

Comparative Evaluation of the Efficacy of Injectable Platelet-rich Fibrin and Hyaluronic Acid Injections in the Treatment of Gingival Black Triangles

Devesh Singh¹, Mozammil Islam², Sanjeev Kumar Salaria^{3*}, Bhumika Sehdev⁴, Mona Dagar⁵, Aashi Bhardwaj⁶

¹BDS, MDS, Department of Periodontology & Implantology, D.J. College of Dental Science and Research, Modinagar, Ghaziabad, Uttar Pradesh
Email: devsoorvanshi@gmail.com

²BDS, MDS, Department of Periodontology & Implantology, D.J. College of Dental Science and Research, Modinagar, Ghaziabad, Uttar Pradesh
Email: imozammil@gmail.com

^{3*}Professor and Head, Department of Periodontology & Implantology, D.J. College of Dental Science and Research, Modinagar, Ghaziabad, Uttar Pradesh
Email: sksalaria@gmail.com

⁴Professor, Department of Periodontology & Implantology, D.J. College of Dental Science and Research, Modinagar, Ghaziabad, Uttar Pradesh
Email: bhumipari919@gmail.com

⁵Professor, Department of Periodontology & Implantology, D.J. College of Dental Science and Research, Modinagar, Ghaziabad, Uttar Pradesh
Email: drmonadagar25@gmail.com

⁶Lecturer, Department of Periodontology & Implantology, D.J. College of Dental Science and Research, Modinagar, Ghaziabad, Uttar Pradesh
Email: aashibhardwaj511@gmail.com

*Corresponding Author:

Sanjeev Kumar Salaria
Professor and Head, Department of Periodontology & Implantology, D.J. College of Dental Science and Research, Modinagar, Ghaziabad, Uttar Pradesh
Email: sksalaria@gmail.com

Abstract

Background: Gingival black triangles (GBTs) are common esthetic defects resulting from loss of interdental papilla. Injectable Platelet-Rich Fibrin (I-PRF) and Hyaluronic Acid (HA) have recently gained attention as minimally invasive treatment options for papillary reconstruction.

Materials and Methods: This prospective, randomized, double-blind clinical study included 40 patients with Papilla Presence Index (PPI) Class II and III defects. Participants were randomly assigned to receive either I-PRF or cross-linked Hyaluronic Acid (Bellast) injections. Plaque Index (PI), Gingival Index (GI), Papilla Presence Index (PPI), and Gingival Black Triangle (GBT) dimensions were recorded at baseline, 1 month, and 3 months. Statistical analysis was performed using one-way ANOVA and independent t-tests.

Results: Both treatment modalities improved papillary reconstruction and reduced gingival black triangle dimensions. No statistically significant differences were observed in PI and GI between the groups. Significant improvements in PPI and GBT measurements were observed in both groups. However, the HA group showed significantly greater improvement in PPI at 1 and 3 months ($p = 0.031$) and greater reduction in GBT dimensions at 1 month ($p < 0.001$) and 3 months ($p = 0.001$) in contrast to the I-PRF group.

Conclusion: Both I-PRF and Hyaluronic Acid were effective for non-surgical management of gingival black triangles. However, Hyaluronic Acid demonstrated superior papillary reconstruction and greater reduction in black triangle dimensions, making it a more predictable treatment option.

Keywords: Gingival black triangle, interdental papilla, injectable platelet-rich fibrin, hyaluronic acid, bellast, periodontal aesthetics.

How to cite this article: Devesh Singh¹ Mozammil Islam² Sanjeev Kumar Salaria^{3*} Bhumika Sehdev⁴ Mona Dagar⁵ Aashi Bhardwaj⁶. Comparative Evaluation of the Efficacy of Injectable Platelet-rich Fibrin and Hyaluronic Acid Injections in the Treatment of Gingival Black Triangles. Int J Drug Deliv Technol. 2026;16(84s):117-122. DOI: 10.25258/ijddt.16.84s.13.

Introduction

An attractive smile depends on the harmony between the teeth and surrounding gingival tissues. One of the most common aesthetic concerns is the presence of gingival black triangles (GBT), which are open embrasure spaces caused by the loss or

reduction of the interdental papilla. Besides affecting smile aesthetics, these spaces may lead to food impaction, speech difficulties, plaque accumulation, and periodontal problems.¹ The prevalence of GBT increases with age and has been

reported in approximately 38–43.7% of adults, particularly in the anterior region where aesthetics is of greatest concern.²

The etiology of GBT is multifactorial which includes periodontal attachment loss, alveolar bone resorption, tooth morphology, orthodontic tooth movement, and traumatic oral hygiene practices etc. Tarnow et al. demonstrated that the distance between the contact point to alveolar crest is a key factor influencing papilla presence if the distance surpass 5 mm, the papillary loss increases significantly.³ Consequently, reconstruction of deficient interdental papillae remains a clinical challenge.

Several surgical procedures, including connective tissue grafts and papilla reconstruction techniques, have been used to manage GBT. However, these procedures are invasive, technique-sensitive, and often associated with patient discomfort and donor-site morbidity.⁴ Therefore, minimally invasive regenerative therapies have gained increasing attention in recent years.

Injectable Platelet-Rich Fibrin (I-PRF) is an autologous platelet concentrate obtained without anticoagulants. It contains a natural fibrin matrix rich in wide varieties of growth factors such as platelet-derived growth factor, vascular endothelial growth factor, transforming growth factor-beta etc., which promote angiogenesis, fibroblast proliferation, and soft tissue regeneration.^{5,6}

Hyaluronic acid (HA) is another promising biomaterial used in periodontal esthetics. As a naturally occurring component of connective tissues, HA possesses excellent biocompatibility, tissue hydration, and wound-healing properties. It promotes cell migration, angiogenesis, and extracellular matrix remodelling while providing soft tissue volume enhancement. Clinical studies have reported significant improvement in papillary height and reduction of black triangle dimensions following HA injections.^{7,8}

Although both I-PRF and HA have shown encouraging results in papilla reconstruction, they act through different biological mechanisms. Despite their growing use, direct clinical evidence comparing their effectiveness in the treatment of gingival black triangles remains limited/scarcely.⁹ Therefore, the present study was undertaken planned to compare the efficacy of Injectable Platelet-Rich Fibrin and Hyaluronic Acid (Bellast) in the management of gingival black triangles, focusing on papillary reconstruction and aesthetic improvement.

Materials and Methods

This prospective, randomized, double-blind clinical study was conducted in the Department of Periodontology, D.J. College of Dental Sciences and Research, Modinagar, Uttar Pradesh, India, over a period of two years. The study protocol was approved by the Institutional Ethics Committee

(Approval No. DJC/IEC/22/2023), and written informed consent was provided by all participants before enrolment.

A total of 54 patients presenting with gingival black triangles were screened according to the predefined inclusion criterion (Patients aged between 18 and 55 years with Papilla Presence Index (PPI) Class II or Class III defects and good systemic health) where as individuals with poor oral hygiene, smoking habits, pregnancy or lactation, diastema, systemic diseases affecting periodontal health, or unwillingness to participate were excluded (Figure 1). Four patients were included in a pilot study, and their data were excluded from the final analysis. The remaining 40 eligible participants were enrolled and randomly allocated into two equal groups (n = 20 each) using coin toss.

A minimum Sample size of 36 sites was recommended; Considering an alpha error of 0.05, study power of 90%, and an anticipated large effect size of 1.0 utilizing G*Power software (Version 3.1.9.6, University of Kiel, Germany). To compensate for possible dropouts, 40 participants were recruited.

Randomization was performed by an independent investigator using sequentially numbered, opaque, sealed envelopes (SNOSE) just before the surgery at the time of intervention only.

All participants initially underwent Phase I periodontal therapy, including scaling and root planning using ultrasonic and hand instruments. Oral hygiene instructions were provided, and patients were advised to use 0.2% chlorhexidine mouthwash twice daily for 10 days. Baseline clinical measurements were recorded after completion of initial periodontal therapy.

The clinical parameters evaluated included Plaque Index (Silness and Loe, 1964), Gingival Index (Loe and Silness, 1963), Papilla Presence Index (Cardaropoli et al., 2004), and black triangle dimensions recorded at baseline (Figure 2a, 3a). The extent of gingival black triangles was assessed using an endodontic k-file with stopper (from contact point to tip of papilla - (Figure- 2b, 3b) and finally calculated with digital vernier caliper - (Figure- 2c, 3c). To improve measurement reliability, all clinical recordings were obtained three times at an interval of 15 minutes on every follow-up visit and the mean value of each parameter was recorded.

All the patients undergone venipuncture from antecubital fossa to obtained 5 ml of blood in sterile serum separator tube (red top tube) and centrifuged at 2700 resolution per minute for 3 minutes followed by upper liquid layer containing I-PRF was aspirated and stored immediately but only half participant received I PRF as per treatment allocation by SNOSE to kept the patients blind.

Participants in Group I received Injectable Platelet-Rich Fibrin (I-PRF) into the deficient interdental papilla using an insulin syringe (Figure-2d). Approximately 0.3–0.4 mL of I-PRF was administered under aseptic conditions.

Participants in Group II also underwent venipuncture +sham procedure that mimics intervention but instead of I-PRF received 0.3–0.4 mL of commercially available cross-linked hyaluronic acid (Bellast®, South Korea) injected directly into the deficient interdental papilla using a micro syringe under aseptic conditions. (Figure 3d) Papilla presence index and black triangle dimensions were reassessed at 1 month and 3 months post operatively (Figure 2e,2f & 3e,3f) for both I PRF and hyaluronic acid treated site respectively, including other clinical parameters utilizing the same standardized methodology.

Data collected by principle investigator was masked by trained examiner and statistical analysis were also performed on masked datasets to masked the statistician. Intragroup comparisons were carried out using one-way ANOVA, while comparison between the groups were appraised exploiting independent t-test. A p-value <0.05 was considered arithmetically significant. Result obtained was unmasked by trained examiner, then final results were assessed by principle investigator and outcome was drawn.

Results

Patients in both the groups maintained optimal oral hygiene with non-significant reduction in plaque and gingival index between both groups at baseline, 1 month, or 3 months ($p > 0.05$) as well as on intra group evaluation (Table 1 and 2) respectively.

Both minimally invasive approaches efficient in the improvement in Papilla Presence Index scores. PPI score comparison within the groups showed $p < 0.05$ changes whereas arithmetic assessment between the groups reported significant change ($p < 0.05$) observed too all intervals except at baseline. (Table 3) dictating HA group was better than I-PRF group in term of PPI.

A substantial reduction in gingival black triangle dimensions was observed in both groups. Statistically significant ($p < 0.05$) reduction was observed in gingival black triangle dimensions on intragroup comparison whereas on intergroup comparison statistically significant changes ($p < 0.05$) observed too all intervals except at baseline (Table 4); dictating HA group was better than I PRF group in term of gingival black triangle dimensions.

Discussion

Gingival black triangles (GBTs), also known as open gingival embrasures, are among the most common aesthetic concerns encountered in periodontal practice. Besides affecting smile appearance, loss of the interdental papilla may lead to food impaction, phonetic difficulties, and increased plaque retention, thereby compromising

periodontal health. Nordland and Tarnow¹⁰ emphasized the importance of papillary architecture in maintaining aesthetics and function, while Tarnow et al.³ demonstrated that the distance between the teeth contact point and the alveolar crest if > 5 millimetre is a critical factor influencing papillary restitution becomes less predictable, making the management of GBTs a clinical challenge.

Traditional surgical approaches for papilla reconstruction have shown varying levels of success. However, the limited vascularity of the interdental region, technique sensitivity of surgical procedures, patient discomfort, and postoperative morbidity^{11–13} might have encouraged the development of minimally invasive treatment options. In recent years, injectable biomaterials such as HA and I-PRF have achieved vast consideration as one of the promising alternatives because they can enhance soft tissue regeneration with minimal patient discomfort.¹⁴

To reduce the bias double blinding was done in which both the patient and statistician were kept blinded.

Patients in both the groups at baseline showed statistically non-significant changes in term of plaque and gingival index suggested that patients under both the groups were exposed equally. Intra and intergroup comparison suggested that patients of both the groups maintained fairly good oral hygiene and gingival health throughout the study protocol and that changes observed in papillary reconstruction were primarily related to the treatment modalities rather than variations in plaque control which is partially in consistency with the reports of Trivedi et al.,¹⁵ reported non-significant on intergroup comparison.

Both HA and I-PRF demonstrated significant improvement in Papilla Presence Index scores, indicating their ability to promote papillary reconstruction. However, better improvement (reduction in .55 units in PPI score) was observed in the HA group in comparison to I-PRF group (0.25 units). This finding suggested that HA provided superior papillary fill and soft tissue regeneration at 3 month post operatively. The reason for the same may be due to its hygroscopic nature, excellent water binding capacity, promotes fibroblast migration, angiogenesis, and extracellular matrix remodeling, which contribute to improved papillary contour and stability. These results are in contrary to Patel B et al.,¹⁶ study reported both treatment modalities equally effective in papillary fill whereas Trivedi et al.,¹⁵ who observed better outcomes with I-PRF. Although the exact reason for this discrepancy in outcome is unclear but may be because of possible differences in injection protocols, volume of material utilized and method of assessment. In the present study, both materials were administered in equal volumes,

Comparative Evaluation of the Efficacy of Injectable Platelet-rich Fibrin and Hyaluronic Acid Injections in the Treatment of Gingival Black Triangles

allowing a more direct comparison. Since only limited studies have compared these two biomaterials, additional clinical trials are required before drawing definitive conclusions.

Both treatment modalities demonstrated significant reduction in gingival black triangle but HA group reported a greater reduction in GBT dimensions at both follow-up intervals. The superior performance of HA may be attributed to its hygroscopic nature, excellent water binding capacity, promotes fibroblast migration, angiogenesis, and extracellular matrix remodelling, which contribute to improved papillary contour and stability which will further contribute to reduction/improvement in GBT dimensions. These findings are in agreement with Becker and Becker,¹⁷ who reported favourable soft tissue augmentation following HA therapy.

The findings of the present study were partially consistent with those reported by Pal et al.,¹⁸ who concluded that both HA and I-PRF were equally effective nonsurgical treatment options for GBT management and in contrast to Trivedi et al.¹⁵ reported superior outcomes with I-PRF. Such variations may be related to differences in study design, sample characteristics, injection technique, and follow-up duration.

Although HA demonstrated superior clinical outcomes, I-PRF also produced significant improvements in both PPI and GBT measurements. I-PRF is freshly prepared autogenous platelet concentrate rich in leukocytes and enriched with growth factors which were released over a period of 10-14 days thereby facilitates both soft and hard tissue regeneration phenomena.¹⁹⁻²¹ Miron et al.²² reported that I-PRF acts as a biological stimulant by enhancing cellular proliferation and tissue regeneration. However, unlike HA, I-PRF lacks long-term volumetric stability and undergoes relatively rapid resorption, which may limit its ability to maintain soft tissue volume over time. This may explain the comparatively lower clinical improvement observed in the present study.

Limitations of Study: lack of control, lack of histological analysis, short sample size, single center study, short follow up, GBT area was not included.

Conclusion

Within the limitations of study, it was concluded that Hyaluronic acid was more effective, predictable minimally invasive treatment modality for the management of papillary fill as well as in term of reduction in gingival black triangle in comparison to i-PRF. Further, Randomized controlled multicenter clinical trials with long-term follow up on large sample size was advised before absorbing the gist of outcome.

LIST OF TABLES

Table 1. Comparison of Plaque Index Scores between Hyaluronic Acid and I-PRF Groups

Time	HA	I-PRF	Inter-group
------	----	-------	-------------

Interval	(Mean ± SD)	(Mean ± SD)	p-value (Independent t-test)
Baseline	1.43 ± 0.10	1.44 ± 0.09	0.871
1 Month	1.25 ± 0.12	1.33 ± 0.13	0.203
3 Months	1.30 ± 0.13	1.40 ± 0.14	0.201
Intra-group p-value (One-Way ANOVA)	0.090	0.190	

Statistically significant at p < 0.05.

Table 2. Comparison of Gingival Index Scores between Hyaluronic Acid and I-PRF Groups

Time Interval	HA (Mean ± SD)	I-PRF (Mean ± SD)	Inter-group p-value (Independent t-test)
Baseline	0.60 ± 0.10	0.71 ± 0.13	0.142
1 Month	0.51 ± 0.07	0.69 ± 0.07	0.620
3 Months	0.49 ± 0.11	0.58 ± 0.04	0.150
Intra-group p-value (One-Way ANOVA)	0.700	0.701	

Statistically significant at p < 0.05.

Table 3. Comparison of Papilla Presence Index Scores between Hyaluronic Acid and I-PRF Groups

Time Interval	HA (Mean ± SD)	I-PRF (Mean ± SD)	Inter-group p-value (Independent t-test)
Baseline	2.05 ± 0.22	2.10 ± 0.31	0.577
1 Month	1.50 ± 0.51	1.85 ± 0.37	0.031*
3 Months	1.50 ± 0.51	1.85 ± 0.37	0.031*
Intra-group p-value (One-Way ANOVA)	<0.001*	0.039*	

Statistically significant at p < 0.05.

Table 4. Comparison of Gingival Black Triangle (GBT) Measurements between Hyaluronic Acid and I-PRF Groups

Time	HA	I-PRF	Inter-group
------	----	-------	-------------

Comparative Evaluation of the Efficacy of Injectable Platelet-rich Fibrin and Hyaluronic Acid Injections in the Treatment of Gingival Black Triangles

Interval	(Mean $\pm$ SD)	(Mean $\pm$ SD)	p-value (Independent t-test)
Baseline	2.35 $\pm$ 0.26	2.29 $\pm$ 0.25	0.544
1 Month	0.39 $\pm$ 0.40	1.42 $\pm$ 0.32	<0.001*
3 Months	0.30 $\pm$ 0.41	1.50 $\pm$ 0.51	0.001*
Intra-group p-value (One-Way ANOVA)	<0.001*	<0.001*	

Statistically significant at $p < 0.05$.

LIST OF FIGURES

Figure 1: Study flowchart depicting patient enrolment, randomization, and treatment allocation.

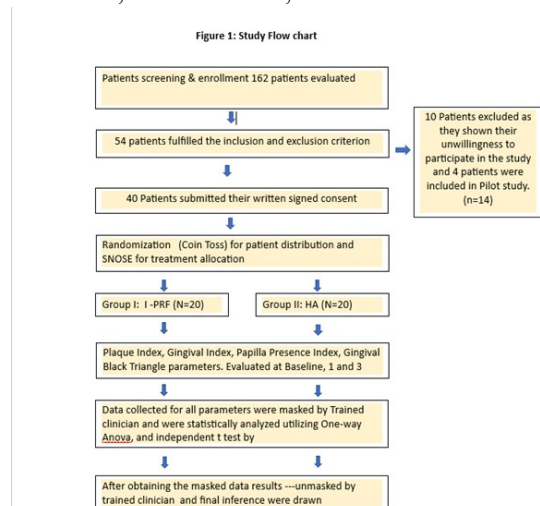


Figure 2. Clinical sequence of gingival black triangle management using Injectable Platelet-Rich Fibrin (I-PRF). (A) Baseline clinical presentation of the gingival black triangle. (B) Measurement of the gingival black triangle using a #15 K-file. (C) Measurement of black triangle width using a digital Vernier caliper (1.7 mm). (D) Injection of I-PRF into the deficient interdental papilla. (E) Clinical appearance at 1-month follow-up. (F) Clinical appearance at 3-month follow-up showing papillary reconstruction and reduction in gingival black triangle dimensions.

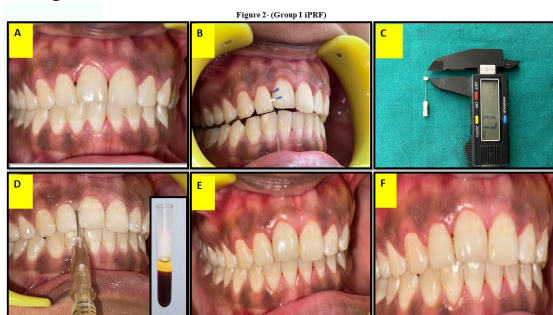
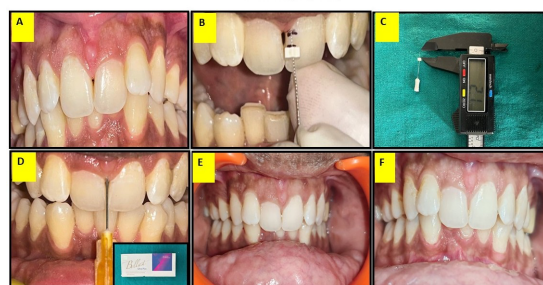


Figure 3. Clinical sequence of gingival black triangle management using Hyaluronic Acid (Bellast). (A) Baseline clinical presentation of the gingival black triangle. (B) Measurement of the gingival black triangle using a #15 K-file. (C) Measurement of black triangle width using a digital Vernier caliper (1.7 mm). (D) Injection of cross-linked Hyaluronic Acid (Bellast) into the deficient interdental papilla. (E) Clinical appearance at 1-month follow-up. (F) Clinical appearance at 3-month follow-up showing papillary reconstruction and reduction in gingival black triangle dimensions.

FIGURE 3: (Group II: HA)



REFERENCES

1. Ziahosseini P, Hussain F, Millar BJ. Management of gingival black triangles. British dental journal. 2014 Nov;217(10):559-63.
2. Rashid ZJ, Gul SS, Shaikh MS, Abdulkareem AA, Zafar MS. Incidence of gingival black triangles following treatment with fixed orthodontic appliance: a systematic review. In Health care 2022 Jul 24 (Vol. 10, No. 8, p. 1373). MDPI.
3. 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 interproximal dental papilla. J Periodontol. 1992;63(12):995-6.
4. Nemcovsky CE. Interproximal papilla augmentation procedure: a novel surgical approach and clinical evaluation of 10 consecutive procedures. Int J Periodontics Restorative Dent. 2001;21(6):553-9.
5. Niemczyk W, Janik K, Żurek J, Skaba D, Wiench R. Platelet-rich plasma (PRP) and injectable platelet-rich fibrin (i-PRF) in the non-surgical treatment of periodontitis—a systematic review. International Journal of Molecular Sciences. 2024 Jun 7;25(12):6319.
6. Punse S, Dhadse P, Salian S, Patil R, Bajaj P. Comparison of Injectable Platelet-rich Fibrin and Semilunar Flap with Tuberosity Graft for Gingival Black Triangles: A Randomized Clinical Trial. The Journal of Contemporary Dental Practice. 2025 Jun 18;26(4):418-25.
7. Tanwar J, Hungund SA. Hyaluronic acid: Hope of light to black triangles. Journal of International Society of Preventive and

- Community Dentistry. 2016 Sep 1;6(5):497-500.
8. Çankaya ZT, Tamam E. An examination of the 2-year results obtained from hyaluronic acid filler injection for interdental papilla losses. *Quintessence Int.* 2020 Apr 1;51(04):274-84.
 9. Alsharif SB, Aljahdali B. The use of hyaluronic acid injection for treatment of black triangle and reconstruction of lost interdental papilla in anterior teeth: a systematic review. *Acta Odontologica Scandinavica.* 2024 Jun 12;83:40864.
 10. Nordland WP, Tarnow DP. A classification system for loss of papillary height. *J Periodontol.* 1998;69(10):1124-6.
 11. Han TJ, Takei HH. Progress in gingival papilla reconstruction. *Periodontol 2000.* 1999;19:65-73.
 12. Azzi R, Etienne D, Carranza FA Jr. Surgical reconstruction of the interdental papilla. *Int J Periodontics Restorative Dent.* 1998;18(5):466-73.
 13. Zucchelli G, Mounssif I. Periodontal plastic surgery. *Periodontol 2000.* 2015;68(1):333-68.
 14. Rasperini G, Acunzo R, Limiroli E, Pagni G. Decision-making in interdental papilla reconstruction. *Int J Esthet Dent.* 2016;11(2):210-24.
 15. Trivedi A, Mishra R, Chandrashekar K, Choudhary A, Jaiswal CS, Tiwari G. Comparative evaluation of injectable-platelet rich fibrin and hyaluronic acid injections in the treatment of gingival black triangles. *Int J Sci Res.* 2021;9(6):64-68.
 16. Patel B, Balu P, Ravidran SK, Muthu J, Sathiyaseelan SD. Efficacy of injectable platelet rich fibrin and cross linked hyaluronic acid for augmentation of interdental papilla in term of true and surrogate end point. *J Indian Soc Periodontol* 2026;30:123-8.
 17. Becker W, Becker BE. Treatment of small papilla deficiencies: surgical and nonsurgical approaches. *Periodontol 2000.* 1995;7:64-83.
 18. Pal M, Jhingran R, Madan R, Paul R, Verma S. Comparative evaluation of hyaluronic acid and injectable platelet-rich fibrin in the management of interdental papilla loss: A clinical study. *J Indian Soc Periodontol.* 2021;25(4):310-16.
 19. Choukroun J, Ghanaati S. Reduction of relative centrifugation force within injectable platelet-rich-fibrin (PRF) concentrates advances patients' own inflammatory cells, platelets and growth factors: the first introduction to the low speed centrifugation concept. *Eur J Trauma Emerg Surg* 2018;44:87-95.
 20. Wang X, Zhang Y, Choukroun J, Ghanaati S, Miron RJ. Behavior of gingival fibroblasts on titanium implant surfaces in combination with either injectable PRF or PRP. *Int J Mol Sci* 2017;18:331.
 21. Kyyak S, Blatt S, Pabst A, Thiem D, Al-Nawas B, Kammerer PW. Combination of an allogenic and a xenogenic bone substitute material with injectable platelet-rich fibrin – a comparative in vitro study. *J Biomater Appl* 2020;35:83-96.
 22. Miron RJ, Fujioka-Kobayashi M, Bishara M, et al. Platelet-rich fibrin and soft tissue wound healing. *Tissue Eng Part B Rev.* 2017;23(1):83-99.