kurdistan Higher Council of Medical Specialties Ethical Committee in 8.12.2022. Intra- and interobserver calibrations were carried out by examining specimens with different morphologies. A calibrated periodontologist evaluated and interpreted the images twice, with a gap between assessments. The reliability data were analyzed with the kappa test to measure agreement levels. After these calibrations, the study images were independently assessed. Reviewers showed a high level of agreement when the kappa test was used (kappa = 0.81). Statistical analysis was conducted by SPSS software version 25.0 for Windows (IBM, developed by Norman H. Nie, Dale H. Bent, and C. Hadlai Hull, Chicago, USA). All metrics had their means and standard deviations determined at baseline, three months, and six months after surgery. It was determined that a probability value (P) of ≤ 0.05 was statistically significant, and $P \leq 0.01$ was extremely significant. An ANOVA test conducted in one direction was used to compare mean values.

Results

This study included twenty patients whose central and lateral incisors had bilaterally

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lacking interdental papillae. 20 mg/ml of HA gel was injected into each patient's right side, while 22 mg/ml of HA gel was injected into their left side. The findings demonstrated enhanced regeneration of recession defects at both the 3-month and 6-month time points, as shown in Figures (1 and 2). Significant differences were found in the clinical measure CP-PT (distance from contact point to papilla tip) between the baseline and 3- and 6-month intervals ($P = 0.01$), as shown in Tables (1 and 2). The 22mg/ml group had considerably better coverage than the 20mg/ml group ($P \leq 0.01$).

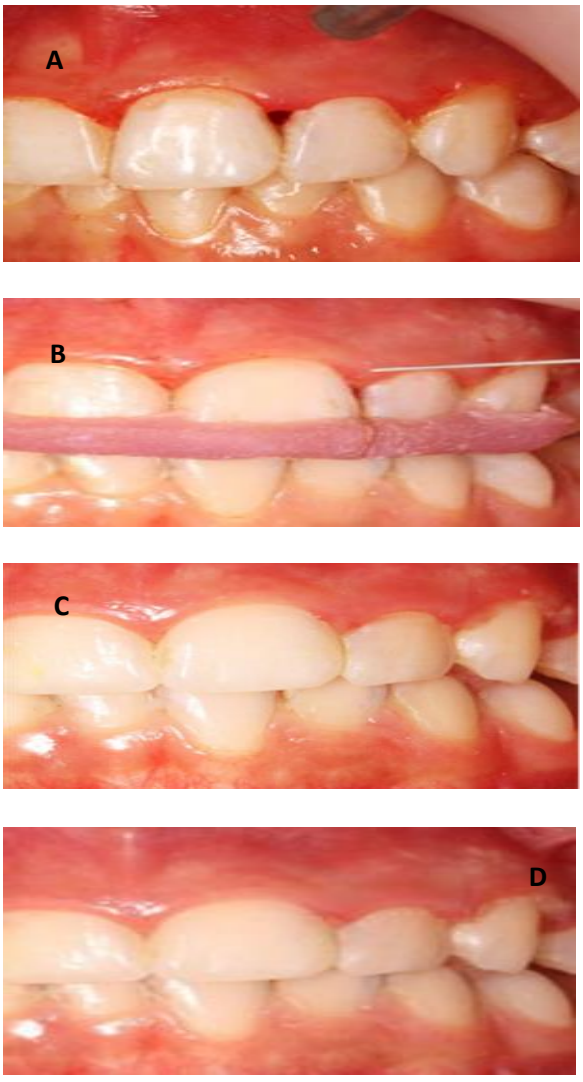

Figure (1): Clinical photographs of representative patients treated with injections of hyaluronic acid on the left side (22mg\ml) (A) baseline, (B) third injection, (C) three months and (D) six months interval

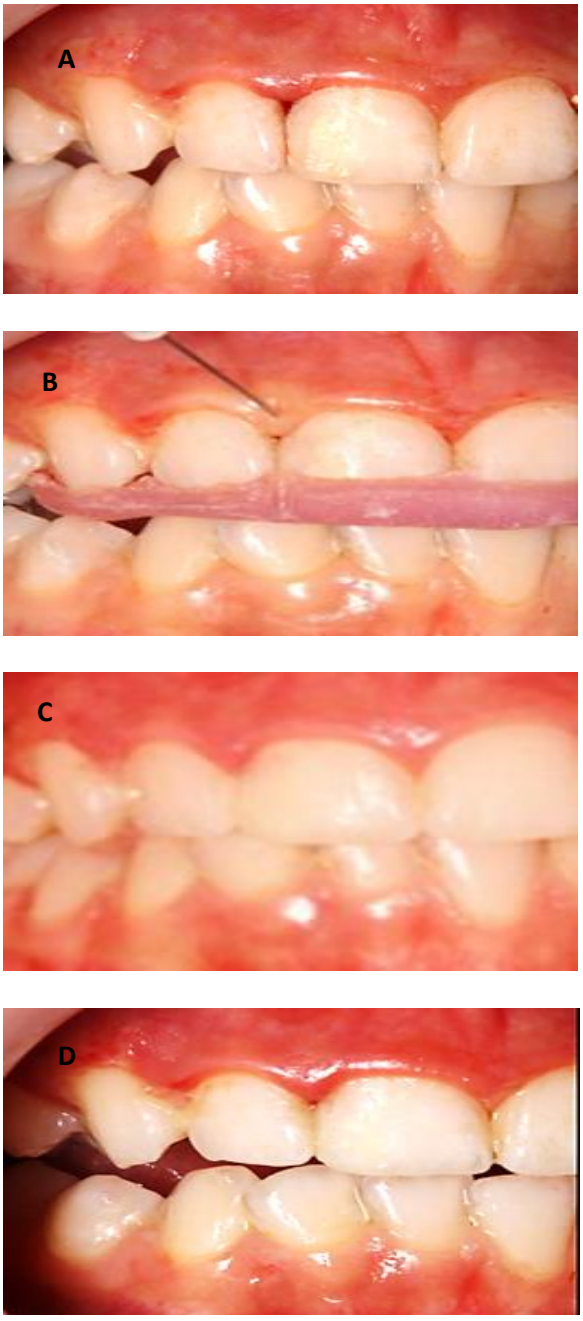

Figure (2): Clinical photos of patients treated with hyaluronic acid injections on the right side (20mg/ml): (A) baseline, (B) third injection, (C) three months, and (D) six months interval.

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Table (1) demonstrates that the black triangle height decreases by an average of 1.16 mm after 3 months and 0.785 mm after six months in the 20mg/ml group. In contrast, the group with a concentration of 22mg/ml experienced a reduction of 1.575mm and 1.285mm after 3 and 6 months, respectively. After 3 months, in the group receiving a dosage of 20mg/ml (on the right side), clinical assessments of PT-CP distance revealed that 50% of the sites (10 out of 20 sites) had full papillary covering, while the other 50% of the sites (10 out of 20 sites) had different levels of partial papillary coverage. Six months in, it had improved dramatically from baseline; just 40% (8 out of 20) sites had maintained full coverage, while 60% had varied degrees of coverage. For the 22mg\ml (left side) group, full coverage was achieved in three months by 75% (15 out of 20) and in six months by 60% (12 out of 20).

Table (1): This table describes the mean, standard deviation, standard error, 95% confidence interval for mean, minimum and maximum for both concentrations measured at baseline, three months, and six months intervals

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Baseline	20	20	1.525	0.4822	0.1078	1.299	1.751	0.5	2.3
	22	20	1.670	0.5302	0.1186	1.422	1.918	0.8	2.5
	Total	40	1.598	0.5056	0.0799	1.436	1.759	0.5	2.5
Three months	20	20	0.375	0.3932	0.0879	0.191	0.559	0	1.0
	22	20	0.105	0.1932	0.0432	0.015	0.195	0	0.5
	Total	40	0.240	0.3350	0.0530	0.133	0.347	0	1.0
Six months	20	20	0.690	0.5340	0.1194	0.440	0.940	0	1.5
	22	20	0.240	0.3235	0.0723	0.089	0.391	0	1.0
	Total	40	0.465	0.4918	0.0778	0.308	0.622	0	1.5

In table (2), after a duration of three months, there was a statistically significant disparity in PT-CP distance measurements between the groups ($p = 0.009$). Furthermore, after a duration of six months, there was very significant evidence of a distinction between the two groups ($p = 0.003$).

Table (2): This table provides a comparison between two groups and within-group measurements, as well as the assessment of their significance.

		df	Mean Square	F	Sig.
Baseline	Between Groups	1	0.210	0.819	0.371
	Within Groups	38	0.257		
	Total	39			
Three months	Between Groups	1	0.729	7.596	.009
	Within Groups	38	0.096		
	Total	39			
Six months	Between Groups	1	2.025	10.390	.003
	Within Groups	38	0.195		
	Total	39			

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Discussion

One of the mucopolysaccharides that can be found in the human body is called hyaluronic acid, which is a naturally occurring substance. It is also available commercially as a gel prepared through biotechnological processes.[20] When HA is injected into the papillary gingiva, it seamlessly integrates into the surrounding tissue, promoting enhanced microcirculatory perfusion. This integration contributes to excellent aesthetic results, improving the appearance of the treated area.[21] The increase in volume observed in the interdental papilla (IDP) can be attributed to the distinctive rheological properties and high hydrophilicity of hyaluronic acid. Hyaluronic acid has the remarkable ability to bind water molecules, up to 1000 times its own molecular weight. This property allows HA attracting and retaining moisture, leading to a volumizing effect in the treated area. Additionally, hyaluronic acid has been shown to stimulate the synthesis of new collagen, further contributing to the enhancement of the IDP.[21] As hyaluronic acid degrades over time, the body initiates a process of novel collagen synthesis to replace it, resulting in a permanent adjustment. Hyaluronic acid's strong cross-linking modifies its capacity to bind water, creating a tissue lift effect. The augmentation of cell division and the elevation of tubulin concentration facilitate the multiplication of fibroblasts, so enhancing tissue regeneration and providing additional structural support.[22] Hyaluronic acid (HA) has both direct effects and mediates the actions of other molecules by acting as a scaffold for their biomaterial synthesis. Regeneration and repair of tissues rely on these chemicals, further enhancing the therapeutic effects of HA injections.[23] Throughout the six-month monitoring period, every participant in the trial underwent straightforward healing without any indications of allergies, infections, or other issues. During the first three days after injection, one patient experienced moderate discomfort and irritation; this pain was alleviated with paracetamol. For this clinical experiment, the main goal was to compare the efficacy of injecting 22mg/ml HA gel versus 20mg/ml HA gel in restoring interdental papilla defects. Specifically, the papilla tip to contact point (PT-CP) distance, which measures the change in height, was evaluated at baseline, 3-month, and 6-month intervals for the evaluation. In favor of the 22mg/ml HA group, the data showed a statistically significant larger mean decrease in PT-CP distance. This study employed a split-mouth technique to compare the effects of two concentrations, 20mg/ml and 22mg/ml, of HA filler on the same patient. The results demonstrated a statistically significant improvement with the 22mg/ml concentration compared to the 20mg/ml concentration ($P \leq 0.01$). Notably, prior research has not explored the specific impact of the 22mg/ml concentration on interdental papilla regeneration. Previous studies by Lee et al.[1] and Pitale et al.[21] have demonstrated the efficacy of injecting 20mg/ml HA gel in reconstructing missing interdental papilla. Additionally, Abdelraouf et al.[24] conducted a randomized controlled trial on ten patients comparing the effect of 20mg/ml HA gel with normal saline. On both the three- and six-month follow-ups from baseline, the researchers found that the HA group had a statistically significant greater mean reduction in black triangle height and surface area. Conversely, Vedamurthy showed a decrease in treatment efficacy over time, notably between the evaluations conducted at four and six months.[23] This was demonstrated by the larger black triangle areas observed at the six-month follow-up in comparison to the measures obtained at the four-month mark. These findings are in line with those of the study. Clinical PT-CP distance measurements at three months in the

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20mg/ml group (right side) revealed that 50% of sites (10 out of 20 sites) had full papillary covering and 50% of sites (10 out of 20 sites) had variable extent of papillary coverage. By the age of six months, 40% (8 out of 20) of the sites maintained complete coverage, while the remaining 60% exhibited varying degrees of coverage, which is notably superior when compared to the initial condition. In the group receiving a concentration of 22mg/ml on the left side, there was a 75% (15 out of 20) rate of complete coverage over a period of 3 months, and a 60% (12 out of 20) rate of complete coverage over a period of 6 months. In Awartani and Tatakis study, ten systemically healthy adults with at least one anterior site with class I or II interdental papilla loss were recruited they found that 11% of the sites (2 out of 17 sites) demonstrated complete papillary repair at 3 months, and then 17% of the sites (3 out of 17 sites) demonstrated complete papillary regeneration at 6 months, both of which are lower than the results of the present study (52%).[25] Becker et al. included 11 patients in his study, he reported 21% of the sites with 100% papillary regeneration, which is lower than the current study's 52%.[26] Complete papillary fill was achieved at 6-month intervals in 63% of the sites (36 out of 57 sites) in a study by Lee et al.[3], however, the same author demonstrated in his other study[1] that 67% of the sites (29 out of 43 sites) had complete papillary regrowth, which is higher than the results of the current study. He stated that hyaluronic acid was administered 3-5 times at each spot. The variation in the outcomes of different studies may arise from variables in patient selection criteria, study design, recession locations, concentration and dosage of hyaluronic acid injection, and the quality of oral cleanliness maintained by the study participants. Despite the favorable results after the injection of HA, which is conservative, non-surgical, and has more persistent outcomes, a limitation should be considered: a longer follow-up period is needed to assess the results after six months.

Conclusion

The findings of this study indicate that interdental papilla restoration can be achieved and maintained for a period of six months by using HA filler, with better results found for the higher dose (22mg/ml). HA filler is a simple and effective way to address esthetic zone papillary recessions. It is regarded as a less invasive therapy for black triangles.

Conflict of interest

None to declare

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