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A COMPARATIVE STUDY OF EXOSOMES THERAPY AND PLATELET RICH PLASMA IN SKIN REJUVENATION AND ACNE SCAR REMODELLING

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Abstract

Skin rejuvenation and atrophic acne scar remodeling remain important challenges in contemporary dermatology due to their physical, aesthetic, and psychological impacts. Regenerative therapies such as platelet-rich plasma (PRP) and exosome therapy have gained increasing attention because of their potential to stimulate tissue repair, collagen regeneration, and dermal remodeling. However, direct comparative evidence between these treatment modalities remains limited. This study aimed to compare the clinical efficacy, safety, and patient-reported outcomes of PRP and exosome therapy in skin rejuvenation and acne scar remodeling.

A prospective, multicenter, comparative interventional study was conducted involving 40 participants aged 18 to 45 years with hyperpigmentation or atrophic acne scars. Participants received either PRP therapy (n = 24) or exosome therapy (n = 16). Clinical outcomes were assessed using photographic evaluation, scar severity scoring, patient satisfaction questionnaires, and safety monitoring. Data were analysed using SPSS version 26.0 through descriptive statistics, independent sample t-tests, effect size analysis, and chi-square tests.

The study concludes that PRP and exosome therapy are both effective and safe regenerative treatment options for skin rejuvenation and acne scar remodeling. Although exosome therapy represents a promising emerging approach, current evidence suggests comparable clinical performance between the two modalities. Further large-scale randomized studies with longer follow-up periods are recommended to establish long-term efficacy and standardized treatment protocols.

INTRODUCTION

Background of the Study

Skin rejuvenation and control of atrophic scars of acne is a major issue in contemporary dermatology. The aging process, the environment, and skin inflammation are some of the factors that cause the skin to undergo some changes in texture, elastin, and general outlook (1). Severe or prolonged acnes causes atrophic acnes scars that consist of depressions or pits in the skin. The physical appearances are not the only effects of these scars but can cause significant psychological effects. People that have high acne scarring often develop low self-esteem, social anxiety and low body image and that is why there is importance of effective dermatological interventions (2). Traditional methods of skin rejuvenation and scar remodelling involve chemical peels, micro needling, laser treatments and autologous platelet-rich plasma treatments. Chemical peels entail

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regulated exfoliation of the outer skins, which enhance the growth and a smoother feel (3). Micro needling involves the use of fine needles to create regulated micro-injuries which provoke collagen production. The laser treatments, depending on the type, either resurface the skin, or induce dermal remodelling. Platelet-rich plasma therapy has earned credibility because it is an autologous treatment, which promotes tissue repair by releasing growth factors (4).

As far as the platelet-rich plasma is a derivative of the patient blood, it is concentrated with platelets releasing growth factors like platelet-derived growth factor, vascular endothelial growth factor, and transforming growth factor-beta (5). These enhance fibroblast growth, collagen and angiogenesis, which promote skin regeneration and scar healing. PRP has been well researched and found to enhance skin texture, pigmentation spots, and dermal remodelling (6). Exosome therapy is a novel application form of regenerative dermatology, which utilizes the extracellular vesicles that are released by mesenchymal stem cells. The exosomes also carry microRNAs, bioactive proteins that control cell signaling, promote the production of collagen and control the effects of inflammation (7). Exosomes do not use cellular components, unlike PRP, which minimizes the effects of immunogenicity and provides more controlled regenerative capabilities. Preliminary research indicates exosomes would stimulate remodeling of the dermal, increase skin elasticity, and speed up the healing process. The current studies adopt a regenerative focus, but there are not direct comparative studies on PRP and exosome therapy (8). Although the results of both modalities are promising, their comparative effectiveness, influence on collagen remodeling, and patient satisfaction is poorly investigated. This knowledge gap highlights the importance of research that compares these treatments to each other and conducts studies to demonstrate the efficacy of each treatment to guide clinical judgment and achieve maximum patient outcomes (9).

The main keywords that should be used in this study are exosomes, platelet-rich plasma, atrophic acnes scars, and skin rejuvenation. The modern dermatology practice requires the understanding of the tissue regeneration mechanisms and the promises of the advanced therapies.

1.1 Importance of the Study / Significance

The clinical importance of the exosome therapy versus platelet-rich plasma comparison is based on the fact that evidence-based recommendations are required to be provided to dermatologists and patients. When several regenerative modalities can be used, clinicians usually experience confusion over which type of treatment is the most effective when skin rejuvenation and acne scar remodeling are required (10). Comparative assessment of the two therapies will help to give information about their effectiveness, safety, patient-centered outcomes, which will result in more conscious clinical choices. Patient outcomes include a patient-centered outcome, like the enhancement of skin texture, elasticity, pigmentation, and scar depth, which are of critical essence in determining the success of the therapeutic intervention. Also, such aspects as downtime, discomfort associated with the treatment, and patient satisfaction can affect their adherence and value of treatment (11). The comprehensive comparison of these outcomes can help the study to outline the benefits and constraints of each of the therapies both in clinical and patient terms.

Translationally, this study can be used in optimization of dermatological practice and creation of clinical guidelines. Knowledge of the processes in which PRP and exosomes enhance collagen regeneration and dermal remodelling can inform from future interventions and combination therapies. Besides, the research can be used to add to the scientific literature by occupying the gaps associated with comparative efficacy and the biological pathways of such regenerative treatments. The results of this study are applicable to dermatologists, researchers and patients. Evidence-based practices can improve the approach of clinicians, researchers can examine new regenerative pathways, and patients can receive better and more individualized treatment schemes. In general, the purpose of the study is to promote the improvement of patient care, scientific knowledge about regenerative therapies,

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and facilitation of the adoption of innovative treatment methods in everyday dermatology.

Purpose of the Study

This research is mainly to perform comparative analysis of exosome therapy and platelet-rich plasma in skin rejuvenation and atrophic acne scar remodelling. The study is aimed at evaluating various areas of clinical outcomes, such as overall efficacy, collagen regeneration, dermal remodelling, and skin texture, elasticity, pigmentation, scar depth, patient satisfaction, and safety profiles (12). The study will attempt to offer detailed evidence on the comparative benefits and constraints of the two regenerative therapies by conducting a systematic analysis of these factors.

Primary objectives of the study are:

- Compare clinical efficacy of exosome therapy versus platelet-rich plasma.
- Evaluate differences in collagen regeneration and dermal remodeling between the two modalities.
- Compare improvements in skin texture, elasticity, pigmentation, and scar depth.
- Assess patient-reported outcomes, including satisfaction and perceived improvement.
- Compare safety profiles and incidence of adverse effects.
- Analyze biological mechanisms underlying the treatments, focusing on growth factor-mediated effects in PRP and microRNA-mediated signaling in exosome therapy.

The proposed study is meant to produce evidence-based and clinically relevant research that would direct the dermatologists in choosing the most effective regenerative therapy to use on patients with acne scars or aging skin.

Relevance and Applicability of Results

The results of this research are highly applicable in clinical and scientific practice and research in regenerative dermatology (10). A direct comparison of exosome therapy with platelet-rich plasma will allow informing dermatologists about the most effective and safe treatment options in terms of skin rejuvenation and remodeling of acne scars. The evidence-based recommendations of this research will empower medical practitioners to customize the treatment options to suit the needs of individual patients, including skin type, severity of scarring, and desired outcomes (11). The paper has also translational implications in the development of clinical guidelines. The knowledge of the collagen regeneration, dermal remodeling, and patient satisfaction differences between the two treatments can help to design more profound treatment and patient satisfaction regimes. Additionally, the research will be able to point out possible research opportunities, such as new regenerative approaches or combination approaches (2). The extended effects would be patient satisfaction, less downtime in treatment and improved safety in the cosmetic surgery. The findings can be used by not only dermatologists but also researchers, policy-makers and institutions that deal with cosmetic dermatology, whereby they will lead to more effective and patient-centred dermatological care (1).

Although there is an increasing interest in regenerative dermatology as a discipline, the comparative studies on the use of exosome therapy and platelet-rich plasma in skin rejuvenation and remodelling of atrophic acne scars are still lacking significantly. The majority of the current research is concentrated on the results of a single type of treatment which gives little information about their comparative effectiveness (6). Also, even though there is almost a report of clinical improvement, few studies investigate the biological processes underlying it, including whether PRP growth factors can be active or microRNA-mediated signaling during exosome therapy. The knowledge of these mechanisms is vital to treating patients using the most efficient methods and forecasting long-term results. The inadequate literature also does not cover patient-centered outcomes such as satisfaction, perceived improvement, downtime of the treatment, and safety (11). All these factors are also important to consider since treatment adherence and overall success directly depend on perception and tolerance by the patient. Through filling these gaps, the study will produce evidence that will

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compare the clinical effects as well as the mechanistic effects of exosome therapy and platelet-rich plasma (8). It is anticipated that the findings would make a contribution to dermatology literature, evidence-based clinical practice, and guide healthcare providers in choosing safe, effective, and individualized treatments to those who want to achieve skin rejuvenation and the enhancement of acne scars.

Methodology

The study was planned as a prospective, comparative, interventional study to compare the relative efficacy, safety, and patient-reported outcome of platelet-rich plasma and exosome therapy in skin rejuvenation and atrophic acnes scar remodellings. The prospective design was chosen because it allowed the controlled observations of the effects of treatments over the specified time and because it was necessary to observe the sequential changes in the skin texture, collagen regeneration, and scar depth (15). It was considered necessary to have a comparative approach as a direct measure of the differences between the two regenerative modalities and the creation of evidence to support evidence-based clinical decision-making.

Standardized procedures were observed in the PRP and exosome therapy, since the study was interventional; thereby, ensuring that the same procedures were performed on all the participants. The use of various centers to conduct the research also created a stronger generalizability of the results by allowing the introduction of a wide range of patients and access to the specialized facilities necessary not only to make PRP but also to introduce the exosomes. It was also easy to standardize the dermatological assessment and the procedure techniques in the multicenter approach, which minimized variability in outcome measures (11).

The chapter 3 provides a description of the methodology. The setting and the study design are described and the time of study is provided. Data collection procedures, population, and sampling, and interventions are described. Ethics and the data analysis plan are also provided and they give a holistic picture on how the study is to be carried out.

Study Design and Setting

It was a prospective, comparative, interventional prospective study in patients who showed clinical evidence of hyperpigmentation or atrophic acne scars. The prospective nature of the design was suitable in the systematic assessment of the overall treatment effects through time and the comparative method used enabled a direct comparison of PRP and exosome therapy (7). Participants were assigned to treatment groups according to clinical feasibility and treatment availability at the participating centers. Although the distribution across groups was not equal, standardized treatment protocols and assessment criteria were applied to maintain consistency between groups.

The study was conducted in a multicenter environment comprising two centers that specialize in dermatology and have all the facilities required during the preparation and injection of PRP and exosomes therapy. Site A contained a dermatology clinic and PRP preparation laboratory, whereas Site B contained a stem cell laboratory and exosomes preparation facilities. Heterogeneous population of patients (the multicenter design guaranteed) provided the possibility of extending the findings to a broader group of patients and provided the effectiveness of the study procedures across different study sites (6).

The study received an ethical approval by the institutional review boards in the centers that were involved. The informed consent was written by all the participants who were served with elaborate explanations of the study goals, procedures, risks and expected outcomes. Respondents were guaranteed confidentiality, and they were told that they could leave the research any time without any consequences (21). This strict ethical code allowed to guarantee compliance with the international requirements regarding human research and to avoid harming the subjects, preserving the scientific quality of the research.

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Study Duration

This research took place in a period of four months. The recruitment and the baseline assessments of the patients took place during the first month. PRP interventions alongside exosome therapy were incorporated in the first two months and systematic follow-up interventions at the end of the second and third months in order to track clinical outcome, patient satisfaction, and safety parameters. The interpretation and data analysis were done in the fourth month. Such a systematic schedule provided sufficient observation of the short-term therapeutic outcomes and the possibility of the overall assessment of the clinical and patient-reported outcomes.

Population and Sampling

Study Population

The group of 40 patients with clinical evidence of hyperpigmentation or atrophic acne scars was used as a study population. It included both male and female participants between the ages of 18 and 45 years. The two centers were used to recruit participants in the dermatology departments, where participants had to be conveniently located to satisfy the inclusion criteria (19). Demographical variables such as age, gender, and the initial skin features were documented to describe the study population and enable them to stratify in the analysis of outcomes.

Sampling Technique

The sampling was done using consecutive method where all the patients who were in the study area within the study period were invited to take part. It was selected as it is practical in interventional dermatology research and it helps to reduce selection bias. The study has incorporated all qualified patients in order and prevented the selective approach of enrolling them, which would have led to poor sample representation of the target population (16) Group allocation depended on treatment availability and participant eligibility during recruitment, which resulted in variation in group size between the two intervention arms.

Sample Size and Group Allocation

The study involved a total sample of 40 participants recruited from the selected dermatology centers. Participants were allocated into two treatment groups based on the intervention received. The platelet-rich plasma (PRP) therapy group consisted of 24 participants, whereas the exosome therapy group included 16 participants. Although the allocation was not equal, both groups were exposed to similar treatment conditions, follow-up schedules, and assessment procedures to ensure comparability of outcomes. The selected sample size was considered appropriate for an exploratory comparative interventional study aimed at evaluating differences in clinical efficacy, patient satisfaction, scar remodeling, and safety outcomes between the two regenerative treatment modalities.

Inclusion and Exclusion Criteria

It would be essential to define the inclusion and exclusion criteria so that the study population is relevant to assessing the comparative effectiveness of PRP and exosome therapy in skin rejuvenation and atrophic acnes scar remodelling (23). The criteria provide safety of participants, relevance of data collected, and validity of results of the study.

Inclusion Criteria

The individuals who were to participate in the study needed to satisfy the following requirements:

1. Dermatological examination proved cases of hyperpigmented or atrophic acnes scars.
2. 18-45 years of age range to focus on adults who have the potential to regenerate their skin.
3. The readiness to receive PRP/exosome therapy and follow up assessment throughout the study.

Exclusion Criteria

The participants were not included in case they fell under the following conditions:

1. PRP application in non-dermatological applications, like orthopedic or dental.
2. Active infections or dermatological conditions, which contradicted the intervention.
3. Pregnancy or lactation because safety was a concern.

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4. Past history of allergic response to any constituent of the interventions.

Table 1 Summary of Eligibility Criteria

Criteria Type	*Description*
Inclusion	Age 18–45, hyperpigmentation or atrophic acne scars, willingness to participate
Exclusion	Non-dermatologic PRP use, active infection, pregnancy, allergies

The criteria were used to make sure that the participants chosen were appropriate to assessing the clinical outcomes as well as patient-reported effects without compromising the integrity of the studies or the safety of the participants.

Intervention Procedures

Two different regenerative procedures platelet-rich plasma (PRP) and exosome were used in the study as two separate intervention methods under controlled conditions to compare their effectiveness in rejuvenating the skin and remodeling atrophic acne scars.

Platelet-Rich Plasma (PRP) Therapy

PRP therapy used is the autologous accumulation of blood of the patient which is centrifuged to extract platelets and growth factors. Each participant was sampled with about 20 mL of blood and a two-step centrifugation procedure was adopted with the aim of reaching a platelet concentration of 4-6 times normal. Calcium chloride was then used to activate the PRP before the administration (28).

Affected areas were treated with intradermal injections via a 30-gauge needle at a depth of 1-2 mm and on either a weekly or biweekly schedule based upon the needs of the specific patient. In some chosen cases, microneedling was done to increase penetration of PRP and to induce further collagen formation. To make sure that the sessions were safe and tolerable, clinical monitoring was carried out at the time of each session and afterward (32).

Exosome Therapy

Exosome therapy was done through extracellular vesicles that were produced by mesenchymal stem cells. The exosomes were developed in special labs, and they were purified, sterile and preserved the active microRNA content. Exosomes were stored under regulated conditions and processed in regard with the laid down procedures before administration (37).

PRP Like in intradermal injections, the topography of the skin aging and acne scar were targeted. The frequency of treatment was a weekly or biweekly treatment. Exosomes were selected due to their modulation of gene expression by the microRNA signaling mechanism, facilitation of paracrine communication, alleviation of inflammation, and promotion of tissue regeneration (41). This method has the potential to have several benefits over conventional treatments, the better organization of collagen, long-term remodeling of the skin and the low level of immunogenicity.

Table 2 Comparison of Intervention Protocols

Parameter	PRP Therapy	Exosome Therapy
Source	Autologous blood	MSC-derived exosomes
Mechanism	Growth factor release	MicroRNA signaling
Administration	Intradermal injections	Intradermal injections
Frequency	Weekly / Biweekly	Weekly / Biweekly

These standardized intervention regimens provided uniformity among the subjects and sites with which the clinical outcome, collagen regeneration, patient satisfaction and safety profiles could be easily compared. The two therapies were carefully observed concerning the

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adverse events and the patients were advised on the expected outcomes, post-procedure measures and follow up schedules.

Data Collection Methods

Systematic collection of data was done to measure the clinical outcomes, patient-reported experiences, and safety profiles of platelet-rich plasma and exosome therapy. Similarity was achieved in the two treatment groups and the multicenters through the use of standardized procedures. Clinical and photographic examination, patient-reported outcome measures, and continuous safety real-time monitoring were included in the data collection process.

Clinical and Photographic Assessment

Baseline, mid-treatment and post-treatment, clinical review of skin rejuvenation and acne scar remodeling were conducted. The appearance of the skin was recorded under standardized lighting, angle and camera settings by use of standardized photographs. Important measures were the skin texture, pigmentation, elasticity and the depth of the scar. In the case of acne scars, the Goodman-Baron scale was the one used to measure the severity and the changes with time. The comparison of pre- and post-intervention outcomes could be conducted objectively based on photographic evidence which could be used to obtain a visual record to verify the quantitative scoring (44).

Patient-Reported Outcomes

The patient experiences and satisfaction were recorded in a systematic fashion by use of structured questionnaires filled at the end of each treatment session. The subjects noted perceived changes in terms of skin appearance, comfort in the process, post-treatment downtime and overall satisfaction (42). These subjective scales added to the clinical measurements and gave data on patient-centered outcomes, which in dermatological treatment are important because the level of aesthetic perception is one of the key areas in patient evaluation.

Safety Assessment

Constant safety observation was made during the research. A standardized adverse event checklist was used to record any adverse events such as erythema, swelling, bruising, infection, or any other unforeseen complication. A follow-up was regular to detect and manage any risk associated with the treatment on time, which was also used in the overall review of the tolerability and safety profiles of PRP and exosome therapy (35).

Table 3 Data Collection Instruments

Outcome Type	Instrument / Method	Timing
Skin texture	Photographic evaluation	Baseline, Month 2, Month 4
Scar depth	Goodman-Baron scale	Baseline, Month 2, Month 4
Patient satisfaction	Survey questionnaire	After each session
Safety	Adverse event checklist	Continuous monitoring

It is a predetermined approach to data gathering that allows the full evaluation of the objective and subjective outcomes that would ensure that the research could potentially address the questions on the comparative efficacy, safety and patient satisfaction of PRP and exosome treatment.

Data Analysis Procedure

The data was analyzed using SPSS version 26.0, to give strict statistical analysis of the clinical, mechanistic, and patient-reported results of platelet-rich plasma and exosome therapy. In summarizing the quantitative variables that comprised of the age, body mass index, skin texture scores as well as scar depth measurements, the means and standard deviations were employed (31). Frequencies and percentages were given in terms of categorical variables like gender distribution, prevalence of adverse effects and patient satisfaction rates.

To evaluate differences in clinical outcomes and patient-reported experiences, the two treatment

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groups were compared to examine their difference in terms of clinical results. Continuous variables were under independent t-test or Mann-Whitney U test analysis based on the normality of the data distribution. The chi-square tests were used to assess the statistically significant relationships between the type of treatment and outcome measures (31). A p-value of ≤ 0.05 was taken as significant difference and revealed that PRP and exosome therapy had significant differences. Missing data management was done through the Last Observation Carried Forward approach. It was a way of minimizing bias as it imputed the final available observation in case of participants whose follow-up data were not complete, and preserved the integrity of comparative analyses (22).

Tables, charts, and comparative mean plots have been used to present results as they would be clearly visualised in order to understand the difference among the treatment groups. Tables gave exact numerical information, whereas charts depicted patterns and the changes in the results with time. The magnitude of the improvement in the skin texture, pigmentation, elasticity, scar depth, and patient satisfaction was plotted in comparative means to support the holistic interpretation of the objective and subjective results.

Table 4 Statistical Analysis Plan

Data Type	Statistical Method	Significance Level
Continuous	Mean ± SD, t-test	$p \leq 0.05$
Categorical	Frequency, chi-square	$p \leq 0.05$
Missing Data	LOCF	N/A
Comparative Plots	Bar / line graphs	N/A

This framework of structured analysis was necessary in order to help the study be capable of evaluating the comparative efficacy, safety and patient-centered outcomes of PRP and exosode therapy in a statistically robust manner.

Results, Findings and Discussion

This chapter presents the statistical results obtained from the analysis conducted using IBM SPSS Statistics, followed by the interpretation of findings and their discussion in relation to existing literature on regenerative dermatology. The analysis focuses on comparing two treatment groups, namely platelet-rich plasma therapy and exosome therapy, in a total sample of 40 participants. The study evaluates clinical outcomes, patient-reported improvement, and safety profiles across both groups using a structured statistical approach. Independent sample t-tests were applied to assess differences in continuous variables such as physician-rated improvement, patient-reported improvement, and final severity scores, while chi-square tests were used to examine associations in categorical variables such as treatment outcomes and adverse events. In addition, effect size analysis was conducted using Cohen's d to determine the magnitude of differences between the two treatment modalities beyond statistical significance. The results are presented in a systematic manner, beginning with descriptive statistics, followed by inferential analysis and interpretation of findings. The purpose of this chapter is not only to report statistical outcomes but also to critically evaluate whether observed differences hold clinical relevance in the context of skin rejuvenation and acne scar remodelling. This chapter evaluates whether significant differences exist between PRP and exosome therapy in terms of clinical outcomes, patient satisfaction, and safety.

Demographic and Group Overview

The study included a total of 40 participants who were divided into two treatment groups based on the intervention received. The platelet-rich plasma group consisted of 24 participants, while the exosome therapy group included 16 participants. Although the distribution is not perfectly equal, the allocation still allows for meaningful

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comparative analysis between the two treatment modalities. The sample size is considered adequate for an exploratory clinical study, particularly within dermatological research where interventional studies often involve moderate sample sizes due to practical and ethical constraints. The inclusion of both male and female participants within the defined age range further supports the representativeness of the sample.

The grouping of participants into PRP and exosome therapy enables a direct comparison of regenerative approaches under controlled conditions. Despite the difference in group sizes, statistical techniques such as independent t-tests account for unequal sample distributions, ensuring valid comparisons between groups. The study design ensures that both groups were exposed to similar clinical conditions, follow-up duration, and assessment criteria, which enhances the internal validity of the results.

Furthermore, the multicenter nature of the study contributes to external validity and generalizability of findings. Data collection from more than one clinical setting reduces the likelihood of location-specific bias and ensures that results are not dependent on a single practitioner or facility. This increases the applicability of findings across broader dermatological practice. Although a larger sample size would improve statistical power, the current sample remains sufficient to identify trends, compare outcomes, and generate meaningful insights into the comparative effectiveness of PRP and exosome therapy. Therefore, the study design provides a reasonable balance between feasibility and scientific rigor for evaluating regenerative dermatological treatments.

Descriptive Statistics

Descriptive statistics were used to summarize the central tendencies and variability of key outcome variables, including physician-rated improvement, patient-reported improvement, and final severity score. These measures provide an initial understanding of differences between platelet-rich plasma and exosome therapy before conducting inferential analysis.

Physician Improvement

The mean physician-rated improvement score for the platelet-rich plasma group was 50.83 with a standard deviation of 23.616, while the exosome therapy group had a mean score of 46.38 with a standard deviation of 20.704. This indicates that, on average, participants receiving PRP therapy showed slightly higher clinical improvement as assessed by physicians compared to those receiving exosome therapy. However, the relatively large standard deviations in both groups suggest considerable variability in responses within each treatment group. This variation may be attributed to differences in baseline skin conditions, severity of acne scars, or individual biological responses to treatment. Despite PRP demonstrating a higher mean value, the difference between the two groups is not substantial, indicating that both therapies produce comparable levels of physician-observed improvement.

Patient Improvement

In terms of patient-reported outcomes, the PRP group had a mean improvement score of 49.67 with a standard deviation of 24.279, whereas the exosome therapy group reported a mean score of 46.50 with a standard deviation of 26.422. Similar to physician-rated outcomes, PRP shows a marginally higher average improvement compared to exosome therapy. However, the difference between the two groups remains small and is accompanied by high variability, particularly in the exosome group. This suggests that while some patients may experience significant benefits, others may show moderate or limited improvement regardless of the treatment type. The close proximity of mean values indicates that patient perception of improvement is relatively similar between both therapies, reinforcing the idea that both interventions are effective in enhancing skin appearance and reducing acne scars from the patient's perspective.

Final Severity Score

The final severity score, which reflects the post-treatment condition of acne scars, showed a mean value of 5.21 for the PRP group and 4.63 for the exosome therapy group. Since a lower severity

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score indicates better clinical outcome, exosome therapy demonstrates a slight advantage in reducing scar severity. The standard deviations for PRP and exosome groups were 1.817 and 2.029 respectively, indicating moderate variability in outcomes. Although exosome therapy appears to produce slightly better results in terms of scar reduction, the difference remains relatively small and does not suggest a strong superiority of one treatment over the other.

Overall, the descriptive statistics indicate that platelet-rich plasma therapy shows marginally higher improvement scores in both physician and patient assessments, whereas exosome therapy demonstrates slightly better outcomes in reducing final scar severity. However, the differences across all variables are minimal, suggesting that both treatments are broadly comparable in effectiveness. This initial observation highlights the need for inferential statistical testing to determine whether these differences are statistically significant or occur due to random variation.

Inferential Analysis (T-Test Results)

Inferential statistical analysis was conducted using independent sample t-tests to determine whether statistically significant differences existed between platelet-rich plasma and exosome therapy across key outcome variables, including physician improvement, patient improvement, and final severity score. Prior to conducting the t-tests, Levene's test for equality of variances was examined to assess homogeneity assumptions. For physician improvement, Levene's test indicated no significant difference in variances ($F = 0.217$, $p = 0.644$), confirming that the assumption of equal variances was satisfied. The independent sample t-test showed a t-value of 0.614 with 38 degrees of freedom and a p-value of 0.543. The mean difference between the two groups was 4.458 with a standard error difference of 7.266, and the 95% confidence interval ranged from -10.250 to 19.167. Since the p-value exceeds the threshold of 0.05 and the confidence interval includes zero, the result indicates that there is no statistically significant difference between PRP and exosome therapy in terms of physician-rated improvement.

A similar pattern was observed in patient-reported improvement outcomes. Levene's test again confirmed equality of variances ($F = 0.319$, $p = 0.576$). The t-test results showed a t-value of 0.390 with 38 degrees of freedom and a p-value of 0.699. The mean difference was 3.167 with a standard error of 8.116, and the 95% confidence interval ranged from -13.263 to 19.597. The wide confidence interval and inclusion of zero further confirm that there is no statistically significant difference between the two treatment groups in terms of patient-perceived improvement. These findings indicate that although PRP demonstrated slightly higher mean scores, the observed difference is not statistically meaningful.

For the final severity score, Levene's test also indicated no violation of variance equality ($F = 0.617$, $p = 0.437$). The independent sample t-test produced a t-value of 0.949 with 38 degrees of freedom and a p-value of 0.348. The mean difference was 0.583 with a standard error of 0.614, and the 95% confidence interval ranged from -0.660 to 1.827. Despite exosome therapy showing a lower mean severity score, suggesting slightly better clinical improvement, the statistical analysis confirms that this difference is not significant. The inclusion of zero within the confidence interval further reinforces that the variation between the two treatments could be attributed to random variation rather than a true difference in effectiveness.

Overall, the inferential analysis demonstrates that there are no statistically significant differences between platelet-rich plasma and exosome therapy across all evaluated clinical outcomes. Although PRP shows marginally higher improvement scores and exosome therapy demonstrates slightly better severity reduction, these differences are not statistically supported. This suggests that both treatments perform similarly in clinical practice. The consistency of non-significant results across all variables, combined with confidence intervals crossing zero, provides strong statistical evidence that both therapies are equally effective in skin rejuvenation and acne scar remodelling.

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Effect Size Analysis

Effect size analysis was conducted using Cohen's d, Hedges' correction, and Glass's delta to evaluate the magnitude of differences between platelet-rich plasma and exosome therapy beyond statistical significance. For physician improvement, Cohen's d was calculated as 0.198, with a 95% confidence interval ranging from -0.437 to 0.831. Hedges' correction produced a similar value of 0.194, while Glass's delta was slightly higher at 0.215. These values indicate a small effect size, suggesting that although PRP demonstrated a higher mean improvement score, the practical difference between the two treatments is minimal.

In the case of patient improvement, Cohen's d was 0.126 with a confidence interval between -0.508 and 0.758. Hedges' correction yielded a value of 0.123, and Glass's delta was 0.120. These results again indicate a small effect size, confirming that the difference in patient-reported improvement between PRP and exosome therapy is negligible. The confidence intervals crossing zero further reinforce the lack of meaningful difference in treatment effectiveness.

For the final severity score, Cohen's d was slightly higher at 0.306, with a confidence interval ranging from -0.332 to 0.941. Hedges' correction and Glass's delta were calculated as 0.300 and 0.288 respectively. Although this represents a small to moderate effect size, it still indicates limited practical significance. The slightly higher effect size for severity score suggests that exosome therapy may have a marginal advantage in reducing scar severity; however, the difference remains insufficient to establish clinical superiority.

Overall, all effect size measures across the three variables fall within the small range, indicating that the magnitude of difference between platelet-rich plasma and exosome therapy is minimal. Although minor numerical differences were observed, the small effect sizes indicate that these differences have limited clinical significance. This supports the conclusion that both therapies provide comparable outcomes in practice and that neither treatment demonstrates a meaningful advantage over the other in terms of effectiveness.

T-Test

Group Statistics

	TreatmentGroup	N	Mean	Std. Deviation	Std. Error Mean
PhysicianImprovment	1	24	50.83	23.616	4.821
	2	16	46.38	20.704	5.176
PatientImprovment	1	24	49.67	24.279	4.956
	2	16	46.50	26.422	6.606
Finalseverityscore	1	24	5.21	1.817	.371
	2	16	4.63	2.029	.507

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PhysicianImprovment	Equal variances assumed	.217	.644	.614	38	.543	4.458	7.266	-10.250	19.167

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	Equal variances not assumed			.630	35.090	.533	4.458	7.073	-9.899	18.816
PatientImprovment	Equal variances assumed	.319	.576	.390	38	.699	3.167	8.116	-13.263	19.597
	Equal variances not assumed			.383	30.365	.704	3.167	8.258	-13.690	20.023
Finalseverityscore	Equal variances assumed	.617	.437	.949	38	.348	.583	.614	-.660	1.827
	Equal variances not assumed			.928	29.780	.361	.583	.628	-.700	1.867

Independent Samples Effect Sizes

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
PhysicianImprovment	Cohen's d	22.511	.198	-.437	.831
	Hedges' correction	22.968	.194	-.429	.814
	Glass's delta	20.704	.215	-.425	.849
PatientImprovment	Cohen's d	25.147	.126	-.508	.758
	Hedges' correction	25.657	.123	-.498	.743
	Glass's delta	26.422	.120	-.516	.752
Finalseverityscore	Cohen's d	1.904	.306	-.332	.941
	Hedges' correction	1.942	.300	-.325	.922
	Glass's delta	2.029	.288	-.358	.924

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

Chi-Square Analysis (Outcome Comparison)

Chi-square tests were conducted to examine the association between treatment type and categorical outcomes, including final treatment outcome and adverse events. For final outcome distribution, the crosstabulation showed that in the PRP group, 8 participants were in category 1, 8 in category 2, 5 in category 3, and 3 in category 4, while in the exosome therapy group, 4 participants were in category 1, 4 in category 2, 6 in category 3, and 2 in category 4. The Pearson chi-square value was 1.414 with 3 degrees of freedom and a p-value of 0.702. The likelihood ratio test also supported this result with a value of 1.400 and a p-value of 0.706. Since the p-value is greater than 0.05, there is no statistically significant association between treatment type and final outcome.

Further analysis using symmetric measures showed that Cramer's V was 0.188, indicating a weak relationship between treatment group and

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outcome category. This suggests that the distribution of outcomes is largely independent of the treatment modality used. Although there are slight variations in frequencies across categories, these differences are not statistically meaningful.

For adverse events, the crosstabulation revealed varied distributions across five categories. In the PRP group, frequencies were 3, 4, 5, 4, and 8 respectively, while in the exosome therapy group, the frequencies were 3, 6, 1, 4, and 2. The Pearson chi-square value was 5.278 with 4 degrees of freedom and a p-value of 0.260, indicating no statistically significant difference between the two groups in terms of adverse events. The likelihood ratio value of 5.558 with a p-value of 0.235 further confirms this finding. Cramer's V was calculated as 0.363, suggesting a moderate but statistically insignificant relationship.

These results indicate that both therapies demonstrate comparable safety profiles, with no statistically significant difference in adverse event distribution. The absence of significant associations in both outcome and safety variables reinforces the conclusion that platelet-rich plasma and exosome therapy perform similarly not only in effectiveness but also in patient safety.

Chi-Square Test

TreatmentGroup * Finaloutcome Crosstabulation

Count

		Finaloutcome				
		1	2	3	4	Total
TreatmentGroup	PRP	8	8	5	3	24
	Exosomes Therapy	4	4	6	2	16
Total		12	12	11	5	40

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.414[a]	3	.702
Likelihood Ratio	1.400	3	.706
Linear-by-Linear Association	.571	1	.450
N of Valid Cases	40		

a. 5 cells (62.5%) have expected count less than 5. The minimum expected count is 2.00.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.188	.702
	Cramer's V	.188	.702
N of Valid Cases		40	

Chi-Square Test

TreatmentGroup * Adverseevent Crosstabulation

Count

	Adverseevent					
	1	2	3	4	5	Total

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TreatmentGroup	PRP	3	4	5	4	8	24
	Exosomes Therapy	3	6	1	4	2	16
Total		6	10	6	8	10	40

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.278[a]	4	.260
Likelihood Ratio	5.558	4	.235
Linear-by-Linear Association	2.052	1	.152
N of Valid Cases	40		

a. 8 cells (80.0%) have expected count less than 5. The minimum expected count is 2.40.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.363	.260
	Cramer's V	.363	.260
N of Valid Cases		40	

Summary of Key Findings

The overall findings of the study indicate that there is no statistically significant difference between platelet-rich plasma and exosome therapy across all evaluated variables. Descriptive statistics showed that PRP demonstrated slightly higher physician and patient improvement scores, while exosome therapy showed marginally better reduction in final severity scores. However, inferential analysis confirmed that these differences are not statistically significant, as all p-values exceeded the threshold of 0.05. Effect size analysis further supported this conclusion, with all values falling within the small range, indicating minimal practical differences between the two treatments. Chi-square analysis also revealed no significant association between treatment type and outcome categories or adverse events, confirming that both therapies have comparable safety and effectiveness profiles. Overall, the results suggest that both platelet-rich plasma and exosome therapy are clinically effective and comparable regenerative treatments for skin rejuvenation and acne scar remodelling.

Discussion

The findings of this study provide important insights into the comparative effectiveness of platelet-rich plasma and exosome therapy within the field of regenerative dermatology. The results demonstrate that there is no statistically significant difference between the two treatment modalities in terms of physician improvement, patient-reported outcomes, and final severity scores. These findings are consistent with the literature discussed in Chapter 2, where both therapies were identified as effective approaches for skin rejuvenation and acne scar remodelling, albeit through different biological mechanisms. Platelet-

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rich plasma operates primarily through the release of growth factors such as platelet-derived growth factor, transforming growth factor-beta, and vascular endothelial growth factor, which stimulate fibroblast activity, collagen synthesis, and angiogenesis. This mechanism is often associated with relatively rapid clinical improvements, particularly in skin texture and early scar remodelling.

In contrast, exosome therapy relies on microRNA-mediated signaling and paracrine communication, which regulate gene expression and promote controlled tissue regeneration. The literature suggests that this mechanism may lead to more sustained and structured dermal remodelling over time. The current study supports these theoretical differences, as PRP demonstrated slightly higher mean improvement scores, while exosome therapy showed marginally better outcomes in reducing final severity scores. However, the absence of statistically significant differences indicates that neither treatment demonstrates clear superiority. This aligns with the identified research gap in Chapter 2, where a lack of direct comparative studies made it difficult to establish definitive conclusions regarding the relative effectiveness of these therapies. The present findings contribute to this gap by providing empirical evidence that both treatments are comparably effective, reinforcing the idea that regenerative therapies may achieve similar clinical outcomes through different biological pathways.

Biological Interpretation

The observed results can be further understood through the biological mechanisms underlying each treatment modality. Platelet-rich plasma therapy is known for its rapid release of concentrated growth factors upon activation, which immediately stimulate cellular processes involved in wound healing and tissue regeneration. This explains why PRP showed slightly higher mean scores in both physician-rated and patient-reported improvement. The immediate availability of growth factors accelerates fibroblast proliferation and collagen deposition, leading to visible improvements in skin texture and elasticity within a relatively short period.

On the other hand, exosome therapy functions through a more controlled and regulated mechanism. Exosomes deliver microRNAs and bioactive molecules that influence gene expression in target cells, promoting long-term dermal remodelling and reducing inflammation. This mechanism supports gradual but sustained improvements, which may explain why exosome therapy demonstrated slightly better outcomes in final severity scores. The lower severity scores suggest more effective structural reorganisation of the dermal matrix, even if the visible improvement is not immediately pronounced.

The lack of statistically significant differences between the two treatments suggests that both biological pathways ultimately converge in producing similar clinical outcomes. While PRP may provide faster initial improvements, exosome therapy may contribute to more stable and long-term regeneration. This complementary nature highlights the potential for future research to explore combination therapies that integrate both mechanisms to maximise treatment outcomes.

Clinical Implications

The findings of this study have important implications for clinical practice in dermatology. Since no statistically significant difference was observed between platelet-rich plasma and exosome therapy, clinicians have the flexibility to choose either treatment based on practical considerations rather than strict efficacy differences. This is particularly valuable in real-world settings where treatment decisions are influenced by multiple factors beyond clinical outcomes.

One of the key factors influencing treatment choice is patient preference. Some patients may prefer PRP due to its autologous nature, as it uses the patient's own blood and is perceived as a more natural treatment. Others may prefer exosome therapy due to its less invasive nature and absence of blood extraction. Cost is another critical factor, as exosome therapy is often more expensive due to advanced laboratory processing and sourcing of extracellular vesicles. Availability also plays a significant role, as PRP is widely accessible in most dermatology clinics, whereas exosome therapy may

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require specialised facilities and regulatory approval.

The results suggest that clinicians can tailor treatment plans based on individual patient needs, expectations, and resource availability without compromising treatment effectiveness. This supports a patient-centred approach to dermatological care, where treatment decisions are personalised rather than standardised.

Patient Perspective

From the patient perspective, the findings indicate that both platelet-rich plasma and exosome therapy provide comparable levels of satisfaction and perceived improvement. The descriptive statistics showed only minor differences in patient-reported outcomes, and inferential analysis confirmed that these differences were not statistically significant. This suggests that patients undergoing either treatment are likely to experience similar levels of satisfaction with the results.

Another important consideration is treatment downtime and comfort. Both therapies are minimally invasive and associated with relatively low recovery periods compared to conventional treatments such as laser resurfacing or deep chemical peels. Although PRP involves blood extraction and intradermal injections, it remains well tolerated by most patients. Exosome therapy, on the other hand, may offer slightly greater comfort due to the absence of blood collection and its less invasive delivery approach.

These factors highlight the importance of patient experience in treatment selection. Since both therapies yield similar clinical outcomes, aspects such as comfort, convenience, and personal preference become key determinants in decision-making. This reinforces the need for clinicians to involve patients in the decision process and provide clear information about the benefits and limitations of each treatment option.

Safety Interpretation

The safety analysis conducted in this study indicates that both platelet-rich plasma and exosome therapy have favourable safety profiles. The chi-square test results showed no statistically significant difference in the distribution of adverse events between the two groups, with a p-value of 0.260. This suggests that both treatments are equally safe and well tolerated by patients.

Platelet-rich plasma is generally considered safe due to its autologous nature, which minimises the risk of immune reactions and disease transmission. Minor side effects such as erythema, swelling, and bruising are typically transient and resolve without complications. Exosome therapy also demonstrated a strong safety profile, with low incidence of adverse events and no evidence of serious complications. The cell-free nature of exosomes reduces the risk of immunogenicity and eliminates concerns associated with stem cell transplantation.

The absence of significant safety differences between the two treatments supports their use in clinical practice and reinforces the role of regenerative therapies in dermatology. Both modalities provide effective and safe alternatives to traditional treatments, with the potential to improve patient outcomes while minimising risks. This finding aligns with existing literature, which highlights the growing acceptance of regenerative approaches as safe and innovative solutions for skin rejuvenation and scar management.

Critical Evaluation of Findings

While the findings of this study provide valuable insights into the comparative effectiveness of platelet-rich plasma and exosome therapy, several limitations must be acknowledged. One of the primary limitations is the relatively small sample size of 40 participants. Although sufficient for preliminary analysis, a larger sample size would increase statistical power and improve the ability to detect subtle differences between treatment groups. The absence of statistically significant results may partly be attributed to limited sample size rather than complete equivalence of treatments.

The study duration of four months represents another limitation. Skin regeneration and scar remodelling are long-term processes, and a longer follow-up period would provide a more comprehensive understanding of treatment effectiveness. It is possible that differences

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between PRP and exosome therapy may become more apparent over extended periods, particularly given the long-term regenerative potential associated with exosome therapy.

Additionally, the lack of long-term follow-up data restricts the ability to assess the دوام of treatment outcomes. Without extended monitoring, it is difficult to determine whether improvements are sustained or diminish over time. Another limitation relates to the chi-square analysis, where several cells had expected counts less than five. This violates one of the assumptions of the chi-square test and may affect the reliability of the results.

Although the results indicate no significant differences, the small sample size may limit statistical power. Despite these limitations, the study provides a structured and controlled comparison of two emerging therapies and offers a foundation for future research. Larger-scale studies with longer follow-up periods and more robust statistical designs are recommended to validate and extend these findings.

Conclusion

This chapter presented the statistical analysis, findings, and discussion of the comparative study between platelet-rich plasma and exosome therapy in skin rejuvenation and acne scar remodelling. The results demonstrated that there are no statistically significant differences between the two treatment modalities across clinical outcomes, patient-reported improvement, and safety profiles. Although minor variations were observed, with PRP showing slightly higher improvement scores and exosome therapy demonstrating marginally better severity reduction, these differences were not statistically or clinically significant.

Both therapies were found to be effective in improving skin texture, reducing acne scar severity, and enhancing overall patient satisfaction. The safety analysis confirmed that both treatments are well tolerated, with no significant difference in adverse events. These findings highlight the comparable nature of the two regenerative approaches and support their use in clinical dermatology.

This chapter presents the conclusion and recommendations derived from the comparative evaluation of platelet-rich plasma (PRP) therapy and exosome therapy in skin rejuvenation and acne scar remodeling. The study investigated the effectiveness, safety profile, and regenerative potential of both minimally invasive therapeutic approaches in aesthetic dermatology. Due to increasing interest in regenerative skin therapies, comparative evidence remains clinically valuable for treatment decision-making (4,11). This chapter summarizes the major findings, discusses their implications, highlights study limitations, and provides recommendations for clinical practice and future research.

Summary of Key Findings / Conclusion of Study

The first objective of this study was to compare the effectiveness of PRP therapy and exosome therapy in skin rejuvenation and acne scar remodeling. Based on physician-rated improvement and patient satisfaction outcomes, both therapies demonstrated measurable clinical benefits. However, statistical analysis revealed no significant difference between the treatment groups, despite slight numerical variations favoring PRP in some physician-rated outcomes and exosome therapy in certain severity reduction measures. These findings suggest that although statistical superiority was not established, small clinical differences may still hold practical relevance in aesthetic dermatology, where patient perception and gradual cosmetic enhancement remain important considerations (7,14).

The second objective examined acne scar remodeling and regenerative improvement following both interventions. The findings indicated that PRP and exosome therapy demonstrated similar regenerative effects, particularly regarding skin texture improvement and scar appearance. A possible explanation for these comparable findings lies in the overlapping regenerative mechanisms of both therapies. PRP promotes collagen synthesis and fibroblast activation through growth factors, whereas exosomes facilitate tissue repair via intercellular signaling and bioactive molecular transfer (12,18). Despite differences in biological pathways, both

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interventions ultimately contribute to dermal remodeling and skin regeneration, which may explain the closely aligned treatment outcomes observed in this study.

The third objective focused on evaluating treatment safety and adverse events. The results demonstrated that both therapies were generally well tolerated, with only minor and temporary adverse effects reported. Common reactions included bruising, erythema, mild swelling, and temporary discomfort at the treatment site, all of which resolved without major clinical complications. No severe adverse reactions were identified, supporting the view that both PRP and exosome therapy can be considered relatively safe minimally invasive regenerative procedures (5,19). Given the increasing preference for non-surgical cosmetic interventions, these findings reinforce the practical relevance of regenerative dermatology approaches for acne scar management and skin rejuvenation.

Overall, the study successfully achieved its research objectives by providing a comparative assessment of PRP therapy and exosome therapy in acne scar remodeling and skin rejuvenation. Although no statistically significant superiority was established between the interventions, both treatment modalities demonstrated encouraging regenerative potential and acceptable patient satisfaction outcomes. Importantly, the absence of statistical significance should not be interpreted as evidence of no therapeutic effect, as the relatively small sample size may have limited statistical power and increased the possibility of a Type II error (9,16). Therefore, while both therapies appear clinically promising, larger comparative investigations are required before definitive conclusions regarding treatment superiority can be established.

Clinical and Scientific Implications

The findings of this study have important implications for dermatologists, cosmetic physicians, and practitioners involved in regenerative dermatology. PRP therapy remains a practical treatment option because of its relatively lower cost, accessibility, and autologous nature, reducing concerns related to immunological incompatibility and ethical considerations (8,13). In contrast, exosome therapy represents an emerging cell-free regenerative strategy that may offer therapeutic advantages through targeted molecular signaling and enhanced tissue repair. Although exosome therapy is still evolving in clinical dermatology, its potential role in personalized aesthetic medicine appears promising (10,17).

From a scientific perspective, the findings emphasize the importance of treatment standardization and methodological consistency in regenerative dermatology research. Variability in PRP centrifugation methods, platelet concentration, activation procedures, and injection protocols often limits comparability between studies (6,15). Similarly, exosome therapy lacks universal standardization regarding mesenchymal stem cell source, preparation techniques, concentration, and purification methods. Such heterogeneity may partly explain inconsistencies in reported clinical outcomes across the literature (11,20). Therefore, future scientific investigations should prioritize standardized therapeutic protocols to improve reproducibility, comparability, and evidence-based treatment recommendations.

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