# Clinical Applications of Pure Recombinant Human Platelet-Derived Growth Factor BB in Esthetic Medicine and Plastic Surgery

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**KEYWORDS**

• Platelet-derived growth factor • Wound healing • Esthetic medicine • Plastic surgery • Regeneration • Rejuvenation • PDGF

**KEY POINTS**

- Platelet-derived growth factor (PDGF) is a critical endogenous initiator of natural healing in skin and other tissues of the human body.
- Pure recombinant PDGF-BB (rhPDGF-BB or pure PDGF) is a pharmaceutical copy of natural PDGF and is the first and only growth factor to be approved by the US FDA to improve healing.
- Pure PDGF has been recently introduced into plastic surgery and esthetic medicine to speed healing, reduce post-procedure downtime, improve esthetic outcomes with promising results.
- The mechanism of action of PDGF and clinical cases using sterile, off-the-shelf pure PDGF in plastic surgery and esthetics are described herein.

## INTRODUCTION

Platelet-derived growth factor (PDGF) is an endogenous, broad-acting, tissue-healing protein primarily released from activated platelets.[1] PDGF signaling drives chemotaxis and mitogenesis in cells of mesenchymal origin and is the key initiator of the healing cascade after injury.[2] The PDGF family of growth factors contains 5 members that are found naturally in the body. These include AA homodimer, AB heterodimer, BB homodimer, CC homodimer, and DD homodimer.[3,4] PDGF dimers exert their biological activities by binding to receptors present on the surface of target cells.[5] PDGF receptors are transmembrane protein tyrosine kinases and exist in 2 isoforms, alpha and beta, which are expressed in various cell types, either individually or together.[6] Binding of the PDGF ligands leads to dimerization of the receptors and activation of downstream signaling cascades. The alpha receptor can bind both A and B subunits of PDGF with high affinity, while the beta receptor binds only the B subunit with high affinity.[7,8] As a result, the BB homodimer can effectively engage both alpha and beta receptors, making PDGF-BB the preferable form of PDGF for therapeutic purposes.

Endogenous PDGF and its receptors are present in many cell types. Examples of cells expressing PDGF-BB and/or its receptors that are of particular importance in plastic surgery and

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**Abbreviations**

| | |
|---|---|
| FDA | Food and Drug Administration |
| HA | hyaluronic acid |
| LRM | Lynch Regenerative Medicine |
| MSC | mesenchymal stem cell |
| PDGF | platelet-derived growth factor |
| PRF | platelet-rich fibrin |
| PRP | platelet-rich plasma |
| RF | radiofrequency |

medical esthetics include, but are not limited to the following:

- Dermal fibroblasts,
- Keratinocytes,
- Osteoblasts,
- Chondrocytes,
- Vascular endothelial cells,
- Mesenchymal stem cells (MSCs),
- Pericytes,
- Smooth muscle cells,
- Skeletal myoblasts, and
- Schwann cells, glial cells and other neural cells.

The level of expression of both the ligand and the receptor are low in healthy intact tissue, but following injury, there is a rapid and localized upregulation of both proteins.[9] While PDGF is primarily produced in blood platelets, it is also released by macrophages, endothelial cells, fibroblasts, and other cell types. Secreted PDGF binds to its receptors, also located on the surface of many different cells types,[5] which activates multiple cellular responses that are critical for tissue repair (**Fig. 1**). These include the stimulation of:

- *Chemotaxis*, exemplified by the directed recruitment or cellular *homing* of MSCs, dermal fibroblasts, osteoblasts, chondrocytes, tenocytes, and pericytes, cell types that are essential for the phases of healing across many different tissues;[2]
- *Mitogenesis*, exemplified by stimulating proliferation of the cells responsible for populating the wound and promoting its healing;[10]
- *Angiogenesis*, exhibited by neovascularization, that is, promoting the formation of a new or improved blood supply, critical for regeneration of tissue and maintaining healthy skin, promotion of vessel stability, and upregulation of vascular endothelial growth factor, another potent angiogenic protein, and stabilization of the endothelial lining,[11–13]
- *Cell survival*, or antiapoptosis as exhibited by protecting the repair cells from cell death, so they remain viable and active for longer in the healing tissues[14–16]; and
- *Metabolic activity,* exhibited by the increased production, deposition, and remodeling of extracellular matrix proteins, including collagens types I, III, and VI as well as fibronectin, hyaluronic acid (HA), and other glycosaminoglycans.[17,18]

PDGF is a key mediator of the body's innate ability to heal and is used therapeutically to accelerate and improve the natural healing process. The upregulation of PDGF receptors at sites of injury supports the potential for exogenous PDGF to enhance healing and recovery, which is critical for successful outcomes following surgical procedures that cause damage to the skin or inflammatory or accidental injuries causing damage to the skin or underlying tissues. Here, we review the background, formulation, safety, and clinical applications of pure PDGF for skin healing and rejuvenation and ruminate novel applications of pure PDGF in medical esthetics.

## PLATELET-DERIVED GROWTH FACTOR PRODUCTS IN REGENERATIVE MEDICINE

Pure recombinant PDGF-BB (rhPDGF-BB or pure PDGF) is a pharmaceutically made protein that is identical to the endogenous protein growth factor but produced by recombinant DNA technology in yeast cells. As of this writing, pure PDGF (100-300 ug/ml) has been used in regenerative medicine for nearly 30 years with the US Food and Drug Administration's (FDA) approval of 4 products that promote healing, regeneration, and rejuvenation of skin, bone, mucosa, and gingiva. Pure PDGF was first available in clinical practice in 1997 with the approval of a topical gel (Regranex Gel; 100 ug PDGF-BB/ml) to speed healing of lower extremity skin wounds in diabetic patients after studies demonstrated faster time to healing when pure PDGF was applied to the wound daily as an adjunct to standard wound care practices.[19] In 2005, the second pure PDGF product (GEM 21S; 300ug PDGF-BB/ml) was approved for bone and soft tissue regeneration in patients undergoing reconstructive surgery for periodontal defects.[20] Ten years later in 2015, and again in 2018, 2 more pure PDGF products (300 ug PDGF-BB/ml) were deemed safe, effective, and less invasive than autogenous bone harvested from the iliac crest or tibia for ankle and hindfoot fusions to treat severe arthritis, deformities, or injuries.[21] To date, it is estimated that more than 5 million people are believed to have been treated with one of these pure PDGF products, demonstrating this growth

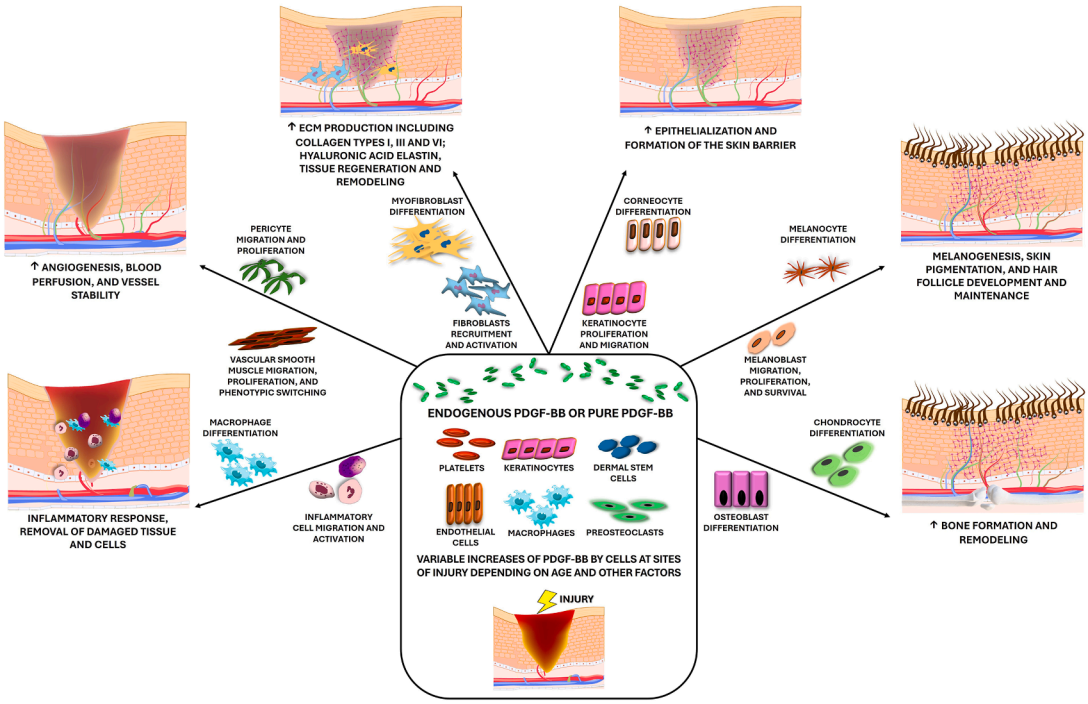


**Fig. 1.** PDGF-BB is a critical activator of tissue repair and exerts its biological effects by the recruitment, proliferation, and differentiation of multiple cell types and cellular processes in all phases of healing and tissue regeneration. (*From* "Pure Recombinant Platelet-Derived Growth Factor in Tissue Repair and Rejuvenation: A Review Exploring Frontiers in Regenerative Medicine". Plastic and Reconstructive Surgery:10.1097/PRS.0000000000012426, September 15, 2025. | DOI: 10.1097/PRS.0000000000012426[49]; with permission.)

factor's tremendous beneficial healing potential across multiple tissue types, indications, and patient populations in regenerative medicine.

Autologous blood-derived products, such as platelet-rich plasma (PRP) and platelet-rich fibrin (PRF), are common practice in esthetics and dermatology that offer a natural source of PDGF from the patient's own blood,[22,23] but the concentration of PDGF and hence, the effectiveness is highly variable based on the donor's age and health and different blood preparation techniques.[24,25] Exosomes offer another way to deliver growth factors via lipid bilayer vesicles carrying a variety of proteins and nucleic acids that are applied to injured or damaged tissue and release the vesicle contents through membrane fusion, endocytosis, or ligand-receptor interactions with the surrounding cells,[26] but there have been significant challenges with producing comparable results between laboratories due to the absence of standardized procedures for their production and the heterogeneity of their protein contents.[27] While these products may enhance healing by stimulating cellular proliferation and boosting extracellular matrix production to a certain extent, the preparation methods are far less predictable than the production of pharmaceutical grade, recombinant pure PDGF, consistently formulated at precise concentrations in a stable, physiologic buffer.

Recently, a topical formulation of pure PDGF debuted in medical esthetics as a cosmetic listed with FDA as a proprietary blend of the same source of pure PDGF (300 ug PDGF-BB/ml) that is present in the 4 FDA-approved medical products packaged together with sterile HA. Pure PDGF can effectively *supercharge* the natural healing process, converting it to the powerful innate response such as present in younger individuals, leading to the improved healing and appearance of skin. Pure PDGF is currently being used as part of the postprocedural management to stimulate healing, reduce downtime and improve the overall patient satisfaction following plastic surgery, laser skin resurfacing, and mechanical or radiofrequency (RF) microneedling.[28]

## SAFETY OF PURE PLATELET-DERIVED GROWTH FACTOR

Recently, there has been a lot of misinformation presented in non–peer-reviewed online channels related to the safety of pure PDGF in medicine. The nonclinical and clinical safety of exogenously applied pure PDGF has been thoroughly evaluated for more than 2 decades through *in vitro* and *in vivo*

testing, clinical safety studies, and postmarket analyses. These studies have assessed the pharmacokinetic profile and potential for pure PDGF to cause unwanted side effects through various routes of administration, including topical application onto wounded skin, repeated intradermal injections, subcutaneous injections, intravenous injections, and surgical implantation into the body, and have evaluated the long term carcinogenicity, acute and repeated dose toxicity, mutagenicity, cytotoxicity, dermal and ocular irritation, hypersensitivity, and reproductive/development toxicity at doses far in excess of the dose used in clinical applications (**Table 1**).

Pharmacokinetic studies confirmed that systemic exposure to pure PDGF was negligible following exogenous application, whether delivered locally (eg, topical, implanted, or injected) or systemically (ie, intravenous injections).[29,30] Nonclinical and clinical biocompatibility and toxicology studies demonstrated that pure PDGF (delivered through a variety of routes of administration, including topical, implanted, and injected, and different dosing frequencies, including one-time and repeated exposures) was noncytotoxic, nonirritating, nonsensitizing, nonmutagenic, nonclastogenic, noncarcinogenic, and nontoxic at doses thousands of times higher than those used in clinical practice.[31–34]

In relation to cancer, nonclinical studies and long-term clinical follow-up demonstrated that pure PDGF was nonmutagenic, nonclastogenic,

**Table 1**
**Summary of biocompatibility and toxicology studies for pure platelet-derived growth factor BB (rhPDGF-BB)**

| Study Type | # Of Studies | Model | Route of Administration | Result |
|---|---|---|---|---|
| Cytotoxicity | 1 | In vitro (ISO 10993–5) | In vitro | Noncytotoxic |
| Dermal and ocular irritation | 5 | Rabbit skin<br>Rabbit ocular | ID<br>SC<br>Ocular | NonIrritant |
| Hypersensitivity | 3 | Guinea pig maximization test | ID | Nonsensitizing and sensitizing[a] |
| Mutagenicity | 8 | Bacterial mutation (AMES)<br>Mammalian cell mutation<br>In vitro chromosomal aberration<br>DNA repair<br>Mouse bone marrow micronucleus | In vitro<br>In vitro<br>In vitro<br>In vitro<br>IP | Nonmutagenic |
| Acute systemic toxicity | 4 | Mouse<br>Rabbit<br>Monkey | IV, IP, SC | No systemic toxicity at human doses |
| Repeat dose toxicity | 4 | Mouse<br>Rabbit<br>Monkey | IV, Topical, SC | Transient effect, with no long term systemic toxicity |
| Chronic toxicity and carcinogenicity | 1 | Rat | Implantation | Nontoxic and noncarcinogenic |
| Reproductive development/ teratology | 1 | Rat | IV | NOAEL: 400 μg/kg/day |
| Local response following implantation | 1 | Rat | Implantation | Transient tissue responses consistent with MOA |

*Abbreviations:* ID, intradermal injection; IP, intraperitoneal injection; IV, intravenous injection; MOA, mechanism of action; NOAEL, no observed adverse event level; SC, subcutaneous injection.

[a] One study was determined to be nonsensitizing and 2 studies were determined to be sensitizing, which was not unexpected for a human protein in an animal model. Three clinical studies (see below) demonstrated that rhPDGF-BB was not sensitizing.

*From* "Safety of Exogenous Recombinant Human Platelet-Derived Growth Factor BB (rhPDGF-BB) for Medical and Cosmetic Applications: A Review." Journal of Cosmetic Dermatology, 2026; 25:e70636 1 of 6 https://doi.org/10.1111/jocd.70636.

noncarcinogenic, and established that there was not an increased risk of cancer incidence or cancer mortality following single-time implantation or repeated, daily applications for up to 20 weeks, (ie, 140 daily doses) of pure PDGF.[35] In 2008, FDA required the Regranex label to add a boxed warning for potential increased risk of cancer mortality when multiple tubes of Regranex (equivalent to 4.5 mg cumulative dose) were dispensed. In 2018, FDA removed the boxed warning based on a review of subsequent clinical studies, including longer term follow-up of the same patient cohort and evaluation of additional patient cohorts (involving approximately 13,000 patients more than 11 years of follow-up), that found no evidence of an increased risk of cancer incidence or mortality among pure PDGF treated patients.[35,36]

In summary, PDGF has undergone extensive nonclinical and clinical safety evaluations when exogenously applied via various routes of administration including topical, surgical implantation, and subcutaneous, intradermal, intraperitoneal, or intravenous injections. The totality of the data demonstrates that pure PDGF, when applied exogenously in single or repeated daily dosing applications, has a favorable safety profile with a strong track record of safe clinical use for more than 25 years.

## PURE PLATELET-DERIVED GROWTH FACTOR IN CLINICAL PRACTICE

Pure PDGF topical solution for skin rejuvenation contains sterile, pharmaceutical grade pure PDGF, produced by recombinant technology in yeast cells. Immediately before topical application, pure PDGF (300 ug/mL) is mixed with sterile hyaluronic acid (HA), a molecule that attracts water and has long been used for aftercare in esthetic procedures to increase hydration and improve the elasticity and appearance of the skin.[37] The cosmetic formulation contains more than 1,000 times the concentration of PDGF in alternative blood-derived applications, such as PRP/PRF and exosomes, and meets the same manufacturing standards for purity, potency, and sterility that were established for the other 4 FDA-approved products.[38] Pure PDGF plus HA is currently being widely used as part of the postprocedural management to improve healing and rejuvenation following laser skin resurfacing, RF[28] and mechanical microneedling, and plastic surgery and pure PDGF mixed with sterile saline is being developed as an injectable for treating fine lines and wrinkles in the infraorbital hollow and forehead and stimulating hair growth for certain types of baldness. Here, we review the clinical practice of using pure PDGF to unlock the body's innate ability to repair itself as in youth and reduce postprocedural recovery time following cosmetic procedures and ruminate novel applications of pure PDGF in medical esthetics.

### *Laser Skin Resurfacing*

Laser resurfacing technologies induce injury to the skin layers to promote collagen production, tighten skin, and reduce dermal imperfections, such as brown spots, hyperpigmentation, redness, broken blood vessels, large pores, acne scars, stretch marks, and crepey skin.[39,40] There are multiple classes of skin resurfacing lasers that combine ablative, nonablative, nonfractional, and fractional techniques, but they differ in their recovery timeline, severity of side effects, and degree of results.

Healing and recovery following laser ablation may last several days to several weeks depending on the type of resurfacing technique performed. Pain, dryness, stinging, peeling, exudation, and edema are side effects of laser treatment, and proper aftercare is critical to optimizing outcomes and reducing the risks of adverse effects, such as erythema and dyspigmentation. Standard of care includes maintaining moisture balance, protecting the newly developing skin barrier, and preventing microbial dysbiosis with small-molecule topical formulations that enhance natural wound healing.[41]

Recently, pure PDGF has been used postresurfacing treatments to alleviate discomfort, reduce downtime, and enhance the results. The topical formulation of pure PDGF combined with HA is applied immediately following the procedure and every 6 hours for 24 hours, postoperatively. Patients treated with pure PDGF experienced less inflammation immediately following laser treatment (**Fig. 2**), reduced redness, swelling, scabbing, and peeling in the days immediately following the laser treatment (**Fig. 3**), and demonstrated faster recovery times and less discomfort overall (see **Fig. 3**).

### *Radiofrequency and Mechanical Microneedling*

Microneedling improves contour and texture of the skin by creating cutaneous microwounds via repetitive skin punctures using needles.[42] In the case of RF microneedling, energy is delivered in a grid-like pattern by the needles to the dermis.[42] This technique stimulates dermal inflammation, cell proliferation, revascularization, and remodeling to improve skin aging, reduce fine lines, treat acne and acne scars, and lessen stretch marks by inducing extracellular matrix deposition and dermal rejuvenation.[43,44] Microneedling side effects that include

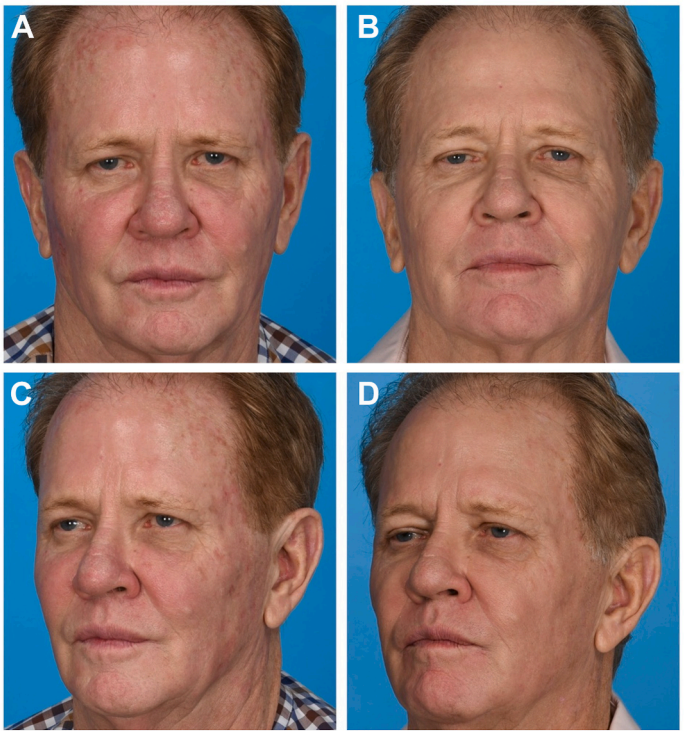


**Fig. 2.** Pure PDGF combined with HA and applied topically following laser treatment reduced discomfort, accelerated recovery, and improved patient satisfaction. (*A*) and (*C*) Immediately before laser treatment and application of pure PDGF; (*B*) and (*D*) Four weeks after laser treatment and application of pure PDGF.

pain, tightness, erythema and edema, swelling, and bruising that are typically mild and resolve after several weeks.[45]

The microchannels produced in the skin following microneedling provide an efficient pathway for topical agents to be delivered and penetrate the deep layers of the skin. Pure PDGF is being used as an adjunct therapy for RF and/or mechanical microneedling due to its potent ability to enhance collagen and elastin production, natural healing, and skin texture and quality.[28] Pure PDGF combined with HA is applied during or following microneedling by covering the area with a thin layer of the solution. Patients were

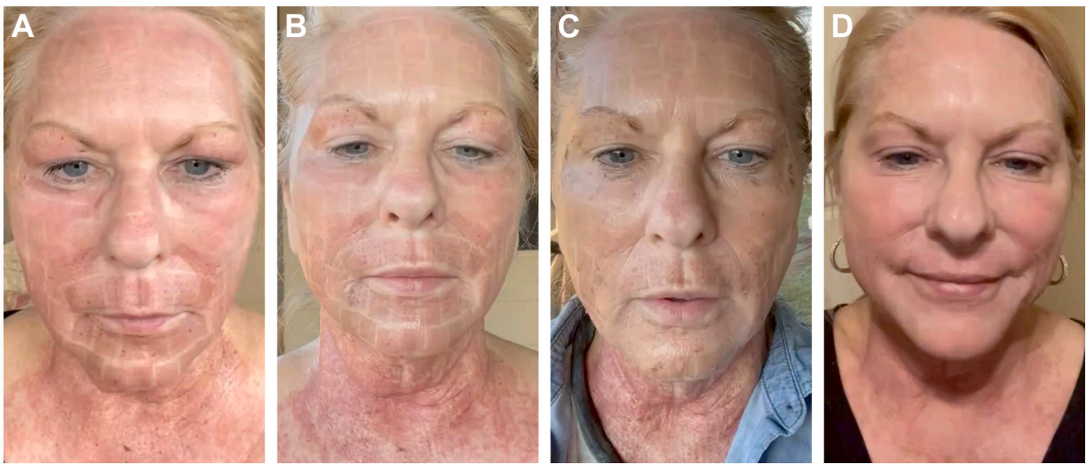


**Fig. 3.** Pure PDGF combined with HA and applied topically immediately following laser treatment and every 6 hours for 24 hours reduced redness, swelling, scabbing, and peeling, accelerated healing and recovery, and resulted in less discomfort for the patient. (*A*) 24 hours after laser treatment; (*B*) 48 hours after laser treatment; (*C*) 72 hours after laser treatment; (*D*) 5 days after laser treatment.

also instructed to follow routine aftercare instructions. Patients treated with pure PDGF plus HA following microneedling have reduced redness and swelling immediately following the treatment (**Fig. 4**) and experienced better long-term outcomes and overall patient satisfaction.

### *Plastic Surgery*

Cosmetic plastic surgery to improve appearance and boost self-confidence involves reshaping or altering the proportion of tissue to change the underlying structures of the body, such as the face, nose, breasts, and stomach.[46,47] Incisions are made to access the bodily structures that will be altered by repositioning or remolding the existing tissue, removal of excessive tissue, or implantation of additional tissue and are closed in layers through specialized techniques to minimize scarring.[48,49] Reducing downtime following plastic surgery has become increasingly important for patients.

Both patients and surgeons continue to search for methods to accelerate healing and recovery, diminish scarring, and reduce postoperative discomfort. Historically, PRP was used for this purpose; however, PRP preparation is a more cumbersome process that requires venipuncture, blood collection, centrifugation, and processing before application. More recently, pure PDGF has been introduced as a streamlined, ready-to-use, sterile alternative. Its standardized concentration and ease of application eliminate the variability and inconvenience associated with PRP preparation.

Pure PDGF combined with HA is evenly distributed across the area immediately following closure of the incisions, then again by the patient during routine care at home. Patients were also instructed to follow routine aftercare instructions. Patients treated with topical pure PDGF combined with HA have observed reduced postoperative bruising and swelling and an overall faster recovery.[50]

### *Novel Applications in Surgery and Esthetic Medicine*

Ongoing clinical studies are evaluating the role of pure PDGF across multiple domains of esthetic medicine and surgery, including periorbital rejuvenation, hair restoration, scar reduction and as an adjunct therapy to promote regeneration of the subcutaneous tissues during plastic surgery. In these applications, pure PDGF is believed to

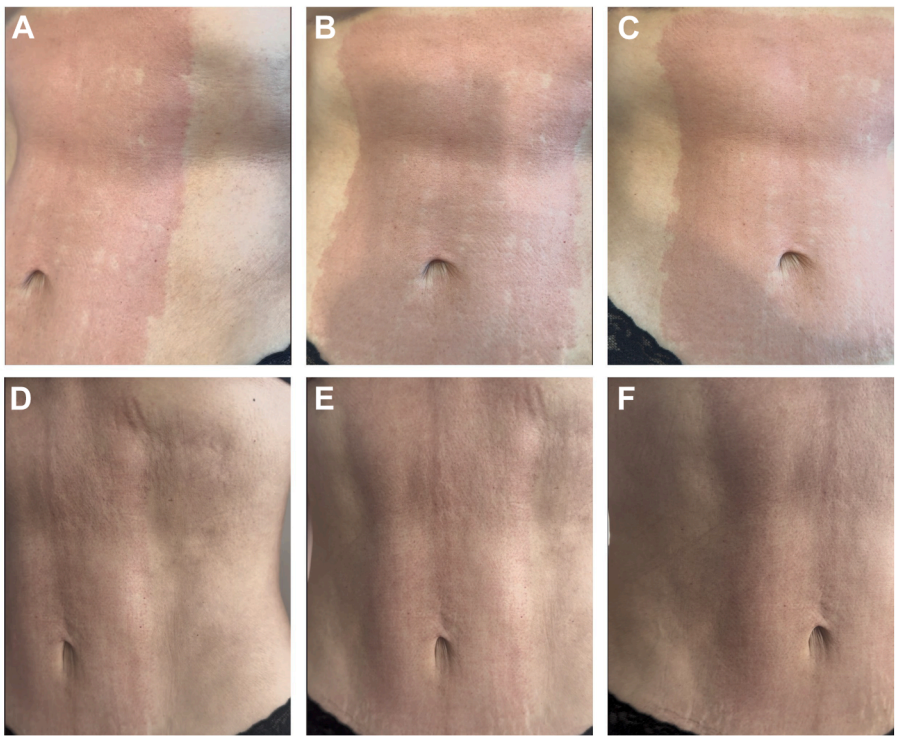


**Fig. 4.** Pure PDGF mixed with HA and applied topically immediately following microneedling treatment reduced redness, inflammation, and discomfort. (*A*), (*B*), and (*C*) Immediately after microneedling, before application of pure PDGF; (*D*), (*E*), and (*F*) after application of the pure PDGF plus HA mix.

enhance dermal regeneration, stimulate fibroblast proliferation, promote angiogenesis, and support extracellular matrix remodeling. When used as an injectable or when used topically in the underlying tissues during surgery, the pure PDGF may be diluted with normal saline to minimize the amount of postprocedural swelling. Preliminary experience suggests potential benefits in reducing postoperative edema and ecchymosis, improving skin tone and texture, and stimulating follicular activity. Further research is underway to establish its efficacy, safety, and optimal protocols for integration into routine surgical or aesthetic practice.

## CLINICS CARE POINTS

- Pure platelet-derived growth factor (PDGF) combined with hyaluronic acid (HA) used topically as part of the postprocedural management of laser skin resurfacing, microneedling, and plastic surgery improves healing, reduces downtime, and optimizes results.
- Pure PDGF is easy to apply, delivers a standardized concentration, and is a streamlined, ready-to-use alternative to platelet-rich plasma, a more cumbersome process that requires venipuncture, blood collection, centrifugation, and processing before application.
- Pure PDGF is safe when used as a single dose or repeated doses in topical cosmetic applications and improves postprocedure patient satisfaction.

## DISCUSSION

Pure PDGF research and development spans decades of preclinical and clinical studies demonstrating potent mitogenic-, chemotactic-, and metabolic-promoting activity in most of the cells involved in tissue healing, regeneration, and rejuvenation. More than 150 clinical trials have established the safety and efficacy of pure PDGF for healing and repair of cutaneous wounds and bone defects. Most recently, pure PDGF is being used in plastic surgery and medical esthetics practices to enhance outcomes following surgical and esthetic procedures and improve the appearance of the skin.

The rapid adoption of pure PDGF in the esthetic market has been driven by the positive clinical outcomes that have been observed. Randomized, controlled clinical trials are underway to further evaluate the potential for pure PDGF to stimulate faster healing, regeneration, and rejuvenation of skin and its supporting tissues following surgery, to reduce fine lines and improve the appearance of the periorbital hallows, and to promote hair regrowth for certain types of baldness, as well as in other fields of regenerative medicine. These and future studies evaluating the safety and effectiveness of pure PDGF in esthetic procedures will add to the decades of historical data supporting PDGF's ability to safely accelerate healing in many different tissues and support the expansion and advancement of its use in esthetic medicine.

## SUMMARY

Pure PDGF is among the most well studied biologics in medicine and has repeatedly been shown to be a safe and effective component of many FDA-approved products for promoting tissue regeneration. It has been found to be a promising new cosmetic product that enhances the body's natural ability to self-heal demonstrated by reducing recovery times and improving results following cosmetic procedures. As patient satisfaction is paramount and one of the biggest challenges in the field, products, such as pure PDGF, that speed healing, reduce side effects, and optimize outcomes have the potential to transform and revolutionize the growing field of medical esthetics.

## DISCLOSURE

Dr S.E. Lynch is the founder of Lynch Regenerative Medicine (LRM). Dr C. Hee is the Chief Scientific Officer of LRM. The other authors have nothing to disclose.

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