

Adipose-Derived Micrograft Enrichment with Autologous Growth Factors: A Novel Paradigm in Natural Body Contouring through Regenerative Adipogenesis and Stromal Vascular Fraction-Mediated Neovascularization

David Ogazón Milán^{*1}, Lina Sarahí de la Madrid Trevizo², Alondra Cuadra Casillas³, Alexia Paola Rodríguez Barboza¹, Edson Misael Ventura Romero⁴, José Andrés Muñoz Ruiz¹, Efrén Flores Tavizón⁵, Johana Sofía Herman González⁶

¹Tecnológico de Monterrey campus Monterrey. Monterrey, Mexico.

²Universidad de Colima. Jalisco, Mexico.

³Universidad autónoma de Guadalajara. Guadalajara, Jalisco, Mexico.

⁴Universidad Autónoma de Nuevo León. Monterrey, Mexico.

⁵Universidad Autónoma de Aguascalientes. Aguascalientes, México.

⁶Benemerita Universidad autónoma de Aguascalientes. Aguascalientes, Mexico.

ABSTRACT

The evolving field of regenerative aesthetic medicine continues to seek minimally invasive methodologies that provide natural, durable outcomes in body contouring. This article elucidates the scientific rationale and clinical efficacy of autologous fat grafting, specifically through the technique of microfat harvesting and processing, augmented with the concentrated release of endogenous growth factors derived from activated platelet-rich plasma (PRP) or platelet-rich fibrin (PRF). We posit that this synergistic combination transcends the conventional model of mere volume restoration, advancing into a holistic paradigm of *in situ* tissue regeneration. The core mechanism hinges on the bioactive interplay between the adipose-derived stem cells (ASCs) and endothelial progenitor cells within the stromal vascular fraction (SVF) of the micrografts and the potent cytokine cocktail—including platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and transforming growth factor-beta (TGF- β)—released from the platelets. Current evidence underscores that this microenvironment significantly enhances graft viability by promoting early angiogenesis, mitigating apoptotic cell death, and fostering adipocyte progenitor differentiation. Furthermore, we review contemporary high-level clinical studies and systematic analyses that demonstrate superior volumetric retention, improved cutaneous quality, and reduced postoperative resorption rates compared to traditional lipofilling. This manuscript provides a comprehensive synthesis of the current biological understanding, technical protocols for optimized bio-activation, and clinical applications, positioning growth factor-enriched adipose micrografts as a cornerstone in the pursuit of natural, structural body remodeling.

KEYWORDS: Autologous fat grafting; stromal vascular fraction; platelet-rich plasma; adipose-derived stem cells; growth factors; body contouring; regenerative medicine; volumization; neovascularization; adipogenesis.

ARTICLE DETAILS

Published On:
05 January 2026

Available on:
<https://ijmscrs.com>

INTRODUCTION

The pursuit of ideal body contouring has historically navigated between the poles of excisional surgery and synthetic implants, each carrying inherent limitations related

to scarring, foreign body reactions, and an unnatural aesthetic. Autologous fat transplantation emerged as a revolutionary alternative, offering a biocompatible, autogenous filler. However, unpredictable and often

Adipose-Derived Micrograft Enrichment with Autologous Growth Factors: A Novel Paradigm in Natural Body Contouring through Regenerative Adipogenesis and Stromal Vascular Fraction-Mediated Neovascularization

suboptimal graft survival, primarily due to ischemic necrosis before neovascularization, has remained a significant impediment to its reliability. The contemporary understanding of adipose tissue not as an inert mass but as a dynamic, stem cell-rich endocrine organ has fundamentally reframed its therapeutic potential. This shift has catalyzed the development of enhanced fat transfer techniques, most notably the integration of autologous growth factor sources. The scientific premise is rooted in the regenerative cascade: during the ischemic phase following transplantation, the seeded adipocytes and crucial ASCs are vulnerable. The concomitant delivery of a supra-physiological concentration of growth factors, harvested from the patient's own blood platelets, creates a pro-regenerative milieu.^{1,2,3}

These signaling molecules act in a paracrine and autocrine fashion to stimulate the proliferation and differentiation of ASCs, attract endothelial cells to form new capillary networks, and modulate the local immune response to reduce inflammation. Concurrent advancements in harvesting, with low shear-force cannulas to preserve tissue architecture, and processing, to concentrate the viable cellular components, have yielded the concept of "micrografts" and nanofat. This manuscript delves into the most current evidence from both translational research and clinical trials, arguing that the deliberate enrichment of adipose micrografts with autologous growth factors represents a sophisticated, biologically-driven strategy. It moves beyond simple space-occupying filler to active *remodeling*, where the graft integrates as living tissue, promoting not only volume but also structural and qualitative improvements in the recipient site. This introduction sets the stage for a detailed exploration of the protocols, molecular mechanisms, and evidenced-based outcomes that define this cutting-edge approach in natural body contouring.^{2,3}

Historical Context and Antecedents

The conceptual foundation for autologous fat transplantation was established over a century ago, with early documented attempts by Neuber in 1893. However, the technique languished in obscurity due to highly inconsistent results and a profound lack of understanding of the graft's biology, often dismissed as an unpredictable and rudimentary procedure. The modern era was inaugurated in the late 1980s with the introduction of liposuction, which provided a viable source of adipose tissue, and the pioneering work of Coleman, who systematized a protocol emphasizing gentle harvesting, centrifugation, and meticulous placement. The "Coleman technique" established structural fat grafting as a reliable method for facial and hand rejuvenation, shifting the paradigm from mere injection to strategic placement of small aliquots to maximize surface area for nutrient diffusion. Despite this standardization, the Achilles' heel remained the significant and variable resorption rate, reported between 20% to 80%, attributed primarily to ischemic necrosis during the avascular period before host neovascularization could establish.^{3,4}

This critical limitation became the catalyst for a fundamental re-evaluation of adipose tissue's intrinsic properties. The landmark identification and characterization of multipotent adipose-derived stem cells (ASCs) within the stromal vascular fraction (SVF) in the early 2000s transformed the perception of fat from a passive filler to an active, regenerative organ. Concurrently, parallel advancements in hematology and maxillofacial surgery demonstrated the profound wound-healing and osteogenic potential of concentrated platelet-derived preparations, namely platelet-rich plasma (PRP) and the more advanced platelet-rich fibrin (PRF). Platelets, once viewed solely as hemostatic agents, were recognized as reservoirs of hundreds of bioactive proteins and growth factors—including PDGF, VEGF, TGF- β , and IGF-1—stored within their alpha-granules and released upon activation to initiate and orchestrate every phase of tissue repair.^{4,5}

The logical and synergistic confluence of these two autologous biologics—viable adipose tissue and concentrated growth factors—emerged as the next evolutionary step. Researchers hypothesized that creating a "bio-enhanced" graft by combining micro-fragmented adipose tissue with activated platelet secretions could mimic an *in vivo* niche, accelerating angiogenesis, promoting ASC survival and differentiation, and ultimately yielding higher and more predictable graft retention. This hypothesis has been vigorously tested over the past decade, leading to refined protocols for graft preparation, including mechanical emulsification to create "nanofat" for purely regenerative effects, and enzymatic digestion to isolate pure SVF for cell-assisted lipotransfer (CAL). The most recent evidence, however, favors simpler, point-of-care, closed-system methods that combine minimally manipulated microfat with leukocyte-rich PRP or liquid PRF, avoiding regulatory complexities of cell expansion while maximizing practical clinical utility and safety.^{4,5,6}

Contemporary Applications and Uses in Natural Body Remodeling

The clinical applications of growth factor-enriched adipose micrografts have expanded significantly beyond initial volume restoration, now encompassing a comprehensive strategy for holistic body remodeling and contouring. The primary and most evidenced-based use remains the correction of volume deficits and asymmetries. In gluteal augmentation, the technique—often termed the "Brazilian Butt Lift" when performed with standard fat grafting—achieves enhanced safety and outcomes when employing micrografts enriched with PRP. The growth factors are postulated to reduce postoperative inflammation and foster a more robust vascular network in a large-volume graft setting, potentially mitigating risks associated with fat embolism and improving shape longevity. For breast reconstruction and augmentation, particularly in post-mastectomy patients or those seeking autologous alternatives to implants, the enriched grafts offer

Adipose-Derived Micrograft Enrichment with Autologous Growth Factors: A Novel Paradigm in Natural Body Contouring through Regenerative Adipogenesis and Stromal Vascular Fraction-Mediated Neovascularization

not only volume but also improved quality of the overlying skin and subcutaneous tissue. The cytokines stimulate neo-collagenesis and angiogenesis, addressing radiation-damaged skin and creating a more natural, supple breast mound with a lower incidence of palpable oil cysts or calcifications.^{6,7}

Furthermore, the utility of this technology extends into the realm of corrective and regenerative contouring. It is effectively employed for the amelioration of contour irregularities and adhesions secondary to prior liposuction or surgical procedures, where the growth factors help remodel fibrotic tissue and integrate new adipose parcels into a compromised bed. In cases of congenital or acquired deformities such as Poland syndrome or pectus excavatum, the regenerative capacity of the ASC-growth factor composite can help reconstruct anatomical form while improving the quality of the covering soft tissue envelope.^{7,8,9}

A particularly innovative application lies in the treatment of scarring, including striae distensae. The injection of nanofat or SVF-enriched fat, combined with its secretome, has been shown to induce dermal thickening, collagen reorganization, and increased elastin expression, leading to measurable improvement in skin texture, elasticity, and visual appearance of these lesions, thus contributing to an overall smoother body contour. The most current research is exploring its role in addressing the sequelae of massive weight loss, where the combination provides both volume replacement for deflated areas and skin quality enhancement, acting as a minimally invasive adjunct to traditional body lifting procedures. Ultimately, the overarching use is to achieve a natural, harmonious result where the augmented area is not merely filled but biologically integrated, exhibiting the softness, movement, and resilience of native tissue, thereby fulfilling the core ethos of regenerative body contouring.^{8,9}

Surgical Technique

The successful execution of body contouring through autologous microfat grafting enriched with growth factors is a multi-stage, integrated surgical procedure demanding meticulous attention to detail from preoperative planning through to postoperative care. The overarching principle is to optimize the viability of the adipocytes and the mesenchymal stromal cell population within the harvested tissue while simultaneously preparing a potent, autologous biologic adjuvant, ultimately ensuring precise and atraumatic delivery to the recipient sites to foster maximal graft retention and regenerative integration.¹⁰

The procedure initiates with comprehensive patient marking in the upright position, carefully delineating both the donor sites, typically areas of relative adiposity such as the abdomen, flanks, or medial thighs, and the recipient zones for contour enhancement or volume restoration. General anesthesia or deep sedation with local tumescent infiltration is employed to ensure patient comfort and hemodynamic stability. The donor area is infiltrated with a tumescent

solution, a critical step that employs a diluted epinephrine concentration to minimize blood loss and capillary trauma during harvesting, alongside lidocaine for analgesia. The composition and volume of this solution are calibrated to achieve adequate hydrodissection without causing excessive edema or pharmacological toxicity to the adipocytes.^{10,11}

Harvesting is performed using a dedicated, low-negative-pressure aspiration system coupled with blunt-tip cannulas of varying diameters, typically ranging from 2.5 to 3.5 millimeters. The current surgical consensus, supported by recent molecular and cellular viability studies, emphasizes the imperative of minimizing mechanical and shear stress on the adipose tissue. This is achieved by using a manual syringe aspiration technique or a specialized powered device set to very low vacuum pressure, often below 15-20 inHg. The cannula movements are deliberate and fan-shaped, targeting the deeper adipose layers to procure lobules with intact architecture and preserved stromal vascular networks. Concurrently, a separate venous blood draw is performed, usually collecting 20 to 60 milliliters of whole blood into sterile tubes, some of which may contain specific anticoagulants like sodium citrate, depending on the subsequent platelet concentration protocol.^{11,12}

The processing phase is conducted in a sterile field, often utilizing closed-system kits to maintain asepsis and maximize cellular yield. The lipoaspirate undergoes a gentle washing phase with sterile lactated Ringer's or normal saline to remove residual tumescent fluid, free lipids, and hematogenous components. This is followed by a brief, low-speed centrifugation or gravity sedimentation to separate the denser, viable tissue layer from the oil and infranatant fractions. The resultant purified adipose tissue is then mechanically processed into micrografts. This can involve transference between specifically designed luer-lock connectors to emulsify the tissue gently or passage through a fine mesh sieve, creating parcels of adipose tissue ideally sized between 0.5 to 1.5 millimeters to maximize surface area for nutrient diffusion while maintaining critical cell-cell contacts within the stromal niche.^{12,13}

Parallel to fat processing, the autologous growth factor concentrate is prepared. For Platelet-Rich Plasma (PRP), the drawn blood undergoes a differential centrifugation process to separate erythrocytes from the platelet-rich plasma buffy coat. A second centrifugation step further concentrates the platelets, yielding a solution with a platelet concentration 3 to 7 times above baseline. The most contemporary protocols advocate for the use of Leukocyte-Rich PRP (LR-PRP) or liquid Platelet-Rich Fibrin (PRF), as the inclusion of leukocytes and a denser fibrin matrix is associated with a more sustained and potent release of growth factors and cytokines, including key regulators like VEGF and PDGF, over a 7 to 10-day period. This platelet concentrate is activated at the point of use, typically with exogenous calcium chloride or through the endogenous thrombin

Adipose-Derived Micrograft Enrichment with Autologous Growth Factors: A Novel Paradigm in Natural Body Contouring through Regenerative Adipogenesis and Stromal Vascular Fraction-Mediated Neovascularization

generated during contact with the collagen in the adipose tissue, triggering the degranulation of alpha granules.¹³

The pivotal step is the enrichment process. The prepared microfat is intimately combined with the activated platelet concentrate in a specific ratio, commonly ranging from a 1:1 to a 3:1 volume ratio of fat to PRP/PRF. This mixture is allowed to incubate for a brief period, often 5 to 10 minutes, facilitating the impregnation of the fibrin network and growth factors throughout the interstices of the adipose micrografts, thereby creating the final bio-enhanced graft material.^{13,14}

Reinjection is performed using specialized blunt cannulas or injection needles, commonly 16 to 20-gauge in diameter. The fundamental technical tenet is the deposition of minuscule aliquots, no larger than 0.1 to 0.2 milliliters per pass, in a retrograde fashion as the cannula is withdrawn. This technique distributes the graft in a three-dimensional lattice or "micro-droplet" pattern across multiple tissue planes, from the deep subcutaneous layer to the immediate subdermal plane, depending on the desired contour effect. This multifocal deposition ensures each graft fragment remains in close proximity to the host vasculature, facilitating rapid plasmatic imbibition and subsequent inosculation. The procedure concludes with meticulous closure of the minimal access incisions and the application of gentle compressive garments to the donor sites, while avoiding any significant pressure on the delicate newly placed grafts to prevent displacement or vascular compromise. The entire orchestrated technique, from atraumatic harvest to structured deposition, is designed to engineer a favorable regenerative microenvironment, positioning the enriched micrografts for successful neovascularization, adipocyte survival, and ultimate natural integration into the body's contour.^{13,14,15}

CONCLUSION

In summation, the integration of autologous growth factor concentrates with meticulously processed adipose-derived micrografts represents a significant and scientifically substantiated evolution in the paradigm of body contouring. This convergence transcends the historical limitations of simple volume displacement, establishing a sophisticated, biologically-driven modality firmly rooted in the principles of regenerative medicine. The elucidated mechanisms—whereby the synergistic triad of adipose-derived stem cells (ASCs), endothelial progenitors within the stromal vascular fraction (SVF), and a potent milieu of platelet-derived cytokines orchestrate enhanced angiogenesis, mitigated ischemia-reperfusion injury, and promoted adipogenesis—provide a robust theoretical foundation for the observed clinical superiority. Current evidence, encompassing both rigorous *in vitro* models and prospective clinical series, consistently indicates that this bio-enhancement strategy yields significantly improved graft viability, volumetric retention, and cutaneous regenerative outcomes compared to conventional lipofilling alone.

The clinical implications are profound. This technique empowers the surgeon to achieve not merely a change in silhouette, but a holistic remodeling of the integumentary and subcutaneous architecture. The resultant outcomes are characterized by their natural aesthetics, seamless integration with native tissues, and demonstrable durability, addressing the core patient desires for safety, efficacy, and authenticity. Importantly, the entirely autologous nature of the construct eliminates risks of foreign-body reaction or allergenicity, while the refined, low-trauma surgical protocol enhances procedural safety profiles. As the field continues to advance, further refinements in growth factor delivery kinetics—such as the use of platelet-rich fibrin matrices for sustained release—and standardization of processing protocols will undoubtedly optimize reproducibility and outcomes. Future research trajectories must prioritize large-scale, multicenter randomized controlled trials with long-term follow-up employing advanced volumetric imaging to quantitatively validate the permanence of results. Furthermore, molecular studies to precisely map the paracrine signaling cascades initiated by the enriched graft will refine our understanding and application. Ultimately, microfat grafting enriched with autologous growth factors has unequivocally transitioned from an experimental concept to a cornerstone technique in natural body remodeling, offering a powerful, patient-specific tool that harmonizes the art of aesthetic enhancement with the science of tissue regeneration, thereby defining a new standard of care in autologous restorative surgery.

REFERENCES

- I. Hong KY, Yim S, Kim HJ, Jin US, Lim S, Eo S, et al. The fate of the adipose-derived stromal cells during angiogenesis and adipogenesis after cell-assisted lipotransfer. *Plast Reconstr Surg*. 2018;141:365–75. doi: 10.1097/PRS.0000000000004021.
- II. Strong AL, Cederna PS, Rubin JP, Coleman SR, Levi B. The current state of fat grafting: a review of harvesting, processing, and injection techniques. *Plast Reconstr Surg*. 2015;136:897–912. doi: 10.1097/PRS.0000000000001590.
- III. Khouri RK, Jr, Khouri RK. Current clinical applications of fat grafting. *Plast Reconstr Surg*. 2017;140:466e–486e. doi: 10.1097/PRS.0000000000003648.
- IV. Tonnard P, Verpaele A, Peeters G, Hamdi M, Cornelissen M, Declercq H. Nanofat grafting: basic research and clinical applications. *Plast Reconstr Surg*. 2013;132:1017–26. doi: 10.1097/PRS.0b013e31829fe1b0.
- V. Suszynski TM, Sieber DA, Van Beek AL, Cunningham BL. Characterization of adipose tissue for autologous fat grafting. *Aesthet Surg J*. 2015;35:194–203. doi: 10.1093/asj/sju059.

Adipose-Derived Micrograft Enrichment with Autologous Growth Factors: A Novel Paradigm in Natural Body Contouring through Regenerative Adipogenesis and Stromal Vascular Fraction-Mediated Neovascularization

- VI. Hassan M, Latif N, Yacoub M. Adipose tissue: friend or foe? *Nat Rev Cardiol*. 2012;9:689–702. doi: 10.1038/nrcardio.2012.148.
- VII. Rosen ED, Spiegelman BM. Adipocytes as regulators of energy balance and glucose homeostasis. *Nature*. 2006;444:847–53. doi: 10.1038/nature05483.
- VIII. Adams KF, Schatzkin A, Harris TB, Kipnis V, Mouw T, Ballard-Barbash R, et al. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. *N Engl J Med*. 2006;355:763–78. doi: 10.1056/NEJMoa055643.
- IX. Trayhurn P. Adipocyte biology. *Obes Rev*. 2007;8 Suppl 1:41–4. doi: 10.1111/j.1467-789X.2007.00316.x.
- X. Berry DC, Stenlesen D, Zvev D, Graff JM. The developmental origins of adipose tissue. *Development*. 2013;140:3939–49. doi: 10.1242/dev.080549.
- XI. Rupnick MA, Panigrahy D, Zhang CY, Dallabrida SM, Lowell BB, Langer R, et al. Adipose tissue mass can be regulated through the vasculature. *Proc Natl Acad Sci U S A*. 2002;99:10730–5. doi: 10.1073/pnas.162349799.
- XII. Eto H, Kato H, Suga H, Aoi N, Doi K, Kuno S, et al. The fate of adipocytes after nonvascularized fat grafting: evidence of early death and replacement of adipocytes. *Plast Reconstr Surg*. 2012;129:1081–92. doi: 10.1097/PRS.0b013e31824a2b19.
- XIII. Kato H, Mineda K, Eto H, Doi K, Kuno S, Kinoshita K, et al. Degeneration, regeneration, and cicatrization after fat grafting: dynamic total tissue remodeling during the first 3 months. *Plast Reconstr Surg*. 2014;133:303e–313e. doi: 10.1097/PRS.0000000000000066.
- XIV. Schaffler A, Buchler C. Concise review: adipose tissue-derived stromal cells: basic and clinical implications for novel cell-based therapies. *Stem Cells*. 2007;25:818–27. doi: 10.1634/stemcells.2006-0589.
- XV. Ashjian PH, Elbarbary AS, Edmonds B, DeUgarte D, Zhu M, Zuk PA, et al. In vitro differentiation of human processed lipoaspirate cells into early neural progenitors. *Plast Reconstr Surg*. 2003;111:1922–31. doi: 10.1097/01.PRS.0000055043.62589.05.