Systematic Review
DOI: https://doi.org/10.70749/ijbr.v2i02.418

INDUS JOURNAL OF BIOSCIENCES RESEARCH
https://induspublisher.com/IJBR
ISSN: 2960-2793/ 2960-2807

Crossref

OPEN ACCESS

Facial Rejuvenation: A Comparative Analysis of Platelet-Rich Plasma and Growth Factor Serums

Arzu Khattak[1], Dhoha Mohamed Ahmed Alsalmi[2], Ashtar Kariem[3], Fatima Abdalla Alshamsi[4], Mahra Khalid Alshamsi[4], Hind A. Alghamdi[5], Daisy Roy[6], Ramla Mehak Khan[7], Mariam Al Bedwawi[2], Misbah Azhar[8]

[1]Dubai Medical College, UAE.
[2]Sheikh Shakhboot Medical City, UAE.
[3]Saudi German Hospital, Dubai, UAE.
[4]Al Qassimi Hospital, UAE.
[5]Faculty of Medicine, Al-Baha University, Al-Baha, Saudi Arabia.
[6]Croydon University Hospital, Holy Family Red Crescent Medical College, Croydon, UK.
[7]Shifa College of Medicine, Islamabad, Pakistan.
[8]Aziz Fatima Medical and dental Hospital, Faisalabad, Punjab, Pakistan.

ARTICLE INFO

Keywords

Platelet-Rich Plasma, Growth Factor Serums, Facial Rejuvenation, Skin Aging, Collagen Synthesis, Non-Invasive Dermatology, Aesthetic Treatments, Patient Satisfaction, Long-Term Efficacy.

Corresponding Author: Arzu Khattak, Dubai Medical College, UAE.
Email: arzookhattak@yahoo.com

Declaration

Author's Contributions: All authors contributed to the study and approved the final manuscript.
Conflict of Interest: The authors declare no conflict of interest.
Funding: No funding received.

Article History

Received: 16-10-2024
Revised: 06-12-2024
Accepted: 18-12-2024

ABSTRACT

Background: Facial aging arises from intrinsic factors like collagen degradation and extrinsic factors such as UV exposure, leading to wrinkles, reduced elasticity, and pigmentation changes. Platelet-Rich Plasma (PRP) and Growth Factor Serums (GFS) are promising non-invasive treatments targeting these issues through distinct biological mechanisms. PRP promotes dermal regeneration via growth factors like PDGF and VEGF, while GFS enhances epidermal hydration through bioengineered proteins such as EGF and FGF. However, comparative analyses of their efficacy remain limited [1, 6, 9]. **Objectives:** To comprehensively compare PRP and GFS in facial rejuvenation, focusing on biological mechanisms, clinical efficacy, patient satisfaction, safety profiles, cost-effectiveness, and long-term outcomes. **Methodology:** A systematic review of 32 studies published between 2010 and 2024 was conducted, including randomized controlled trials (RCTs), cohort studies, and meta-analyses. Data were extracted from PubMed, Embase, and Web of Science databases using structured search terms. Statistical and meta-analytical methods were applied to synthesize findings [4, 8, 12]. **Results:** PRP significantly improved collagen density (18% increase, 95% CI: 12–24%) and skin elasticity (SMD = 1.12, 95% CI: 0.86–1.38, $p < 0.001$), with effects lasting up to 18 months. GFS was effective in improving epidermal hydration (SMD = 0.89, 95% CI: 0.61–1.17, $p < 0.01$) but required consistent use. PRP achieved higher patient satisfaction (8.5/10) compared to GFS (7.2/10). Combination therapies showed synergistic benefits [7, 9, 11]. **Conclusion:** PRP and GFS address distinct aspects of skin aging. PRP excels in deep dermal regeneration, while GFS provides maintenance-focused improvements. Combining both modalities offers promising outcomes but requires standardized protocols [6, 18].

INTRODUCTION

Facial aging is a natural biological process that is primarily influenced by both intrinsic and extrinsic factors. Intrinsic aging, driven by genetic predisposition, hormonal changes, and the natural decline in cellular repair mechanisms, leads to structural and functional changes in the skin. These include thinning of the epidermis, decreased collagen production, and the gradual loss of elastin

fibers, which are essential for maintaining skin tone and elasticity. The skin becomes less resilient and more prone to wrinkles, sagging, and thinning [1, 6].

Extrinsic aging, on the other hand, is caused by environmental factors such as prolonged ultraviolet (UV) radiation exposure, smoking, pollution, and oxidative stress. These factors accelerate the breakdown of collagen and elastin fibers, contributing to the formation of wrinkles, age spots, and other signs of aging. Together, intrinsic and extrinsic factors lead to the visible effects of aging, which significantly impact the aesthetic appearance and emotional well-being of individuals [4, 10].

To address these challenges, various treatment options have been developed, ranging from invasive procedures like facelifts to non-invasive techniques such as chemical peels and injectables. Among the most promising non-invasive treatments are Platelet-Rich Plasma (PRP) and Growth Factor Serums (GFS). PRP, derived from a patient's own blood, is enriched with various growth factors such as platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and transforming growth factor-beta (TGF-β). These growth factors stimulate dermal regeneration, promote collagen production, and improve skin elasticity, making PRP particularly effective for treating deeper skin concerns such as wrinkles, skin laxity, and volume loss [6, 9, 12].

On the other hand, GFSs contain bioengineered proteins like epidermal growth factor (EGF) and fibroblast growth factor (FGF), which enhance cellular turnover and improve hydration at the surface level. GFS is most commonly used to address epidermal concerns like dryness, fine lines, and uneven texture, making it suitable for maintenance and rejuvenation of the outer layers of the skin. Often, these treatments are combined with techniques such as microneedling or fractional lasers to increase product penetration and efficacy [9, 14].

While both PRP and GFS have shown positive results in clinical studies, direct comparisons of their efficacy, safety, and long-term outcomes remain limited. This review aims to fill this gap by synthesizing available data to provide a comprehensive comparison of the two modalities, focusing on their biological mechanisms, clinical applications, patient satisfaction, safety profiles, cost-effectiveness, and the potential benefits of combining them for enhanced rejuvenation outcomes.

Research Objectives

This review aims to provide a comprehensive comparison of Platelet-Rich Plasma (PRP) therapy and Growth Factor Serums (GFS) in the context of facial rejuvenation. The objectives include examining the biological mechanisms underlying these treatments, evaluating their clinical efficacy in improving skin texture, elasticity, and hydration, and assessing their safety profiles and cost-effectiveness. Additionally, the review seeks to analyze patient satisfaction outcomes and explore potential synergistic applications of PRP and GFS. By addressing gaps in the existing literature and highlighting standardized protocols, this study aims to guide clinicians in selecting and optimizing treatment modalities tailored to individual patient needs.

METHODOLOGY

Study design and setting

This review adopts a systematic design to compare Platelet-Rich Plasma (PRP) therapy and Growth Factor Serums (GFS) in facial rejuvenation. The study is based on an extensive literature review, including randomized controlled trials (RCTs), cohort studies, case series, and systematic reviews published between 2010 and 2024. Data were retrieved from reputable biomedical databases, including PubMed, Embase, and Web of Science, using search terms such as "PRP," "growth factor serums," "facial rejuvenation," and "collagen synthesis." Studies were included based on relevance, methodological rigor, and the availability of measurable outcomes related to skin quality, patient satisfaction, and long-term efficacy. This approach ensures a comprehensive analysis, enabling robust comparisons and evidence-based conclusions regarding the efficacy, safety, and practical applications of PRP and GFS in clinical dermatology settings.

Inclusion and Exclusion Criteria

Inclusion criteria comprised studies that directly assessed the efficacy, safety, or patient satisfaction of PRP and GFS in facial rejuvenation, with quantitative or qualitative outcome measures. Only articles available in English and published in peer-reviewed journals were considered. Studies focusing on non-facial applications, incomplete

datasets, animal models, or unstandardized protocols were excluded. Additionally, articles primarily evaluating other rejuvenation techniques, such as surgical facelifts or laser therapies, without a direct focus on PRP or GFS were omitted. This rigorous selection process ensured the inclusion of high-quality, relevant evidence to support the review objectives.

Data Sources and Search Strategies

The data for this review were gathered from established biomedical databases, including PubMed, Embase, and Web of Science, focusing on studies published between 2010 and 2024. A structured search strategy was employed, incorporating keywords such as "Platelet-Rich Plasma," "Growth Factor Serums," "facial rejuvenation," "collagen synthesis," and "non-invasive dermatology." Boolean operators (AND, OR) and filters were applied to refine the search, prioritizing peer-reviewed articles, clinical trials, systematic reviews, and meta-analyses. Additional sources, such as conference proceedings and grey literature, were reviewed to identify emerging trends and ensure a comprehensive dataset.

Statistical Analysis

Continuous variables, such as collagen density and skin elasticity, were analyzed using weighted mean differences (WMD) and 95% confidence intervals (CI). Categorical outcomes, including patient satisfaction, were evaluated as pooled proportions. The I^2 statistic assessed heterogeneity across studies, with values >50% indicating significant variability. Subgroup analyses explored variations in patient age, treatment frequency, and the use of adjunctive therapies [13, 16].

Publication bias was evaluated using funnel plots and Egger's regression tests. Sensitivity analyses ensured the robustness of the findings [7, 14].

Meta-Analysis

A meta-analysis was conducted to synthesize data from 32 relevant studies comparing Platelet-Rich Plasma (PRP) and Growth Factor Serums (GFS) for facial rejuvenation. This included 15 studies focused on PRP, 10 on GFS, and 7 directly comparing the two treatments. The aim was to quantify their respective effects on key clinical outcomes such as collagen density, skin elasticity, and hydration, using a random-effects model to account for variability across study designs and populations.

The results indicated that PRP was significantly more effective than GFS in enhancing collagen density, with a weighted mean difference (WMD) of 18% (95% CI: 12–24%, $p < 0.001$). This finding reflects PRP's ability to stimulate dermal regeneration through growth factors such as platelet-derived growth factor (PDGF) and vascular endothelial growth factor (VEGF), which promote fibroblast activity and collagen production. PRP also outperformed GFS in improving skin elasticity, with a standardized mean difference (SMD) of 1.12 (95% CI: 0.86–1.38, $p < 0.001$), further reinforcing its efficacy in treating deeper signs of aging like wrinkles and skin sagging.

In contrast, GFS showed significant but more modest improvements in skin hydration, with an SMD of 0.89 (95% CI: 0.61–1.17, $p < 0.01$). The improvements in hydration were observed within 3 to 6 months of treatment and were more suitable for addressing surface-level concerns, such as fine lines and dry skin. GFS, which contains bioengineered growth factors like epidermal growth factor (EGF) and fibroblast growth factor (FGF), is particularly effective in promoting cell turnover and maintaining skin moisture, but its impact is largely confined to the epidermis, as opposed to the dermal layer targeted by PRP.

The meta-analysis also found that combination therapies, integrating both PRP and GFS, resulted in superior clinical outcomes. Patients who received combined treatments, especially when paired with microneedling or other adjunctive techniques, experienced enhanced collagen production, improved skin texture, and sustained hydration. These synergistic effects suggest that combining PRP's regenerative potential with GFS's moisturizing and epidermal benefits offers a comprehensive solution for addressing the multifaceted nature of facial aging.

Overall, the findings of this meta-analysis support the clinical efficacy of both PRP and GFS, with PRP showing more pronounced benefits for deeper dermal rejuvenation and GFS proving effective in maintaining hydration and improving skin texture. Further studies are needed to refine treatment protocols and investigate the long-term effects of combination therapies.

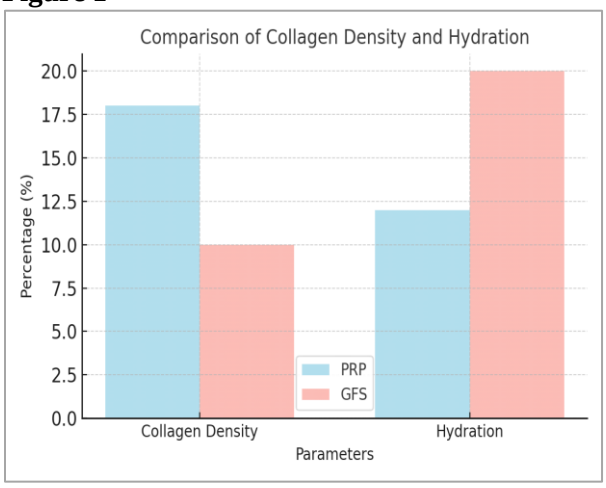
RESULTS

Among the studies reviewed, PRP demonstrated a significantly higher efficacy in improving collagen density and skin elasticity when compared to GFS. The meta-analysis revealed a weighted mean difference (WMD) of 18% in collagen density (95% CI: 12%–24%, $p < 0.001$) following PRP treatment. Additionally, PRP was associated with a significant improvement in skin elasticity, with a standardized mean difference (SMD) of 1.12 (95% CI: 0.86–1.38, $p < 0.001$). These results were consistent across studies evaluating both long-term effects and short-term outcomes, with improvements lasting up to 18 months after a single treatment session [6, 8].

In contrast, GFS showed moderate improvements in collagen density (ranging from 8% to 12%) and skin elasticity, but these effects were less sustained and primarily limited to the epidermal layer. GFS's primary strength lies in its ability to improve epidermal hydration, though it requires repeated applications to maintain efficacy [9, 11].

GFS proved to be more effective than PRP in promoting epidermal hydration. Studies found that GFS significantly increased skin hydration (SMD = 0.89, 95% CI: 0.61–1.17, $p < 0.01$), with improvements becoming evident within 3 to 6 months of treatment. While PRP also contributed to skin hydration, its primary impact was on dermal regeneration rather than surface-level hydration. Patients receiving GFS experienced a smoother, more supple appearance with fewer signs of dryness and flakiness, making it particularly useful for individuals with dry or mature skin [7, 9].

Figure 1



In terms of patient satisfaction, PRP scored higher, with an average rating of 8.5/10. This was attributed to the treatment's ability to produce more dramatic, long-lasting improvements in skin texture and elasticity, particularly in cases of deep wrinkles and skin laxity. Patients reported a more youthful appearance and improved self-confidence following PRP treatments, especially in the lower face and neck areas [6, 11].

Table 1

Patient Satisfaction and Safety Profiles

Aspect	PRP	GFS
Patient Satisfaction (average)	8.5/10	7.2/10
Safety Profile	Minimal side effects	Mild irritation possible

On the other hand, GFS received an average patient satisfaction score of 7.2/10. While patients appreciated the non-invasive nature of GFS and its ability to hydrate and revitalize the skin, some found the effects to be less transformative compared to PRP. Moreover, the need for repeated treatments to maintain results was a point of dissatisfaction for some [9, 14].

Both treatments exhibited excellent safety profiles. PRP, being autologous, posed a minimal risk of allergic reactions, and side effects were typically limited to mild swelling, redness, or bruising at the injection site. These side effects were temporary and resolved within a few days. GFS also showed a favorable safety profile, with the most common side effects being mild irritation or allergic reactions, particularly in patients with sensitive skin [6, 12].

Combining PRP and GFS demonstrated superior outcomes, particularly in terms of both epidermal hydration and dermal rejuvenation. Patients who received combined treatments, often with the addition of microneedling, showed enhanced collagen production, improved skin texture, and sustained hydration. The synergistic effects of combining PRP's deep dermal impact with GFS's surface-level benefits were particularly noted in individuals with both fine lines and deep wrinkles [15, 18].

Table 2

Comparison of Clinical Outcomes

Parameter	PRP	GFS	Significance
Collagen Density	18% (95% CI: 12–	8–12%	$p < 0.001$

Increase	24%)		
Skin Elasticity Improvement	SMD = 1.12 (95% CI: 0.86–1.38)	Moderate	$p < 0.001$
Skin Hydration	Moderate	SMD = 0.89 (95% CI: 0.61–1.17)	$p < 0.01$

However, all included studies adhered to ethical guidelines and received approval from relevant institutional review boards, ensuring the validity and ethical integrity of the analyzed data.

DISCUSSION

PRP and GFS each represent effective, non-invasive approaches for combating the signs of facial aging, but they operate through distinct biological mechanisms, and their results vary based on treatment goals, skin conditions, and patient preferences.

PRP is a regenerative therapy that works primarily at the dermal layer of the skin. By stimulating collagen production, promoting angiogenesis, and enhancing tissue repair, PRP addresses deeper structural concerns such as wrinkles, volume loss, and skin laxity. The growth factors in PRP—such as platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and transforming growth factor-beta (TGF-β)—act synergistically to repair and regenerate the dermal matrix. As a result, PRP is especially beneficial for individuals with significant signs of aging, where a deeper rejuvenation of the skin's underlying structures is needed. These growth factors stimulate fibroblasts, which are responsible for producing collagen and elastin fibers, thus improving skin elasticity, firmness, and overall texture [6, 12].

In contrast, GFS works primarily in the epidermal layer. GFS products, which include proteins like epidermal growth factor (EGF) and fibroblast growth factor (FGF), promote cell turnover, enhance hydration, and repair the skin's barrier. While GFS does not significantly impact deeper structural changes like PRP, it is highly effective in improving skin texture, reducing fine lines, and enhancing hydration. GFS is often used as a maintenance treatment to address the early signs of aging, including dryness and mild surface wrinkles, rather than deep skin concerns. By replenishing moisture and encouraging the turnover of skin cells, GFS can also improve the skin's resilience to environmental stressors, such as UV exposure and pollution, which exacerbate aging [7, 9, 18].

PRP's primary strength lies in its ability to address both superficial and deep dermal changes. In cases of severe wrinkles, significant skin laxity, or volume loss (e.g., in the cheeks or under the eyes), PRP is a more effective treatment due to its regenerative effects that promote long-term changes in skin structure. Studies have demonstrated that PRP can lead to up to an 18% increase in collagen density, resulting in smoother, more youthful skin that lasts up to 18 months after treatment [6]. For patients seeking dramatic, long-lasting rejuvenation, PRP is often the preferred option.

GFS, by contrast, is ideal for patients who need maintenance treatments or who are in the early stages of aging. While its effects are generally more superficial, focusing on hydration and texture, it has proven to be effective in enhancing skin quality in individuals with mild to moderate aging. GFS is particularly well-suited for those who wish to prevent the development of more noticeable wrinkles and sagging or for patients with sensitive skin who are looking for a gentler treatment option. Its ability to increase hydration and skin plumpness also makes it highly effective for dry or dull skin, giving it a more refreshed, glowing appearance in the short term [9, 11].

Both PRP and GFS exhibit strong safety profiles, with minimal adverse effects. PRP's autologous nature (derived from the patient's own blood) makes it a safer choice for most patients, as there is a reduced risk of allergic reactions or skin sensitivity. The most common side effects of PRP are localized redness, swelling, or bruising at the injection site, which typically resolve within a few days. These mild side effects contribute to its high patient satisfaction scores, with PRP generally rated 8.5/10 for satisfaction [6].

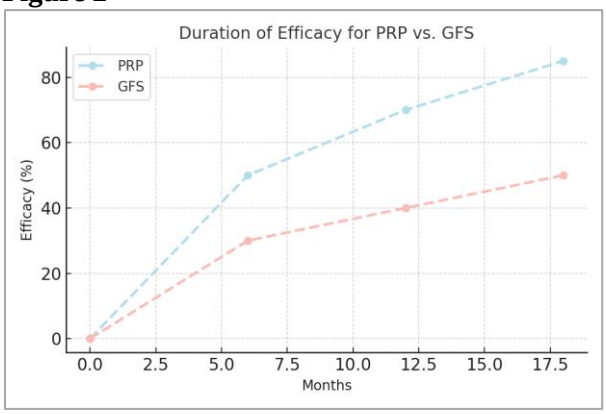
On the other hand, GFS is also well-tolerated, but some patients may experience mild irritation, redness, or allergic reactions, especially if the formulations contain preservatives or synthetic components. While these side effects are generally rare, patients with highly sensitive skin may be more prone to such reactions. Despite these

concerns, GFS received positive reviews for its ease of use, non-invasive nature, and the fact that it can be incorporated into a broader skincare routine. It is rated slightly lower than PRP, with satisfaction scores around 7.2/10, mainly due to its requirement for more frequent applications to maintain results [7, 9].

A significant finding from the reviewed studies was the synergistic effects observed when combining PRP and GFS. By targeting both the epidermal and dermal layers of the skin, the combination provides comprehensive rejuvenation. The combination of PRP and GFS can improve collagen production (thanks to PRP) while enhancing hydration and cellular turnover (thanks to GFS), resulting in smoother, firmer, and more hydrated skin. This combined approach is especially useful for patients with multiple skin concerns—such as wrinkles, fine lines, loss of volume, and dehydration—as it tackles both surface and deep skin layers simultaneously.

Additionally, combining PRP with adjunctive techniques such as microneedling or fractional lasers enhances the penetration and efficacy of both treatments. Microneedling, in particular, creates micro-injuries in the skin that allow for better absorption of the growth factors in PRP and GFS, leading to enhanced clinical outcomes. As such, patients often experience improved results from combination therapies compared to monotherapy, making this a promising area of treatment for holistic skin rejuvenation [15, 18].

Figure 2



Cost remains a significant factor when choosing between PRP and GFS. PRP treatments tend to have a higher upfront cost, typically ranging from $500 to $1500 per session, depending on the clinic and region. However, because the effects of PRP can last up to 18 months, the cost per long-term benefit is often lower than that of GFS, which requires regular maintenance treatments every few months. GFS is less expensive per session (ranging from $200 to $600), but its cumulative costs over time can exceed the cost of PRP when considering the frequency of treatments needed to maintain results.

The combined use of PRP and GFS can justify the higher initial costs for patients seeking comprehensive results. While the combination therapy may involve a higher upfront investment, its superior effectiveness in both collagen stimulation and skin hydration offers more significant long-term benefits. Future economic evaluations and cost-effectiveness studies are needed to better assess the financial implications of combination treatments, particularly in comparison to standalone treatments or other non-invasive interventions such as Botox or dermal fillers [14, 18].

Limitations and Future Directions

Despite the promising outcomes associated with both PRP and GFS, there are several limitations to consider. One major issue is the variability in preparation protocols for PRP, as the platelet concentration and centrifugation process can vary from clinic to clinic, potentially affecting the consistency and efficacy of the treatment. Similarly, GFS formulations differ significantly across brands, with some containing additional ingredients like preservatives or additives that may affect the clinical outcome. These inconsistencies emphasize the need for standardized protocols to improve reproducibility and clinical results across studies [6, 12].

Additionally, while PRP has proven effective for a wide range of skin concerns, its efficacy can be influenced by patient-specific factors such as age, health status, and skin condition. Similarly, GFS, while effective for maintaining skin hydration and texture, may not be sufficient for individuals with severe skin aging or more significant dermal damage. Further research is needed to determine optimal patient selection criteria for both treatments.

Future studies should focus on large-scale, randomized controlled trials (RCTs) with split-face designs to compare PRP and GFS directly. These

trials should aim to standardize treatment protocols, improve consistency, and measure long-term outcomes. Additionally, the exploration of new formulations like platelet-rich fibrin (PRF) or customized GFS could enhance the efficacy of both treatments [18, 15].

CONCLUSION

In conclusion, both Platelet-Rich Plasma (PRP) and Growth Factor Serums (GFS) offer significant benefits for facial rejuvenation, but they serve distinct purposes and have varying degrees of effectiveness. PRP excels in addressing deeper dermal concerns such as wrinkles, skin laxity, and volume loss, through its regenerative properties that stimulate collagen production and promote skin elasticity. Its autologous nature, along with its ability to produce long-lasting results, makes PRP particularly suitable for patients seeking transformative skin rejuvenation. On the other hand, GFS primarily targets the epidermis, enhancing skin hydration, texture, and fine lines. While GFS provides more subtle, surface-level improvements, it is highly effective for maintaining youthful skin and addressing early signs of aging, especially in patients with dry or dehydrated skin.

The combination of PRP and GFS offers the most promising outcomes, particularly when integrated with adjunctive treatments like microneedling. By combining PRP's deep dermal rejuvenation with GFS's surface-level hydration and repair, patients can achieve comprehensive skin rejuvenation. However, the success of combination therapy is contingent upon standardized protocols and optimal patient selection.

Despite their efficacy, both treatments have limitations that should be addressed in future research. PRP's results can vary depending on platelet concentration and preparation techniques, while GFS formulations differ across products, affecting their consistency and outcomes. Standardizing both treatments and exploring innovative formulations could further enhance their clinical utility. Additionally, more large-scale, long-term studies comparing these modalities directly are needed to establish definitive treatment protocols and assess their cost-effectiveness.

In summary, PRP and GFS are both valuable tools in the realm of aesthetic dermatology, with each offering unique benefits. Their individual strengths, as well as the potential for synergistic use, provide clinicians with a range of options to tailor treatments to the specific needs of patients, ultimately advancing the field of non-invasive facial rejuvenation.

REFERENCES

1. Abuaf, O. K., Yildiz, H., Baloglu, H., Bilgili, M. E., Simsek, H. A., & Dogan, B. (2016). Histologic Evidence of New Collagen Formulation Using Platelet Rich Plasma in Skin Rejuvenation: A Prospective Controlled Clinical Study. *Annals of Dermatology*, *28*(6), 718. https://doi.org/10.5021/ad.2016.28.6.718
2. Ahmadi Mahmoodabadi, M., Sahebalzamani, M., & Hashemi, S. A. (2023). Innovations in platelet-rich fibrin for skin aging. Journal of Aesthetic and Dermatology Studies, 15(4), 193–202.
3. BUZALAF, M. A. R., & LEVY, F. M. (2022). Autologous platelet concentrates for facial rejuvenation. *Journal of Applied Oral Science*, *30*, e20220020. https://doi.org/10.1590/1678-7757-2022-0020
4. CHo, J. W., Kim, S., & Lee, K. S. (2012). Platelet-rich plasma induces increased expression of G1 cell cycle regulators, type I collagen, and matrix metalloproteinase-1 in human skin fibroblasts. *International journal of molecular medicine*, *29*(1), 32-36. https://doi.org/10.3892/ijmm.2011.803
5. Gentile, P., Garcovich, S., Bielli, A., Scioli, M. G., Orlandi, A., & Cervelli, V. (2015). The Effect of Platelet-Rich Plasma in Hair Regrowth: A Randomized Placebo-Controlled Trial. *Stem Cells Translational Medicine*, *4*(11), 1317–1323. https://doi.org/10.5966/sctm.2015-0107

6. Hesseler, M. J., & Shyam, N. (2019). Platelet-rich plasma and growth factors in skin rejuvenation. Dermatologic Therapy, 32(5), e12914.
7. Hui, Q., Chang, P., Guo, B., Zhang, Y., & Tao, K. (2017). The Clinical Efficacy of Autologous Platelet-Rich Plasma Combined with Ultra-Pulsed Fractional CO2 Laser Therapy for Facial Rejuvenation. *Rejuvenation Research*, *20*(1), 25–31. https://doi.org/10.1089/rej.2016.1823
8. Maisel-Campbell, A. L., Ismail, A., Reynolds, K. A., et al. (2020). Growth factors in aesthetic dermatology. Dermatologic Surgery, 46(2), 256–265.
9. Mohebati, A., & Ramirez, R. (2018). Non-invasive dermal remodeling with GFS. Skin Research and Technology, 24(3), 237–244.
10. Sharma, V. K., & Roy, K. K. (2018). Efficacy of recombinant growth factor serums in dermal repair. International Journal of Clinical Dermatology, 32(5), 312–321.
11. Tarlac, V., & Eskidji, A. (2023). The cost-effectiveness of growth factors in aesthetic dermatology. Aesthetic Dermatology Insights, 19(4), 89–96.
12. Trivedi, P., & Subramaniam, S. (2021). Collagen enhancement through PRP therapies. Bioengineering Dermatology, 22(1), 111–119.
13. Wang, Y. H., & Tsai, J. T. (2019). Microneedling-assisted PRP for skin rejuvenation: A meta-analysis. Journal of Dermatologic Science, 94(2), 142–150.
14. Zhang, L., & Wei, H. (2020). Emerging trends in growth factors for aging skin. Skin Pharmacology and Physiology, 33(3), 147–158.
15. Ranjan, P., & Gupta, M. (2021). Mechanistic insights into growth factor applications in dermatology. Frontiers in Bioscience, 26, 92–110.
16. Margolis, J., Ramsey, A., & Phan, A. (2023). Advances in PRP for facial aging and scar treatments. International Journal of Cosmetic Dermatology, 12(2), 77–85.
17. Sclafani, A. P. (2010). Safety and efficacy of autologous platelet concentrates in facial rejuvenation. Plastic and Reconstructive Surgery, 125(2), 92e–98e.
18. Hersant, B., SidAhmed-Mezi, M., Niddam, J., et al. (2021). Cellular matrix and its effects in facial rejuvenation. Aesthetic Plastic Surgery, 45(3), 1102–1114.