

REGENERATIVE & AESTHETIC MEDICINE

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ABSTRACT

Regenerative and aesthetic medicine is expanding faster than its evidence base can be appraised. This empirical paper maps the registered clinical-study landscape for platelet products, cell/adipose products, and secretome/exosome products used for hair restoration, cutaneous scar remodeling, and skin rejuvenation. ClinicalTrials.gov was queried through its version 2 application programming interface on 12 August 2026. Six indication searches were combined, deduplicated, and screened using prespecified intervention and anatomical criteria. Descriptive statistics, cross-tabulation, chi-square tests, Cramér's V , Kruskal–Wallis testing, and exact comparisons of results posting were applied. Of 186 unique records, 136 met eligibility criteria; 135 were interventional. Hair restoration/alopecia accounted for 65 studies (47.8%), scars for 48 (35.3%), and skin rejuvenation/aging for 23 (16.9%). Platelet products were the primary modality in 62 studies (45.6%), followed by combination regimens in 32 (23.5%), cell/adipose products in 30 (22.1%), and secretome/exosome products in 12 (8.8%). Ninety-six studies (70.6%) were randomized, yet median enrollment was only 30 participants. Study starts rose from 17 through 2015 to 46 during 2024–2026. Modality differed by indication ($\chi^2=14.61$, $p=.024$; Cramér's $V=.232$), while enrollment did not differ significantly across modalities ($H=4.83$, $p=.184$). Only 5 of 53 studies with actual primary completion at least one year before extraction had posted results (9.4%). The evidence pipeline is active but fragmented, small, and weakly transparent. Standardized product characterization, validated aesthetic outcomes, timely results disclosure, and longer safety follow-up are necessary before registry activity can be interpreted as clinical maturity.

Keywords: *Regenerative medicine¹; aesthetic medicine²; platelet-rich plasma³; mesenchymal stromal cells⁴; exosomes⁵; ClinicalTrials.gov⁶; evidence transparency⁷.*

1. Introduction

1.1 Scientific convergence in regenerative aesthetics

Regenerative and aesthetic medicine joins biological repair with appearance-related outcomes. Its most visible modalities are autologous platelet concentrates, adipose-derived cell preparations, mesenchymal stromal-cell products, cell-conditioned media, and extracellular vesicles. Platelet-rich plasma (PRP) and platelet-rich fibrin are not single products: centrifugation, leukocyte content, activation, and fibrin architecture generate biologically different preparations [1]. Their proposed action is the localized release of platelet-derived growth factor, vascular endothelial growth factor, transforming growth factor, and other mediators that may influence

angiogenesis, matrix turnover, and follicular signaling [2]. Cell-based interventions are similarly heterogeneous. Consensus definitions distinguish culture-expanded mesenchymal stromal cells from uncultured stromal vascular fraction (SVF), yet aesthetic marketing often compresses these categories into the imprecise term “stem cells” [3], [4].

Exosomes add another layer of complexity because vesicle identity, cargo, source, dose, and purity require explicit characterization under extracellular-vesicle standards [5], [6]. Thus, regenerative aesthetics is best understood as a family of platform technologies rather than one therapy. The platforms also occupy different regulatory and evidentiary positions. A minimally manipulated autologous concentrate prepared at the point of care is not analytically equivalent to a culture-expanded allogeneic cell product or a purified vesicle formulation. Dose may be expressed as platelet concentration, nucleated-cell count, viable-cell fraction, protein mass, particle count, or an incompletely specified treatment volume. Without a common product ontology, two trials bearing the same commercial label may test nonexchangeable interventions, limiting synthesis even before outcomes are compared.

1.2 Evidence, safety, and translational tension

Aesthetic indications create a distinctive translational tension. Patients may accept minimally invasive procedures and pay out of pocket, clinical endpoints can be subjective, and commercial diffusion may occur before comparative trials establish durable benefit. The ethical issue is not that aesthetic outcomes are trivial: alopecia, disfiguring scars, and visible aging can affect identity, social participation, and quality of life. The problem is that expectation-sensitive outcomes and repeated treatment schedules make weak designs especially vulnerable to placebo effects, assessor bias, selective reporting, and optimistic interpretation. Safety also cannot be inferred from autologous origin alone.

Processing, contamination, injection technique, immune signaling, ectopic tissue effects, and poorly characterized vesicle products create modality-specific risks. The U.S. Food and Drug Administration has warned that unapproved stem-cell and exosome products may be illegally marketed and that registration on ClinicalTrials.gov is not equivalent to regulatory review or approval [7]. International stem-cell guidance likewise emphasizes independent oversight, rigorous manufacturing, prospective trials, and transparent communication rather than premature clinical commercialization [8]. Measurement creates a second vulnerability. Hair counts may be objective yet depend on imaging area and cycle timing; scar scales can mix color, pliability, thickness, and observer judgment; facial-aging outcomes may use photography, biophysical instruments, investigator ratings, and satisfaction scores that do not move together. Repeated-session protocols further complicate attribution and durability. High patient satisfaction shortly after an invasive procedure may reflect edema, attention, or expectation rather than stable remodeling. Credible evidence therefore requires both biological standardization and outcome standardization, with assessor masking and follow-up long enough to distinguish transient procedural effects from regeneration.

1.3 Study objective and hypotheses

The present study asks whether the registered research pipeline displays the structural features expected of a maturing field. Clinical-trial registries capture planned design, enrollment, recruitment state, sponsorship, and posted results, thereby revealing the architecture of evidence production even when journal publication is incomplete [9], [10]. Three hypotheses were specified. First, study activity would be concentrated in hair restoration and platelet-based interventions because PRP is comparatively accessible and already embedded in procedural practice. Second, newer exosome and secretome studies would be fewer, smaller, and more often active than mature platelet studies. Third, results availability would lag behind study completion across all modalities. The analysis therefore measures composition, design rigor, time trend, completion state, and disclosure, while testing relationships between indication and modality, study vintage and registry status, and modality and enrollment. The central contribution is empirical: it distinguishes growth in the number of registered studies from growth in clinically interpretable evidence. This distinction is useful to clinicians, regulators, researchers, and patients because each reads the same registry signal differently. A clinician needs comparative benefit and harm, a regulator needs product identity and manufacturing control, a researcher needs reproducible methods, and a patient needs realistic probabilities and alternatives. By treating status maintenance and results deposition as measurable features of evidence maturity, the study broadens evaluation beyond whether a trial was merely launched.

2. Literature Survey

The broader registry literature shows why this distinction matters. ClinicalTrials.gov has evolved from a recruitment directory into a major infrastructure for protocol and results disclosure, but coverage and record quality vary across sponsors, countries, and eras [10]. A landscape analysis of registrations through 2020 documented substantial growth and diversification, together with persistent shifts in geography, sponsorship, and design [11]. Registry data are therefore suitable for studying research portfolios, not for estimating treatment effect. They record what investigators planned and whether summary results were deposited; they do not independently verify product quality, protocol adherence, or publication accuracy. In regenerative aesthetics, those limitations are informative because the terminology itself is unstable. “PRP,” “nanofat,” “SVF,” “stem-cell secretome,” and “exosome” can describe materially different products. A registry-based survey can expose this fragmentation, identify where trials cluster, and assess whether reporting practices are keeping pace with commercialization.

PRP has the largest clinical literature. Its mechanistic rationale and preparation taxonomies are well described, but protocols remain difficult to compare because platelet concentration, leukocyte content, activation method, injection depth, number of sessions, and co-interventions differ [1], [12]. In alopecia, systematic reviews generally report improved hair density or thickness, although certainty is constrained by small samples, heterogeneous comparators, and inconsistent follow-up [13]. Reviews comparing PRP with minoxidil,

finasteride, and cell-based approaches similarly conclude that signals of benefit coexist with protocol variability and limited standardization [14]. A meta-analysis restricted to randomized trials found support for PRP in androgenetic alopecia but emphasized the need for larger, consistently measured studies [15]. For facial rejuvenation, clinical studies report changes in texture, elasticity, wrinkles, or patient satisfaction, yet objective instruments and treatment schedules vary [16]. Accordingly, prevalence of PRP trials should not be mistaken for a settled dose, preparation, or effect size.

Scar treatment illustrates the multimodal character of the field. PRP is frequently paired with microneedling, fractional carbon-dioxide laser, subcision, or fat grafting because controlled injury and biologic signaling are expected to interact. A systematic review of PRP for acne scars found encouraging findings but substantial clinical and methodological heterogeneity [17]. Meta-analysis of microneedling plus PRP suggested an incremental response over microneedling alone, although differences in scar grading and short follow-up limited certainty [18]. A wider meta-analysis across scar types reached a similarly cautious position: pooled improvement did not eliminate concerns about bias, intervention diversity, and outcome comparability [19]. These observations predict a sizeable “combination” category in registry data. They also create an attribution problem. When a laser, needling procedure, or surgical release is combined with a regenerative product, a positive result cannot establish the independent contribution of the biologic component unless the comparator isolates that contribution.

Secretome and exosome interventions are newer and potentially more difficult to standardize. Reviews describe plausible paracrine effects on inflammation, angiogenesis, extracellular-matrix remodeling, pigmentation, and follicular cycling, while emphasizing that source cells, culture conditions, purification, storage, potency assays, and contaminants may alter biological activity [20]–[22]. A randomized split-face study combining an adipose-derived exosome-containing solution with microneedling reported short-term improvement in facial-aging measures [23], but one trial cannot resolve product-class efficacy. Adipose-derived cells and SVF have a longer translational history, including facial rejuvenation, alopecia, and scar remodeling. Reviews report promising signals while identifying inconsistent cell characterization and limited controlled evidence [24]–[26]. A systematic review of randomized regenerative dermatology trials likewise found broad interest but uneven certainty [27]. Collectively, prior work supports biological plausibility and selected efficacy signals; it also predicts the small, heterogeneous, disclosure-sensitive evidence structure tested here.

Reporting behavior is a final part of clinical validity. Earlier research found that many applicable trials did not report results on ClinicalTrials.gov within expected timeframes [28], and a later cohort analysis documented incomplete legal compliance even among large sponsors [29]. Cell-therapy trials are not exempt: a registry study found poor result-reporting rates and called for stronger transparency [30]. For aesthetic regenerative interventions, nonreporting has amplified consequences because patients may encounter commercial claims while null or adverse findings remain inaccessible. Timely summary results do not replace peer review, but they reduce publication bias, permit safety scrutiny, and make completion meaningful. The present survey therefore

treats results posting as an outcome in its own right and applies a conservative eligibility window actual primary completion at least one year before extraction so that newly completed or still-active studies are not mislabeled as overdue.

3. Methodology

This study used a cross-sectional, registry-based empirical design. ClinicalTrials.gov version 2 was queried on 12 August 2026 using six condition fields Alopecia, Skin Aging, Facial Rejuvenation, Scar, Wrinkle, and Photoaging combined separately with an intervention expression containing “platelet rich plasma,” “stem cell,” “exosome,” “adipose derived,” and “stromal vascular fraction” [9]. All pages were downloaded in JavaScript Object Notation format. The six searches returned 206 appearances and 186 unique NCT records after identifier-level deduplication. Eligible records were human interventional or observational studies addressing hair restoration/alopecia, cutaneous scars/remodeling, or skin rejuvenation/aging and containing a qualifying platelet, cell/adipose, secretome/exosome, or multiple-regenerative intervention. Records concerning corneal, uterine, vocal-fold, cardiac, orthopedic, or other noncutaneous scars were excluded. Studies lacking a regenerative intervention, studies outside the three aesthetic indications, and reviews were also removed. Screening rules were implemented reproducibly with title, condition, and intervention text; borderline records were resolved by the stated anatomical and product definitions rather than by recruitment status or outcome direction.

For each included record, the analysis extracted study type, overall status, phase, allocation, masking, intervention model, planned or actual enrollment, lead-sponsor class, countries, start date, primary completion date, and the registry’s results indicator. Indications were coded hierarchically as hair restoration/alopecia, cutaneous scars/remodeling, or skin rejuvenation/aging. Modalities were coded from intervention names and titles as platelet products; cell/adipose products, including SVF and nanofat; secretome/exosome products, including conditioned media; or combination/multiple regenerative when more than one class was present. Status was collapsed into completed, recruiting/active, paused/ended early, and unknown. “Unknown” was retained because it is a registry state, not treated as evidence of failure. A result-reporting-eligible subset required an actual primary completion date on or before 12 August 2025, allowing at least one year for deposition. Enrollment zeroes and extreme values were retained because they are part of the public record; medians and interquartile ranges were therefore preferred to means.

Analysis was performed at the study-record level. Counts, percentages, medians, and interquartile ranges describe the cohort. Pearson’s chi-square test assessed the indication–modality and start-period–status relationships, with Cramér’s V quantifying association strength. A Kruskal–Wallis test compared enrollment distributions across four modality groups because cohort sizes were skewed and heteroscedastic. Exploratory Fisher exact tests compared posted-results proportions in the eligible subset by platelet versus other modality, industry versus nonindustry sponsorship, at least five versus fewer than five years since primary completion, and randomized versus nonrandomized allocation. Two-sided p values below .05 were considered statistically

significant; exact estimates were interpreted cautiously because only five eligible studies had results. The dataset contains protocol-level public information rather than individual health data, so institutional review-board approval and patient consent were not required. Missing categorical fields were retained as “not reported”; no imputation was performed. Sensitivity was favored during retrieval and specificity during anatomical screening, with all exclusions assigned one primary reason. No treatment-effect meta-analysis was attempted, and no claim of efficacy was inferred from registration, completion, or study count.

4. Data Collection and Analysis

The empirical results are organized as seven linked analyses. Each table reports the underlying values, and each figure visualizes a distinct feature of selection, clinical focus, modality, time, status, study scale, or results disclosure. Statistical tests are descriptive associations at the registry-record level; they do not establish patient-level causality or treatment effectiveness.

4.1 Search yield and cohort construction

Table 1: Registry search and eligibility flow

Screening stage	n	Decision rule
Condition-query appearances	206	Broad retrieval before deduplication
Unique NCT records after deduplication	186	20 overlapping appearances removed
Excluded: noncutaneous/non-aesthetic indication	28	E.g., corneal, uterine, vocal-fold, cardiac, orthopedic
Excluded: no eligible regenerative intervention	12	Conventional drug, device, cosmetic, or procedure
Excluded: no eligible aesthetic indication	9	Outside hair, cutaneous scar, or skin-aging scope
Excluded: review rather than primary study	1	Registered systematic review
Final included cohort	136	73.1% of unique screened records

Table 1 establishes the analytic denominator and shows why simple keyword totals would overstate the aesthetic regenerative pipeline. The six condition searches produced 206 appearances, but 20 were repeat appearances because the same NCT record could match more than one indication term. Deduplication reduced the pool to 186 unique records. The largest exclusion group was noncutaneous or non-aesthetic anatomy: generic “scar” queries retrieved corneal, uterine, vocal-fold, cardiac, and orthopedic studies that were scientifically regenerative but outside the paper’s scope. Twelve records used conventional devices, drugs, cosmetics, or procedures without a qualifying regenerative product, and nine lacked an eligible hair, scar, or skin-aging

indication. One registered systematic review was excluded because the unit of analysis was a primary clinical study. The final cohort of 136 represents 73.1% of unique records screened. This flow demonstrates a substantive methodological point: regenerative-medicine vocabulary is broad and registry search fields are semantically porous. A reproducible anatomical and product screen is therefore necessary before drawing conclusions about aesthetic research. The final count should be interpreted as an operationally defined cohort rather than the universe of every regenerative cosmetic procedure, particularly because unregistered practice, non-U.S. registries, and studies described with different terminology are not captured.

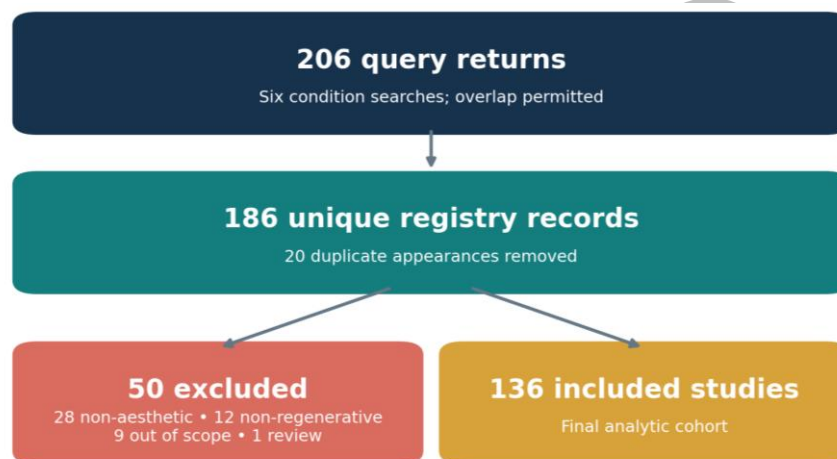


Figure 1: Registry search and eligibility flow.

Figure 1 makes the denominator visually explicit. Search sensitivity was intentionally broad, so the principal reduction occurred after anatomical and intervention screening rather than through hidden manual selection. Overlap removal was modest 20 appearances but scope exclusions were substantial. The figure helps prevent a common error in registry reviews: treating the sum of query returns as independent studies. It also shows that eligibility was driven by prespecified concepts, not by whether a study was positive, completed, or industry sponsored. The 136-record endpoint is therefore suitable for portfolio analysis while remaining transparently bounded by one registry, one extraction date, and the stated vocabulary.

4.2 Portfolio profile and clinical focus

Table 2. Characteristics of included registered studies (N = 136)

Domain	Category	n / value	%
Study type	Interventional	135	99.3
	Observational	1	0.7

Registry status	Completed	52	38.2
	Recruiting/active	34	25.0
	Paused/ended early	9	6.6
	Unknown	41	30.1
Allocation	Randomized	96	70.6
	Nonrandomized	8	5.9
	Not applicable	31	22.8
	Not reported	1	0.7
Masking	Open label/none	61	44.9
	Single	20	14.7
	Double/triple/quadruple	54	39.7
	Not reported	1	0.7
Lead sponsor	Other (academic/health system)	100	73.5
	Industry	25	18.4
	Other government	10	7.4
	Network	1	0.7
Location field	At least one country reported	111	81.6
	Not reported	25	18.4
Structured results	Results posted	5	3.7
Enrollment	Median (IQR)	30 (20–50)	

Table 2 describes a predominantly experimental but methodologically mixed portfolio. Almost every record was interventional, and 96 studies reported randomized allocation. That 70.6% randomized share is encouraging, yet randomization alone does not ensure an informative comparison: 61 records were open label, 31 listed allocation as not applicable, and median enrollment was only 30. Fifty-four studies used double, triple, or quadruple masking, indicating that credible blinding is possible even in procedure-heavy research, often through split-face, split-scalp, placebo injection, or assessor-blinded designs. Sponsor composition was led by universities, hospitals, and other nonindustry organizations (100 records), while industry led 25. The status profile is less

reassuring. Only 52 records were completed; 41 carried unknown status, generally indicating that an older record had not been recently verified, and nine were withdrawn or terminated. Thirty-four were recruiting or otherwise active. Locations were reported in 111 records, with the United States appearing most often, followed by Egypt, China, Pakistan, and Indonesia. Only five records contained posted summary results. Taken together, the table depicts substantial trial activity but limited public closure. It also cautions against equating “registered” with adequately powered, current, completed, or reported.

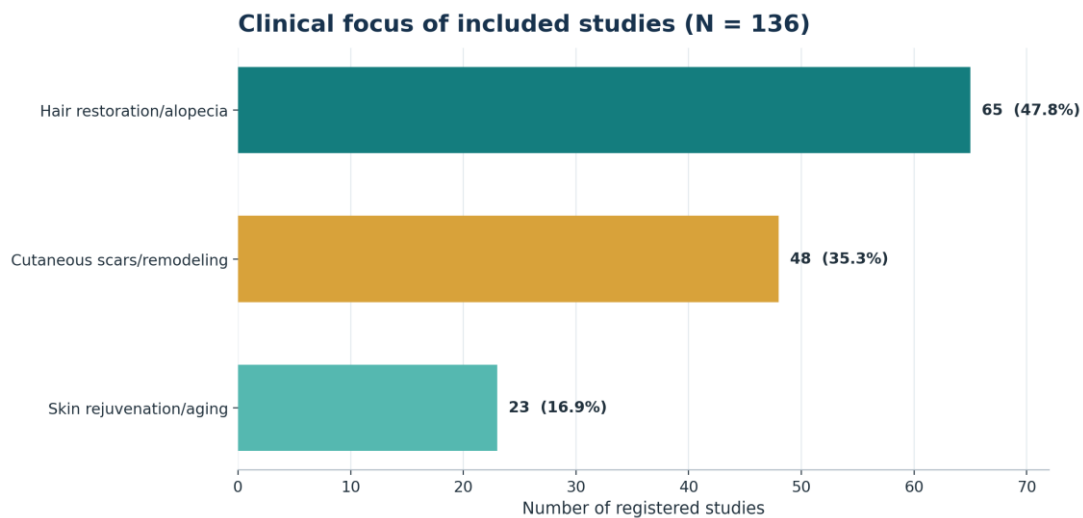


Figure 2: Clinical focus of included studies.

Figure 2 shows that almost half of the portfolio concerns hair restoration or alopecia. Cutaneous scar remodeling forms a substantial second domain, while facial and skin-aging studies are comparatively few. This imbalance matters because the public visibility of rejuvenation procedures may suggest a larger trial base than the registry supports. It also means that aggregate statements about “regenerative aesthetics” will be disproportionately shaped by scalp and scar studies. The figure reinforces the need for indication-specific interpretation: outcome instruments, treatment schedules, comparators, and acceptable follow-up differ substantially between hair density, scar texture, and facial-aging endpoints.

4.3 Relationship between indication and modality

Table 3: Regenerative modality by aesthetic indication

Indication	Platelet	Cell/adipose	Secretome/ exosome	Combination	Total
Hair	29 (44.6%)	7 (10.8%)	9 (13.8%)	20 (30.8%)	65

restoration/alopecia					
Cutaneous scars/remodeling	22 (45.8%)	16 (33.3%)	1 (2.1%)	9 (18.8%)	48
Skin rejuvenation/aging	11 (47.8%)	7 (30.4%)	2 (8.7%)	3 (13.0%)	23
Total	62	30	12	32	136

Table 3 provides the first tested relationship. Platelet products formed the largest single class in every indication: 44.6% of hair studies, 45.8% of scar studies, and 47.8% of rejuvenation studies. The similarity of those percentages shows PRP's breadth. The statistically significant chi-square result arises mainly from the distribution of the other modalities. Combination regimens comprised 30.8% of hair studies but only 13.0% of rejuvenation studies. Cell/adipose products represented one-third of scar studies and 30.4% of rejuvenation studies, but only 10.8% of hair studies. Secretome/exosome products were concentrated in hair restoration, where nine of the twelve records occurred; only one scar record used that category. The association was significant ($\chi^2=14.61$, six degrees of freedom, $p=.024$), while Cramér's $V=.232$ indicates a modest not deterministic relationship. Thus, the choice of regenerative platform is partly indication-specific. The pattern is biologically and procedurally plausible: adipose products integrate naturally with volume restoration and scar release, whereas exosome commercialization has strongly targeted scalp applications. However, the table measures research attention, not comparative effectiveness. A modality can be frequent because it is accessible, marketable, or easy to combine, not because it produces superior patient outcomes.

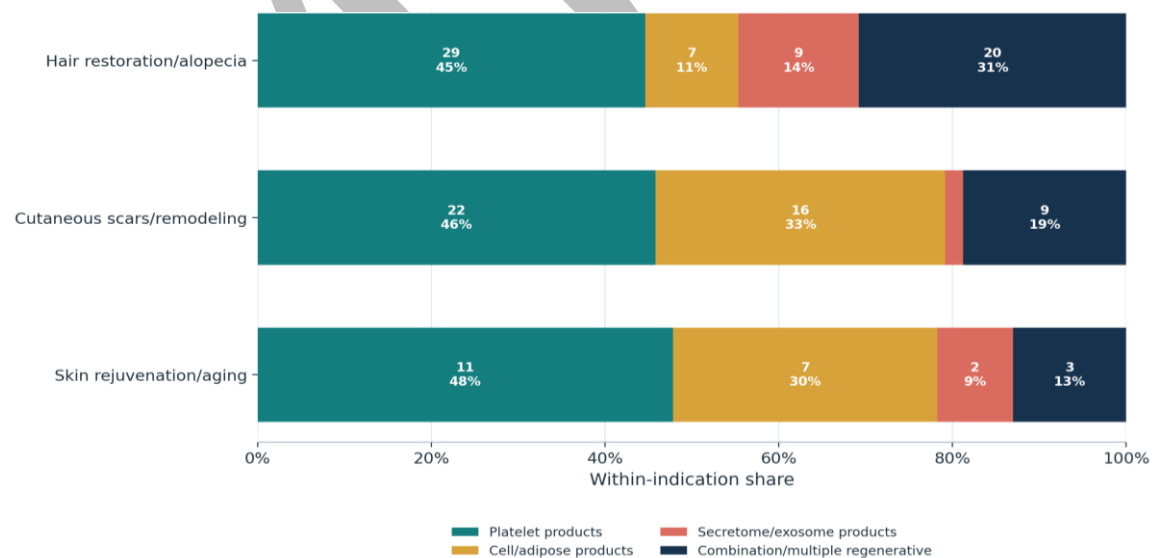


Figure 3. Within-indication modality composition.

Figure 3 interpretation. Figure 3 converts Table 3 into within-indication percentages. Platelet products occupy nearly half of every bar, but the residual composition differs markedly. Hair research contains the largest combination and secretome/exosome shares; scar research shows the greatest cell/adipose share; rejuvenation combines platelet and cell/adipose approaches with fewer combination trials. The display clarifies why a statistically significant association can coexist with PRP dominance across all indications. The relationship is driven not by one exclusive pairing but by moderate shifts among emerging platforms. Since these are study shares, the chart describes investigators' choices and commercial-development patterns rather than relative therapeutic benefit.

4.4 Modality and registry status

Table 4: Current registry status by regenerative modality

Modality	Completed	Active	Ended early	Unknown	Total
Platelet products	27 (43.5%)	11 (17.7%)	7 (11.3%)	17 (27.4%)	62
Cell/adipose products	8 (26.7%)	8 (26.7%)	0 (0.0%)	14 (46.7%)	30
Secretome/exosome products	4 (33.3%)	6 (50.0%)	1 (8.3%)	1 (8.3%)	12
Combination/multiple regenerative	13 (40.6%)	9 (28.1%)	1 (3.1%)	9 (28.1%)	32
Total	52	34	9	41	136

Table 4 separates scientific maturity from administrative status. Platelet studies had the largest completed count (27) and the largest number paused or ended early (seven), reflecting both their longer history and greater volume. Cell/adipose products had only eight completed studies and fourteen unknown-status records; the resulting 46.7% unknown share is the highest among modalities. That concentration may reflect older pilot studies whose records were not updated, but it also weakens confidence in the visible development pathway. Secretome/exosome products were distinctive: six of twelve were recruiting or active, four were completed, one ended early, and only one was unknown. This is consistent with a newer pipeline rather than proof of rapid success. Combination studies occupied an intermediate position, with thirteen completed, nine active, nine unknown, and one ended early. Across the complete cohort, 38.2% were completed, 25.0% active, 6.6% paused or ended early, and 30.1% unknown. These categories should not be read as patient outcomes. Completion can occur without efficacy, and “unknown” does not mean that a product was unsafe. Nonetheless, status maintenance is part of research integrity: stale records obstruct systematic review, participant decision-making, and identification of unpublished findings.

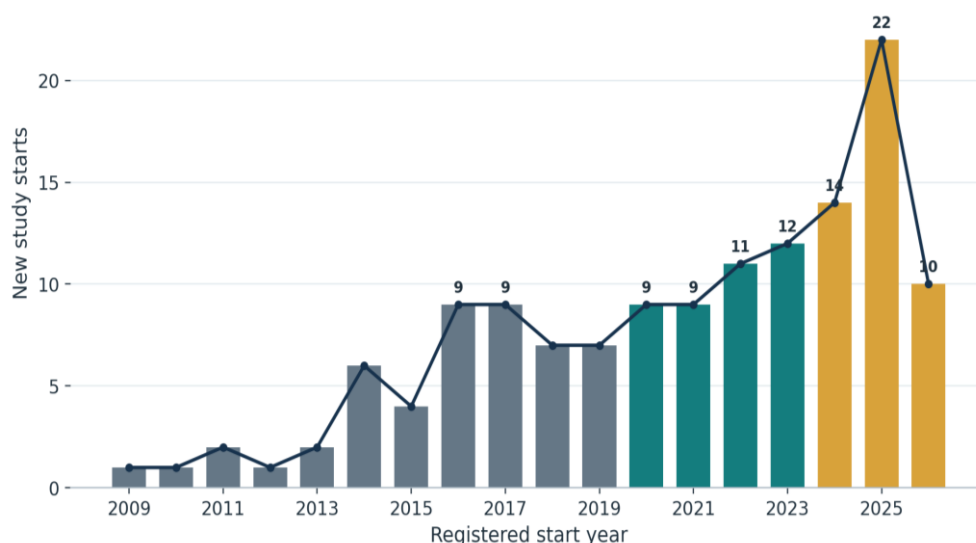


Figure 4: Annual registered study starts, 2009–2026.

Figure 4 displays annual registered start dates and reveals a clear rise after 2020, culminating in 22 starts in 2025. The ten starts shown for 2026 cover only the period available by 12 August and should not be annualized without qualification. Counts can also change when sponsors update or retrospectively register records. Even with those cautions, the trajectory supports a rapidly expanding research market. Growth is not synonymous with maturation: later figures show that most recent studies remain active and that results deposition is scarce. The chart therefore provides the “growth” side of the paper’s central growth–transparency contrast.

4.5 Temporal growth and administrative status

Table 5. Start period by current registry status

Start period	Completed	Active	Ended early	Unknown	Total
≤2015	8 (47.1%)	0 (0.0%)	1 (5.9%)	8 (47.1%)	17
2016–2019	18 (56.2%)	0 (0.0%)	3 (9.4%)	11 (34.4%)	32
2020–2023	19 (46.3%)	3 (7.3%)	2 (4.9%)	17 (41.5%)	41
2024–2026	7 (15.2%)	31 (67.4%)	3 (6.5%)	5 (10.9%)	46
Total	52	34	9	41	136

Table 5 demonstrates a strong relationship between study vintage and current registry status ($\chi^2=70.37$, nine degrees of freedom, $p<.001$; Cramér’s $V=.415$). The newest period, 2024–2026, contains 46 studies, of which

31 are active and only seven completed; this is the expected profile of a growing pipeline. By contrast, none of the studies starting through 2019 remained active under the collapsed status definition. The concern lies in older unknown records: eight of seventeen studies that began through 2015 and eleven of thirty-two that began during 2016–2019 were unknown. Even the 2020–2023 cohort contained seventeen unknown records. This pattern suggests that administrative aging, not modality alone, drives much of the stale-status burden. The period counts also show acceleration: 17 starts through 2015, 32 in 2016–2019, 41 in 2020–2023, and 46 in the partial 2024–2026 period. Because the latest period covers less than three full years, its size is notable, although registry updates and retrospective registration can shift a study’s recorded start-year profile. The table supports the abstract’s central relationship: rapid expansion has produced a large active frontier while disclosure and record maintenance lag in earlier cohorts.

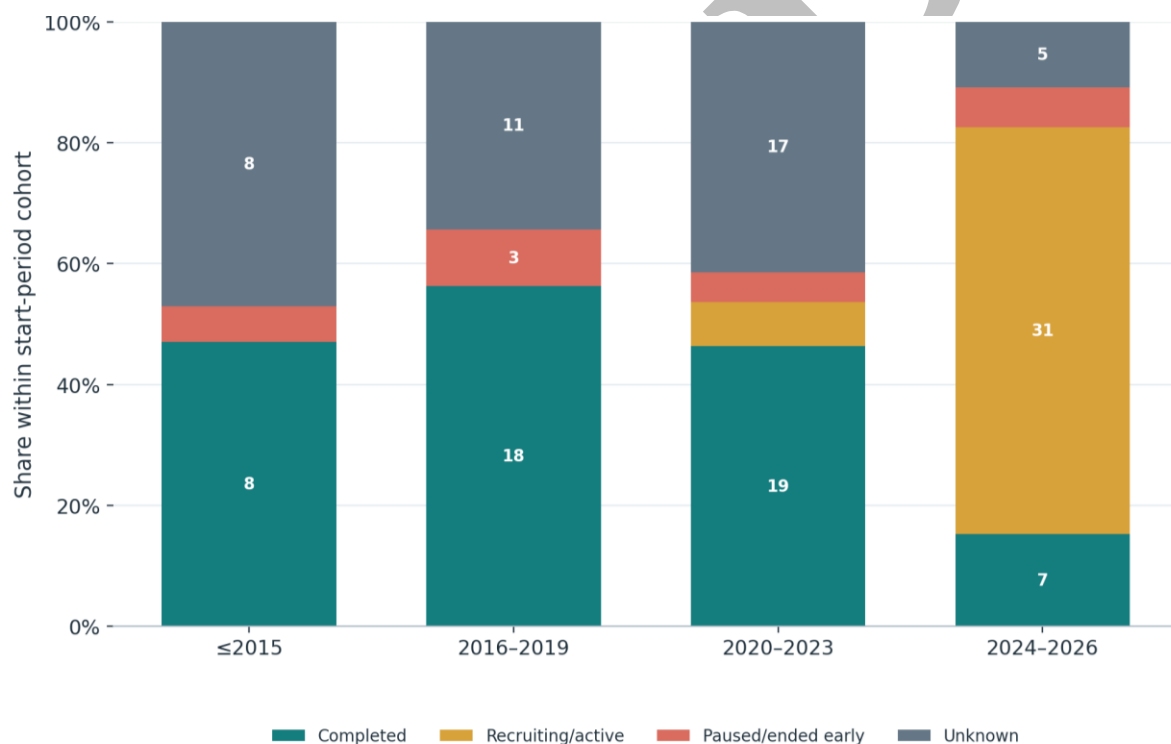


Figure 5: Status composition within start-period cohorts.

Figure 5 normalizes each start-period cohort to 100%, making age-related status differences easier to compare than raw counts. Two-thirds of 2024–2026 studies are active, which is appropriate for recent starts. Older cohorts, however, contain large gray unknown-status segments: 47.1% through 2015 and 34.4% in 2016–2019. The 2020–2023 cohort also has 41.5% unknown. These values explain the strong chi-square association. The figure should not be interpreted as a survival curve because registry status is administrative and the cohorts have unequal follow-up. Its practical message is that the evidence map needs systematic record maintenance as much as new registration.

4.6 Study scale and design characteristics

Table 6: Enrollment and design indicators by modality

Modality	N	Enrollment, median (IQR)	Randomized	≥Double mask	Industry led
Platelet products	62	30 (17.75–54.5)	47 (75.8%)	24 (38.7%)	6 (9.7%)
Cell/adipose products	30	26.5 (15–37)	16 (53.3%)	9 (30.0%)	10 (33.3%)
Secretome/exosome products	12	27 (15.75–30)	8 (66.7%)	7 (58.3%)	5 (41.7%)
Combination/multiple regenerative	32	37.5 (24–52.25)	25 (78.1%)	14 (43.8%)	4 (12.5%)

Table 6 tests whether newer or more complex products are being studied in materially larger cohorts. They are not. Median enrollment ranged from 26.5 for cell/adipose products to 37.5 for combination studies, with overlapping interquartile ranges. The Kruskal–Wallis test was not significant ($H=4.83$, $p=.184$), so the observed differences do not support a modality-level enrollment relationship. Randomization was common in platelet and combination studies (75.8% and 78.1%, respectively), lower in secretome/exosome studies (66.7%), and lowest in cell/adipose studies (53.3%). Double-or-higher masking occurred in 58.3% of secretome/exosome studies but only 30.0% of cell/adipose studies, possibly because harvesting and grafting procedures make participant blinding difficult. Industry sponsorship was proportionally greatest for secretome/exosome products (41.7%) and cell/adipose products (33.3%), compared with 9.7% for platelet products. The table therefore reveals a commercial–design contrast: the product classes with more industry involvement are not being tested in larger studies. Small enrollment does not invalidate an early safety or feasibility trial, but repeated small studies can fragment evidence and inflate imprecision. Future confirmatory research should justify sample size against validated, clinically meaningful endpoints rather than replicate underpowered exploratory protocols.

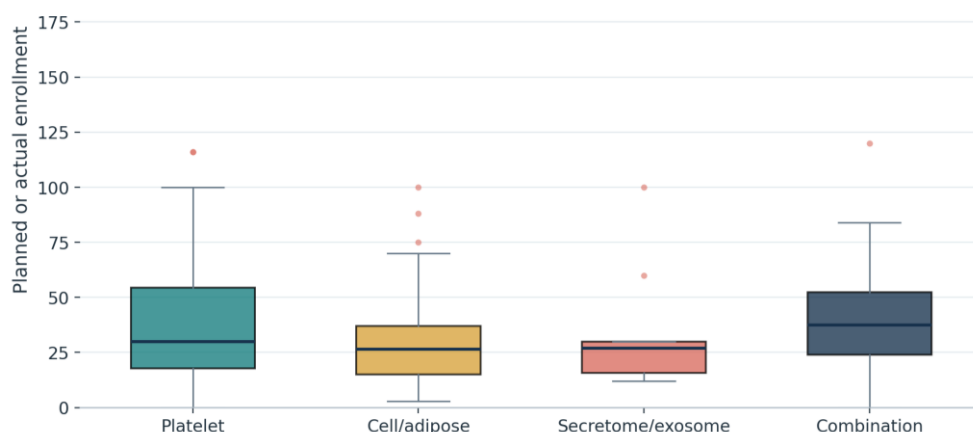


Figure 6: Enrollment distribution by regenerative modality.

Figure 6 shows compact enrollment distributions with several high-end outliers. Medians cluster near 30 participants, and the boxes overlap across all four modalities. Combination studies have the highest median, but the nonsignificant Kruskal–Wallis test confirms that between-class variation is small relative to within-class variation. The figure highlights an evidence-scale problem: cell and exosome products, despite greater manufacturing and regulatory complexity, are not generally evaluated in larger cohorts than autologous platelet procedures. Outliers should not obscure the typical study. For clinicians, the relevant inference is not that small trials are useless, but that rare harms, subgroup effects, and durable aesthetic benefit remain difficult to quantify.

4.7 Results availability after primary completion

Table 7: Exploratory relationships with posted results in the eligible subset (n = 53)

Comparison	Group	Results posted	Exact OR	Fisher p
Primary modality	Platelet products	4/26 (15.4%)	4.73	.192
	Other modalities	1/27 (3.7%)	Reference	
Lead sponsor	Industry	1/10 (10.0%)	1.08	1.000
	Nonindustry	4/43 (9.3%)	Reference	
Time since primary completion	≥5 years	5/32 (15.6%)	Not estimable†	.144
	1 to <5 years	0/21 (0.0%)	Reference	
Allocation	Randomized	3/35 (8.6%)	0.75	1.000
	Not randomized	2/18 (11.1%)	Reference	

Table 7 focuses on the 53 studies with an actual primary completion date at least one year before extraction. Only five had posted summary results, a rate of 9.4%. Platelet-primary studies had four postings among 26 eligible records versus one among 27 other-modality records. The exact odds ratio was 4.73, but $p=.192$ and the sparse cells show that this apparent advantage is uncertain. Industry-led and nonindustry studies had nearly identical rates (10.0% and 9.3%; exact $p=1.000$). Randomized studies were not more likely to post results than nonrandomized studies (8.6% versus 11.1%; $p=1.000$). All five postings occurred among records at least five years beyond primary completion, compared with none among 21 records one to under five years beyond completion; the exact $p=.144$ remains nonsignificant. These comparisons are exploratory and should not be mistaken for evidence that waiting improves compliance. The dominant finding is the absolute disclosure deficit across every subgroup. Registry obligations vary by jurisdiction, product, and trial status, so the table does not adjudicate legal noncompliance. It does show that an external reader cannot access structured summary outcomes for most apparently mature studies, limiting cumulative evidence appraisal and weakening the interpretive value of “completed” status.

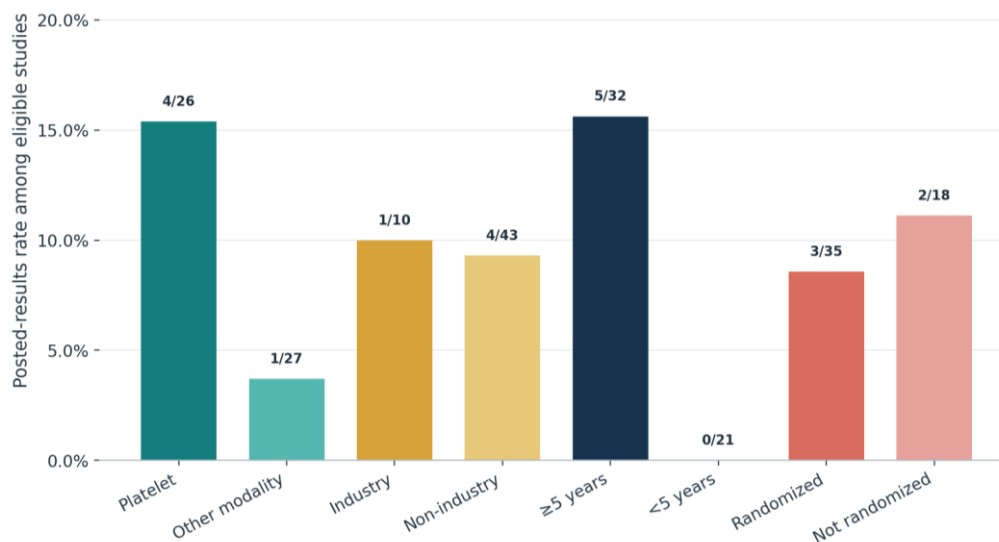


Figure 7: Posted-results rates among studies beyond a one-year reporting window.

Figure 7 presents observed reporting rates rather than unstable multivariable estimates. Every subgroup is low. Platelet studies appear higher than other modalities, and records at least five years beyond completion account for all postings, but each numerator is tiny. Labels show the actual fractions so readers can see the denominator behind each percentage. The lack of industry and randomization differences should not be interpreted as equivalence; Fisher tests have little power with five events. The figure’s robust conclusion is descriptive: after a conservative one-year window, 48 of 53 eligible records lacked posted structured results. That shortfall constrains safety synthesis, effect estimation, and informed consent.

5. Discussion: Critical Analysis and Comparison with Past Work

5.1 Critical interpretation of the empirical findings

The data portray regenerative and aesthetic medicine as an expanding but incompletely consolidated research field. The first hypothesis was supported: hair restoration was the largest indication and platelet products the largest modality. PRP's dominance is understandable because it is autologous, procedurally familiar, relatively inexpensive, and adaptable to scalp, scar, and facial applications. Yet dominance did not produce scale. The median study enrolled 30 participants, and enrollment distributions did not differ significantly by modality. This means that the field is accumulating many small experiments rather than a smaller number of decisive trials. Randomization in 70.6% of records is a strength, but it must be interpreted alongside open-label designs, split-body methods, short follow-up, heterogeneous preparations, and likely variation in outcome definitions. A randomized label cannot rescue an underpowered study or a comparator that fails to isolate the regenerative component.

The indication–modality association provides a more nuanced result than simple popularity counts. Secretome/exosome records clustered in hair research, while cell/adipose products were relatively prominent in scars and rejuvenation. These pairings reflect biological narratives and procedural convenience, but they may also reflect market segmentation. Registry data cannot separate scientific opportunity from sponsor strategy. Combination regimens are particularly difficult. Pairing PRP or cell products with microneedling, laser resurfacing, subcision, transplantation, or fat grafting may be clinically sensible, but it complicates causal attribution. Confirmatory trials should use factorial, split-area, or additive designs where feasible, state the biologic product's composition, and predefine a clinically meaningful incremental effect over the procedural base.

The second hypothesis was partially supported. Secretome/exosome studies were uncommon and half were active, consistent with a newer pipeline; however, their median enrollment was not lower than other classes and their rate of higher-order masking was comparatively strong. Cell/adipose studies showed the highest unknown-status share, which signals poor record maintenance rather than a specific safety result. The strong start-period–status association confirms that study age structures registry status. Recent activity is genuine, but the 41 unknown records prevent a clean account of what happened to many earlier projects.

The third hypothesis received the strongest descriptive support. Only 9.4% of reporting-eligible studies had posted results. Sparse exact comparisons did not identify a reliable sponsor, design, or modality advantage. This is not merely an administrative inconvenience. In a commercially visible field, absent summary results amplify publication bias, prevent aggregation of null findings and adverse events, and allow study registration to function as a marketing signal without corresponding disclosure. The remedy is not to slow innovation, but to

link innovation to complete protocol registration, product characterization, validated outcomes, adverse-event definitions, and time-bound reporting.

5.2 Comparison with prior evidence

These findings align with, but also sharpen, the past literature. PRP reviews in alopecia generally report favorable efficacy signals while repeatedly identifying small samples and protocol heterogeneity [13]–[15]; the present median enrollment of 30 and broad platelet coding show the pipeline-level source of that problem. Scar reviews describe potential incremental benefit when PRP accompanies microneedling or resurfacing, but they also emphasize heterogeneous scar scales and multimodal attribution [17]–[19]. The registry’s 32 combination studies demonstrate that this is not a minor analytic issue it is a central design feature of the field.

The exosome literature emphasizes biological plausibility together with unresolved manufacturing and identity standards [20]–[22]. This analysis adds a clinical-development perspective: only 12 records met eligibility, six were still active, and none of the reporting-eligible exosome/secretome studies had posted results. That does not refute the short-term improvements reported in a randomized split-face trial [23]; it shows that independent replication and transparent class-level evidence remain thin. Reviews of adipose-derived interventions similarly describe promising facial, hair, and scar applications but inconsistent characterization and limited controlled data [24]–[27]. The high unknown-status share among cell/adipose records compounds those concerns.

Finally, the 9.4% posting rate is directionally consistent with prior demonstrations of incomplete ClinicalTrials.gov reporting [28], [29] and with poor disclosure in cell-therapy trials [30], although direct rate comparison is inappropriate because eligibility rules, eras, jurisdictions, and legal coverage differ. The present study’s value is not a legal compliance verdict. It is an evidence-availability audit tailored to regenerative aesthetics. Compared with treatment-focused reviews, it identifies what precedes meta-analysis: small studies, stale records, mixed products, and inaccessible results. Those structural weaknesses explain why promising biological and clinical signals have not yet produced uniformly high-certainty guidance.

Several limitations bound the inference. ClinicalTrials.gov is a major international registry but not the only registry, and aesthetic procedures performed outside formal studies are invisible. Search-field semantics can miss products described with proprietary terms or retrieve false positives; the prespecified screen reduces but cannot eliminate classification judgment. Registry fields are sponsor reported, continuously revised, and sometimes incomplete. Planned enrollment may differ from final enrollment, “unknown” status has multiple administrative causes, and a posted-results flag does not measure publication quality. Most importantly, the study analyzes the evidence pipeline rather than participant outcomes, adverse-event rates, or effect sizes. Its statistical relationships are ecological and should not guide individual treatment selection. Future work should link registry records to publications, regulatory actions, protocol-level product specifications, and harmonized outcomes, then assess whether completion and disclosure predict evidence quality. These limitations narrow the

claims, but they do not erase the core finding that public research activity and publicly accessible results have expanded at very different speeds.

6. Conclusion

Regenerative and aesthetic medicine has a visible and rapidly growing registered research pipeline, but the pipeline is not yet equivalent to a mature evidence base. Among 136 eligible ClinicalTrials.gov records, hair restoration and platelet products dominated; study starts accelerated after 2020; and randomization was common. At the same time, the typical cohort contained only 30 participants, nearly one-third of records had unknown status, and only 5 of 53 studies with an actual primary completion at least one year earlier had posted results. The significant indication–modality relationship confirms that product development is being shaped by clinical niche, while the absence of an enrollment difference shows that newer, more complex platforms are not being evaluated at greater scale.

The practical conclusion is conditional rather than dismissive. PRP, adipose-derived preparations, cell products, and extracellular-vesicle approaches may yield clinically useful treatments, but trial counts and biological plausibility cannot substitute for standardized manufacturing, appropriate controls, validated objective and patient-reported outcomes, adequate power, and long-term adverse-event surveillance. Investigators and sponsors should update registry status, deposit summary results, report product composition and dose, and design combination trials that isolate incremental benefit. Clinicians should distinguish approved products from investigational or unapproved offerings and communicate uncertainty without minimizing patients' aesthetic and psychosocial goals. If transparency and methodological scale rise with trial volume, regenerative aesthetics can progress from a commercially dynamic collection of procedures to a reproducible, patient-centered clinical discipline. Until then, shared decision-making should present these interventions according to product-specific evidence and regulatory status, not under a single reassuring “regenerative” label.

7. References

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Data Availability Statement

The analysis is based on public ClinicalTrials.gov records retrieved through the version 2 API on 12 August 2026. The screening logic, de-identified record-level analytic dataset, and chart-generation code were retained with the manuscript production files. Because the registry is continuously updated, exact counts may change in later replications.