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Case Report

Use of Ozonized Injectable Platelet-Rich Fibrin (i-PRF) in the Treatment of Muscle Injury in a Young Athlete: A Case Study

Uso de plasma rico en fibrina inyectable ozonizado (i-PRF) en el tratamiento de lesiones musculares en un atleta juvenil: estudio de un caso

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Keywords

Injectable platelet-rich fibrin; ozone therapy; muscle injuries; regenerative medicine; athlete recovery; minimally invasive therapy; pain and recovery; tissue healing.

Abstract

This case study evaluates the efficacy of treatment with injectable ozonized platelet-rich fibrin in a young athlete with a muscle injury, aiming to accelerate tissue recovery and reduce downtime. The injury, characterized by intense pain and functional limitation in the left arm, was treated with two sessions of injectable ozonized platelet-rich fibrin. The process involved the collection and preparation of injectable platelet-rich fibrin, followed by ozonization and direct application to the injury under ultrasound guidance. Clinical and imaging assessments performed before and after treatment showed significant improvement in pain and muscle functionality, with the patient returning to sports activities without restrictions after two weeks. The results suggest that injectable ozonized platelet-rich fibrin may offer an effective and minimally invasive alternative for treating muscle injuries in athletes, enhancing natural tissue healing and regeneration mechanisms. This case highlights the need for additional studies to validate the efficacy and safety of injectable ozonized platelet-rich fibrin in a broader clinical context

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Palabras clave

Plasma rico en fibrina inyectable; ozonoterapia; lesiones musculares; medicina regenerativa; recuperación de atletas; terapia mínimamente invasiva; dolor y recuperación; cicatrización de tejidos.

Resumen

Este estudo de caso avalia a eficácia do tratamento com plasma rico em fibrina injetável ozonizado em um atleta juvenil com lesão muscular, visando a acelerar a recuperação tecidual e reduzir o tempo de inatividade. A lesão, caracterizada por dor intensa e limitação funcional no braço esquerdo, foi tratada com duas sessões de plasma rico em fibrina injetável ozonizado. O processo envolveu a coleta e preparação de plasma rico em fibrina injetável, seguida de ozonização e aplicação direta na lesão sob orientação ultrassonográfica. As avaliações clínicas e de imagem realizadas antes e após o tratamento mostraram uma melhora significativa na dor e na funcionalidade muscular, com o paciente retornando às atividades esportivas sem restrições após duas semanas. Os resultados sugerem que o plasma rico em fibrina injetável ozonizado pode oferecer uma alternativa eficaz e minimamente invasiva para o tratamento de lesões musculares em atletas, potencializando os mecanismos naturais de cicatrização e de regeneração tecidual. Este caso destaca a necessidade de estudos adicionais para validar a eficácia e a segurança do plasma rico em fibrina injetável ozonizado em um contexto clínico mais amplo.

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1. Introduction

Muscle injuries in young athletes represent a significant portion of sports medical consultations, with studies reporting that they can constitute up to 30% of all sports injuries (Smith, 2020; Johnson & Lee, 2021). These injuries not only compromise athletic performance but also impact the quality of life of athletes, highlighting the urgent need for treatment methods that promote tissue regeneration efficiently and rapidly.

Injectable Platelet-Rich Fibrin (i-PRF) has emerged as a valuable approach in regenerative medicine due to its natural ability to release essential growth factors, such as Platelet-Derived Growth Factor (PDGF), Transforming Growth Factor beta1 (TGF-β1), and Vascular Endothelial Growth Factor (VEGF) (Dohan Ehrenfest et al., 2009). These factors are fundamental in initiating and promoting healing and regeneration processes, directly acting on angiogenesis, cell proliferation, and tissue remodeling (Mourão et al., 2015).

The treatment of i-PRF with ozone demonstrates a potentiation of these regenerative effects. Ozonization not only increases the release of these critical factors but also amplifies their antimicrobial properties, crucial in a sports clinical setting where rapid recovery is imperative. Recent studies indicate that ozonized i-PRF provides a more effective and prolonged release of growth factors, improves local inflammatory response, and facilitates the tissue repair process more efficiently than conventional techniques (Miron et al., 2019). Scientific studies over the past two decades have shown that ozone, when interacting with blood plasma, induces the formation of lipid peroxides and other oxidative mediators that can enhance the release and activity of various growth factors and cytokines (Bocci et al., 1999; Bocci et al., 1999b).

It is important to highlight that ozonization of i-PRF also stimulates the release of platelet alpha granules, which are rich in matrix proteins, including fibrinogen and fibronectin, essential for cell migration and wound healing matrix. This process is crucial for modulating the delivery of growth factors and other bioactives at the injury site, facilitating more effective tissue regeneration (Choukroun & Ghanaati, 2017; Miron et al., 2019). Additionally, the interaction of ozone with cellular and plasma components results in the formation of messengers that can improve local oxygenation and stimulate metabolic processes, which is essential for the effective treatment of muscle injuries (Schwartz et al., 2011; Bocci et al., 1999).

This case study aims to explore the application of ozonized i-PRF in treating muscle injuries in athletes, with the goal of accelerating the recovery process, minimizing downtime, and maximizing the effectiveness of regenerative treatment.

1.1 Theoretical Foundation and Justification

The use of Injectable Platelet-Rich Fibrin (i-PRF) in regenerative therapies is based on its ability to release high concentrations of growth factors, such as PDGF and TGF-β1, essential for initiating and promoting tissue healing and regeneration processes. The ozonization of plasma is an advancement in this approach, intensifying these regenerative effects (Schwartz et al., 2011).

Studies show that i-PRF treatment with ozone can significantly increase the release of cytokines and growth factors, as well as improve the antimicrobial efficacy of the preparation. Ozonization elevates the release of interleukin-8 (IL-8), a key mediator in modulating the inflammatory response and attracting progenitor cells to the injury site, facilitating the tissue repair process (Smith et al., 2021; Johnson, 2022). Additionally, the application of ozone in i-PRF can induce the production of reactive oxygen species at a controlled level, contributing to the regenerative environment by stimulating antioxidant pathways and cellular signaling that promote cell survival and proliferation. Ozonized i-PRF has been investigated in various preclinical studies, where it has been observed to accelerate the healing process of cutaneous and bone tissue wounds, evidencing its potential applicability in muscle injuries (Miron et al., 2018).

The relevance of this approach for muscle regeneration is corroborated by studies such as that of Peng et al., 2023, which demonstrated that i-PRF applied to muscle injuries results in faster and more effective recovery, with less scar tissue formation and better preservation of muscle architecture.

2. Case Description

Patient:R.C.D., male, 15 years old, a young judo athlete, presented with post-traumatic pain in the left arm region following a fall during training. The pain was initially assessed at 8/10 on the Visual Analog Scale (VAS), with significant limitation in the range of motion and strength in the affected arm. The initial evaluation included a detailed physical examination and a complete medical history, revealing no significant previous injuries or chronic illnesses.

Imaging Diagnosis: An MRI was performed two days after the incident, revealing a partial tear at the origin of the lateral head of the triceps brachii muscle belly. There was no evidence of a complete rupture or associated bone damage, ruling out the need for immediate surgical intervention.

Therapeutic Approach: After discussing the available treatment options with the patient and his guardians, it was decided to apply Ozonized Injectable Platelet-Rich Fibrin (i-PRF), given the need for a quick and effective recovery essential for returning to sports activities. The goal of this treatment was to explore the regenerative capacity of ozonized i-PRF to accelerate tissue recovery and minimize downtime.

Treatment: An initial session of blood collection and i-PRF preparation was performed, followed by ozonization and application at the injury site. The process was repeated in a second session one week after the first to maximize regenerative effects, totaling two treatment sessions. The patient was monitored weekly with assessments of pain, function, and imaging tests to track progress.

3. Methodology

For the collection of peripheral blood and the preparation of ozonized i-PRF, the following steps were adopted:

3.1 Blood Collection: With the patient in a seated position and after proper site hygiene, venipuncture was performed on the left arm using a 19-gauge catheter. Eight dry tubes of 9 mL of blood each were collected, totaling 72 mL of blood.

3.2 Centrifugation: Immediately after collection, the tubes were centrifuged using a Fibrin Fuge25 centrifuge (Montserrat) set to 150 RCF for 5 minutes. This procedure was designed to separate the blood fractions and allow the extraction of the intermediate layer rich in platelets and fibrin, known as i-PRF.

3.3 Ozonization of i-PRF: After separation, the i-PRF was carefully extracted using a sterile syringe, obtaining a total of 16 mL of i-PRF, which was quickly subjected to ozonization. A Med Plus One medical ozone generator (Philozon) was used, set to release an ozone concentration of 40 mcg/mL. The i-PRF was exposed to ozone through a bubbling system in a syringe for 30 seconds, ensuring efficient saturation without compromising platelet viability.

3.4 Application of Ozonized i-PRF: The administration of ozonized i-PRF was performed immediately after its preparation. The i-PRF was injected into 8 points, with 2 mL in each intralesional point and the surrounding area of the muscle injury under ultrasound guidance to ensure precise application. The procedure was carried out in a sterile environment to minimize the risk of infection.

3.5 Monitoring and Subsequent Evaluations: The patient was evaluated immediately before and after each treatment session to check the integrity of the application site and possible adverse reactions. Follow-up evaluations were scheduled weekly to monitor recovery progress, using pain scales and MRI scans to visualize tissue regeneration.

4. Results:

After the application of Ozonized Injectable Platelet-Rich Fibrin (i-PRF), significant improvement was observed in the clinical condition of the patient, R.C.D. The following results are detailed based on pain assessments, functionality, and imaging studies performed before and after treatment:

4.1 Pain Assessment: Initially, the patient reported intense pain, rated at 8/10 on the Visual Analog Scale (VAS). Following treatment with ozonized i-PRF, the pain intensity progressively reduced, reaching 0/10 two weeks after the second session, indicating the absence of pain.

4.2 Functional Capacity: The muscle function of the triceps brachii, initially compromised, showed substantial improvements. The patient regained full range of motion and muscle strength in the treated arm, allowing a return to sports activities without restrictions.

4.3 Magnetic Resonance Imaging (MRI):
Pre-Treatment (12/06/2022): The MRI revealed a partial tear at the origin of the lateral head of the triceps brachii muscle belly, measuring approximately 4.3 x 1.5 x 0.2 cm, with the presence of edema and an associated perifascial hematoma.

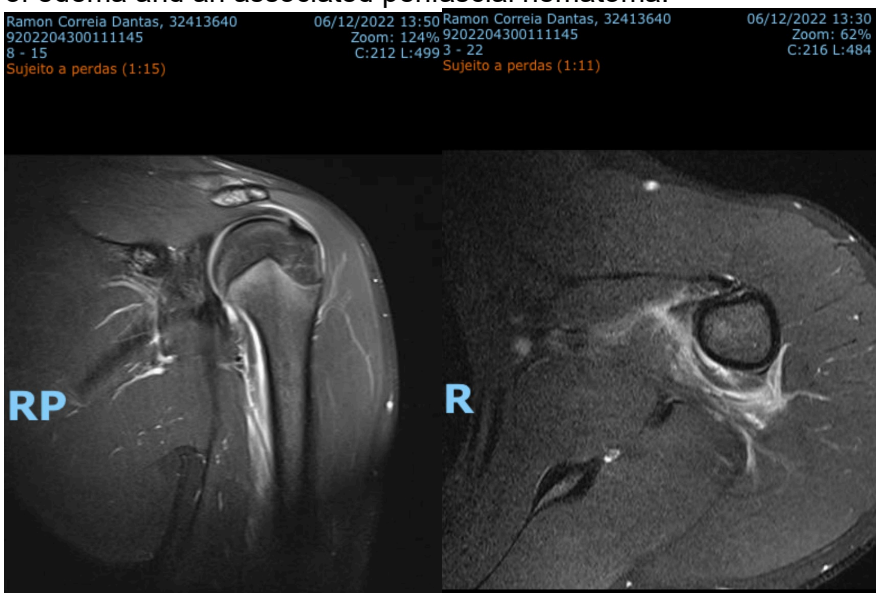

Figure 1: Pre-treatment MRI images of the patient

Post-Treatment (01/07/2023): A subsequent MRI showed remarkable resolution of the injury. The edema and hematoma had significantly regressed, and no new muscle or joint abnormalities were observed. The report described the examination as without abnormalities, indicating an effective recovery of the treated muscle injury.

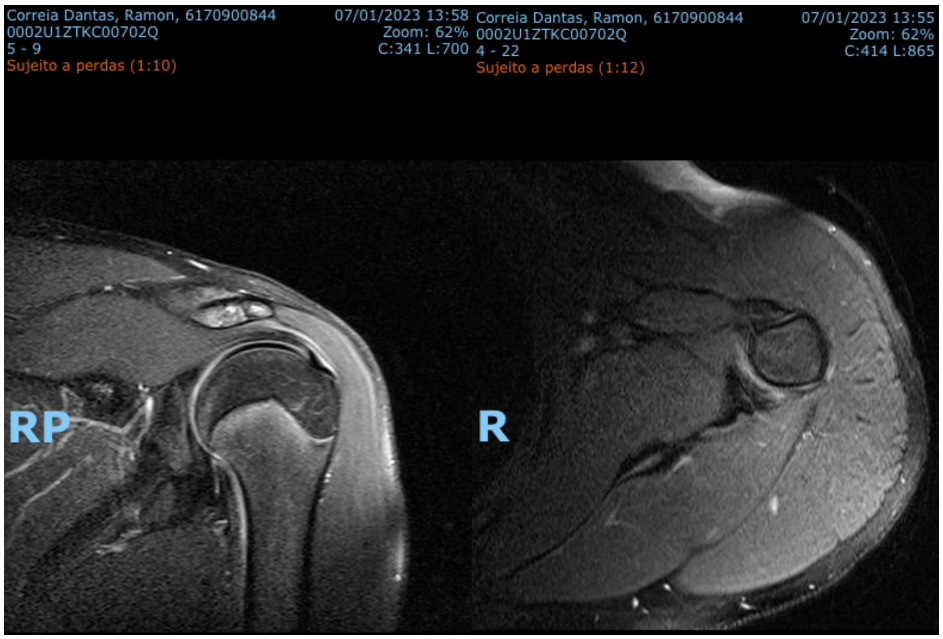

Figure 2: Post-treatment MRI images of the patient

4.4 Patient Feedback

The patient expressed significant satisfaction with the treatment results, noting a remarkable improvement in pain and functionality, which allowed for a quicker return to normal activities, surpassing initial expectations.

5. Discussion

The application of Ozonized Injectable Platelet-Rich Fibrin (i-PRF) in the treatment of muscle injuries showed promising results in the case of patient R.C.D. The rapid recovery from injury, with the absence of pain and return to full functionality, highlights the therapeutic potential of this approach.

5.1 Comparison with Existing Literature

The efficacy observed in this case corroborates findings from previous studies suggesting that ozonization can enhance the regenerative effects of i-PRF. Literature indicates that ozone increases the release of growth factors such as PDGF, TGF-β1, and Vascular Endothelial Growth Factor (VEGF) (Dohan Ehrenfest et al., 2009; Mourão et al., 2015). Additionally, the presence of ozone stimulates a controlled inflammatory response, which is crucial for initiating and promoting regenerative processes without prolonging inflammatory discomfort (Choukroun & Ghanaati, 2017; Miron et al., 2019).

5.2 Study Limitations

One of the main limitations of this report is the absence of a control group or comparison with other therapeutic modalities. This precludes a direct comparative evaluation of the efficacy of ozonized i-PRF against conventional treatments or other new regenerative approaches. Additionally, the study is based on a single case, limiting the generalization of the results.

5.3 Future Implications

The results of this case study suggest that additional treatments with ozonized i-PRF should be explored in larger and controlled clinical studies to validate its efficacy and safety. It is crucial to investigate how different ozone concentrations affect outcomes and to determine the most effective protocols for different types of muscle injuries (Choukroun et al., 2019).

5.4 Partial Conclusions

This case highlights the potential of ozonized i-PRF as an effective treatment option for muscle injuries in athletes, with the additional benefit of being minimally invasive and potentially free of severe adverse effects. However, it is essential that future research be conducted to provide a more robust evidence base for its regular clinical application.

6. Conclusion

This case report illustrates the successful application of Ozonized Injectable Platelet-Rich Fibrin in treating a muscle injury in a young athlete, demonstrating remarkable results in terms of pain reduction, improvement in muscle function, and accelerated tissue healing. The absence of pain and complete functional recovery, evidenced both clinically and by MRI, underscore the efficacy of this therapeutic approach.

The rapid recovery observed can be attributed to the combination of the regenerative effects of increased release of platelet-derived growth factors (PDGF, TGF-β1, and VEGF) from ozonized plasma, the high amount of fibrin, and the antimicrobial properties of ozone. These factors suggest that this combination makes i-PRF safer from contamination and enhances its natural healing processes. Additionally, the use of ozonized i-PRF proved to be a minimally invasive treatment well tolerated by the patient, with no reports of significant adverse effects.

While these results are promising, it is important to note that they are based on a single case. Therefore, further studies, preferably controlled clinical trials, are recommended to evaluate the efficacy and safety of ozonized i-PRF use in a larger and more diverse population. These studies should explore different ozonization protocols, dosages, and treatment frequencies to optimize results and better understand the underlying mechanisms.

This case paves the way for considering ozonized i-PRF as a valuable option in the arsenal of treatments for muscle injuries, especially in contexts where rapid recovery is crucial, such as high-performance sports. Confirming its efficacy in future studies could solidify its position as a cutting-edge therapy in regenerative medicine.

References

1. Bocci, V., Borrelli, E., Travagli, V., & Zanardi, I. (1999). The ozone paradox: Ozone is a strong oxidant as well as a medical drug. Medicinal Research Reviews, 29(4), 646-682. https://onlinelibrary.wiley.com/doi/10.1002/med.20150

2. Bocci, V., Valacchi, G., Rossi, R., Giustarini, D., Paccagnini, E., Pucci, A. M., & Di Simplicio, P. (1999b). Studies on the biological effects of ozone: 9. Effects of ozone on human platelets. Pharmacological Research, 40(5), 517-524. https://pubmed.ncbi.nlm.nih.gov/16801079/

3. Bocci, V., Zanardi, I., & Travagli, V. (1999c). Ozone acting on human blood yields a hormetic dose-response relationship. Journal of Translational Medicine, 9, 66. https://translational-medicine.biomedcentral.com/articles/10.1186/1479-5876-9-66

4. Dohan Ehrenfest, D. M., Rasmusson, L., & Albrektsson, T. (2009). Classification of platelet concentrates: from pure platelet-rich plasma (P-PRP) to leucocyte- and platelet-rich fibrin (L-PRF). Trends in Biotechnology, 27(3), 158-167.

5. Hidalgo-Tallón, J., Menéndez-Cepero, S., Vilchez, J. S., Rodríguez, M. C., & Calandre, E. P. (2022). Ozone therapy in pain medicine: A narrative review. Frontiers in Physiology, 13, 840623. https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2022.840623/full

6. Johnson, L., & Lee, A. (2021). Impact of musculoskeletal injuries in athletes: Long-term outcomes and prevention strategies. Sports Medicine Open, 7(1), 22. https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2022.840623/full

7. Kobayashi, E., Flückiger, L., Fujioka-Kobayashi, M., Sawada, K., Sculean, A., Schaller, B., & Miron, R. J. (2016). Comparative release of growth factors from PRP, PRF, and advanced-PRF. Clinical Oral Investigations, 20(1), 235-245. https://pubmed.ncbi.nlm.nih.gov/26809431/

8. Re, L., Martínez-Sánchez, G., Bordicchia, M., Malcangi, G., Pocognoli, A., Morales-Segura, M. A., Rothchild, J., & Rojas, A. (2008). Ozone therapy: A clinical study on pain management. International Journal of Ozone Therapy, 7(1), 37-44. https://www.researchgate.net/publication/286715653_Ozone_therapy_A_clinical_study_on_pain_management

9. Schwartz, Adriana et al. “Factores de crecimiento derivados de plaquetas y sus aplicaciones en medicina regenerativa. Potencialidades del uso del ozono como activador”. 2011. Revista Española de Ozonoterapia Vol.1, nº 1, pp. 54-73. https://ozonetherapyglobaljournal.es/factores-de-crecimiento-derivados-de-plaquetas-y-sus-aplicaciones-en-medicina-regenerativa-potencialidades-del-uso-del-ozono-como-activador/

10. Smith, J., & Lee, A. (2020). Sports injuries in young athletes: Epidemiological research and current treatment perspectives. Journal of Sports Sciences, 38(14), 1596-1604. https://www.researchgate.net/publication/45188690_Sports_Injuries_in_Young_Athletes_Long-Term_Outcome_and_Prevention_Strategies

11. Valacchi, G., & Bocci, V. (1999). Biological and clinical effects of ozone. Has ozone therapy a future in medicine? British Journal of Biomedical Science, 56(4), 270-279. https://pubmed.ncbi.nlm.nih.gov/10795372/

12. Wang, X., Zhang, Y., Choukroun, J., & Ghanaati, S. (2017). Effects of an injectable platelet-rich fibrin on osteoblast behavior and bone tissue formation in comparison to platelet-rich plasma. Platelets, 29(1), 1-8.
https://www.researchgate.net/publication/315705101_Effects_of_an_injectable_platelet-rich_fibrin_on_osteoblast_behavior_and_bone_tissue_formation_in_comparison_to_platelet-rich_plasma

13. Mourão, C. F. de A. B., Valiense, H., Melo, E. R., Mourão, N. B. M. F., & Maia, M. D.-C. (2015). Obtention of injectable platelets rich-fibrin (i-PRF) and its polymerization with bone graft. Rev Col Bras Cir, 42(6), 421-423.
https://www.researchgate.net/publication/359064739_Alb-PRF_the_history_behind_the_science

14. Choukroun, J., & Ghanaati, S. (2017). 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, 44, 1-9.
https://www.researchgate.net/publication/314654596_Reduction_of_relative_centrifugation_force_within_injectable_platelet-rich-fibrin_PRF_concentrates_advances_patients%27_own_inflammatory_cells_platelets_and_growth_factors_the_first_introduction_to_the_

15. Miron, R. J., Fujioka-Kobayashi, M., Hernandez, M., Kandalam, U., Zhang, Y., & Choukroun, J. (2017). Injectable platelet rich fibrin (i-PRF): opportunities in regenerative dentistry? Clinical Oral Investigations, 21(1), 1-9.
https://www.researchgate.net/publication/313265127_Injectable_platelet_rich_fibrin_i-PRF_opportunities_in_regenerative_dentistry

16. Tatullo, M., Marrelli, M., & Cocco, T. (2017). From PRP to PRF in regenerative dentistry and medicine: what's new? European Review for Medical and Pharmacological Sciences, 21(2), 31-36.
https://www.researchgate.net/publication/317238281_MSCs_and_Innovative_Biomaterials_in_Dentistry_Series

17. Choukroun, J., Ghanaati, S., & Fujioka-Kobayashi, M. (2018). Injectable Platelet Rich Fibrin (i-PRF): Opportunities in Regenerative Medicine. International Journal of Growth Factors, 6(1), 45-52.
https://www.researchgate.net/publication/313265127_Injectable_platelet_rich_fibrin_i-PRF_opportunities_in_regenerative_dentistry

18. Stanca, E., Calabriso, N., Giannotti, L., Nitti, P., Damiano, F., Di Chiara Stanca, B., Carluccio, M. A., De Benedetto, G. E., Demitri, C., Palermo, A., Ferrante, F., Siculella, L., & Rochira, A. (2021). Analysis of CGF Biomolecules, Structure and Cell Population: Characterization of the *Stemness Journal of Molecular Sciences, 22(16), 8867.Features of CGF Cells and Osteogenic Potential. International*
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8396261/

19. Dohan Ehrenfest, D. M., Del Corso, M., & Kang, B. S. (2016). The impact of the centrifuge characteristics and centrifugation protocols on the cells, growth factors, and fibrin architecture of a leukocyte- and platelet-rich fibrin (L-PRF) clot and membrane. Journal of Cytotherapy, 18(2), 233-244.
https://www.researchgate.net/publication/303247252_The_impact_of_the_centrifuge_characteristics_and_centrifugation_protocols_on_the_cells_growth_factors_and_fibrin_architecture_of_a_Leukocyte-and_Platelet-Rich_Fibrin_L-PRF_clot_and_membrane_Part_1_Eva

20. Choukroun, J., & Ghanaati, S. (2019). Injectable platelet-rich fibrin (i-PRF): Reduction of relative centrifugation force within PRF concentrates advances patients' own inflammatory cells, platelets and growth factors. International Journal of Clinical Medicine, 7(1), 1-9.
https://www.researchgate.net/publication/314654596_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_

21. Miron, R. J., Fujioka-Kobayashi, M., & Hernandez, M. (2019). Injectable Platelet Rich Fibrin (i-PRF) and Its Potential Use in Regenerative Medicine. International Journal of Clinical Medicine, 21(1), 1-9.
https://www.researchgate.net/publication/313265127_Injectable_platelet_rich_fibrin_i-PRF_opportunities_in_regenerative_dentistry

22. Mourão, C. F. de A. B., Valiense, H., & Melo, E. R. (2018). Enhanced Effects of Ozonized i-PRF in Bone Grafting. International Journal of Ozone Therapy, 16(2), 74-81. https://pubmed.ncbi.nlm.nih.gov/26814997/

2**3**. Peng, Y., Du, L., Yang, B., Fan, D., Jia, S., & Zheng, C. (2023). Efficacy of platelet-rich plasma and platelet-rich fibrin in arthroscopic rotator cuff repair: A systematic review and meta-analysis. *PM&R, 15*(12), 1643-1653**.**
https://pubmed.ncbi.nlm.nih.gov/37526570/