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Treatment Algorithm of Complications after Filler Injection: Based on Wound Healing Process

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ABSTRACT

Cosmetic facial filler injections have become a cornerstone in aesthetic dermatology; however, associated complications, ranging from mild erythema to severe vascular compromise, necessitate effective and timely intervention. This study proposes a treatment algorithm grounded in the biological stages of wound healing: hemostasis, inflammation, proliferation, and remodeling. By aligning therapeutic strategies with these stages, clinicians can address adverse events more systematically and promote tissue recovery. Early-stage complications such as edema or erythema can often be managed with conservative measures, whereas mid- to late-stage events like granuloma formation or tissue necrosis require more invasive approaches, including hyaluronidase administration, corticosteroids, or surgical debridement. The algorithm emphasizes the importance of early diagnosis, risk stratification, and individualized care, considering patient history, filler type, and injection technique. Additionally, adjunctive therapies such as hyperbaric oxygen, laser treatment, or platelet-rich plasma may enhance healing outcomes. This framework aims to reduce long-term morbidity and provide practitioners with a clear, biologically informed decision-making pathway to manage filler-related complications effectively.

Introduction

Cosmetic facial fillers are among the most performed non-surgical procedures worldwide. Although generally safe, complications especially vascular events and delayed inflammatory reactions can result in devastating outcomes such as skin necrosis or even blindness [1]. The challenge lies in early recognition and appropriate management. Applying the wound healing paradigm offers a logical and physiologic approach to managing these complications based on the body's natural recovery phases [2].

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Table 1. Literature Review on Treatment Algorithm of Filler Injection Complications Based on Wound Healing

Ref No.	Study	Focus	Key Findings & Relevance
[3]	AlQahtani et al. (2024)	Management of early vascular compromise post-filler	Introduced a phased treatment protocol aligned with inflammatory and proliferative phases of wound healing; emphasized immediate hyaluronidase administration. (AlQahtani et al., 2024)
[4]	Zhang et al. (2024)	Histological response to HA filler-induced ischemia	Demonstrated macrophage recruitment and tissue granulation around occluded vessels; suggested treatment windows during proliferation phase. (Zhang et al., 2024)
[5]	Lee & Choi (2024)	Long-term outcomes after delayed filler complications	Reviewed 30 cases with granulomas and fibrosis; supported corticosteroid and 5-FU in remodeling phase. (Lee & Choi, 2024)
[6]	Sharma et al. (2024)	Algorithm-based interventions in filler embolism	Proposed a five-step algorithm combining aspiration, massage, heat, hyaluronidase, and systemic steroids. Outcome correlated with wound healing dynamics. (Sharma et al., 2024)
[7]	Ramesh & Dutta (2023)	Complications based on filler type	Compared HA, CaHA, and PLLA fillers in terms of inflammatory response and chronic complications; recommended tailored wound-based management. (Ramesh & Dutta, 2023)
[8]	Tan et al. (2023)	Ocular embolism cases post-filler	Outlined emergency algorithm focusing on arterial recanalization and anti-inflammatory measures; matched with wound repair stages. (Tan et al., 2023)
[9]	Ibrahimi et al. (2022)	Hyaluronidase dosing efficacy	Found high-dose pulsed hyaluronidase more effective within first 6 hours of occlusion; aligns with hemostasis/inflammation overlap. (Ibrahimi et al., 2022)
[10]	Morris et al. (2022)	Treatment of nodules and granulomas	Encouraged ultrasound-guided corticosteroid or 5-FU injection in late complications resembling chronic wound behavior. (Morris et al., 2022)
[11]	Jung et al. (2021)	Anatomical review for avoiding vascular events	Emphasized anatomical danger zones; indirectly informs prevention and early-stage wound-oriented strategies. (Jung et al., 2021)
[12]	Feng & Guo (2021)	Healing trajectory post-intradermal HA injection	Histopathology showed overlapping healing stages, especially during 3–14 days post-injection; recommended dynamic treatment. (Feng & Guo, 2021)
[13]	Lewis et al. (2020)	Multimodal therapy in late complications	Demonstrated benefits of pulsed ultrasound, anti-TNF agents, and laser in chronic nodules; mimicked advanced wound care regimens. (Lewis et al., 2020)
[14]	Han & Kim (2020)	Algorithm of aesthetic emergencies	Developed decision-tree integrating time of onset, filler type, vascular symptoms, and healing stage; improved intervention outcomes. (Han & Kim, 2020)

Classification of Filler Complications

Filler-related complications can be classified by time and severity:

- ✓ **Immediate (within hours):** Pain, bruising, edema, vascular occlusion;
- ✓ **Early (1–2 weeks):** Infection, lumps, hypersensitivity;
- ✓ **Delayed (weeks to months):** Granulomas, nodules, biofilm-related infections [15].

A wound healing–based management algorithm provides a structured approach to these varying presentations.

Wound Healing Phases and Corresponding Management Strategies

Hemostasis Phase (Minutes to Hours Post-Injury):

- ✓ **Goal:** Control bleeding and initiate clotting.
- ✓ **Relevant Complications:** Vascular occlusion, hematoma formation [16].

Treatment Approach:

- ✓ **Immediate recognition of vascular compromise:** Signs include blanching, pain, and livedo reticular is.

- ✓ **Injection of hyaluronidase:** 150–450 IU immediately, repeated as needed [17].

Warm compresses to encourage vasodilation:

- ✓ Aspirin administration: (300 mg) to reduce clotting.
- ✓ Topical nitroglycerin paste in case of occlusion.
- ✓ Urgent ophthalmology referral if vision is affected [18].

Inflammation Phase (Hours to Days)

- ✓ **Goal:** Recruit immune cells, contain infection.
- ✓ **Relevant Complications:** Swelling, pain, infection, hypersensitivity.

Treatment Approach:

- ✓ Systemic corticosteroids (e.g., prednisolone 20–40 mg/day) to reduce inflammation.
- ✓ Antibiotics (e.g., amoxicillin-clavulanic acid or doxycycline) if infection is suspected.
- ✓ Avoid massage during this phase to prevent pathogen spread.
- ✓ Biofilm consideration: If symptoms persist, use dual antibiotic and corticosteroid therapy.

Proliferation Phase (Days to Weeks):

- ✓ **Goal:** Tissue regeneration and neovascularization [19].
- ✓ **Relevant Complications:** Nodule formation, foreign body reaction.

Treatment Approach:

- ✓ Needle aspiration for fluctuant nodules.
- ✓ Intraregional corticosteroids (e.g., triamcinolone 5–10 mg/ml).
- ✓ 5-FU injections for steroid-resistant nodules.
- ✓ Ultrasound guidance may be used to locate granulomas.

Remodeling Phase (Weeks to Months):

- ✓ **Goal:** Collagen remodeling and tissue strengthening.
  Relevant Complications: Fibrosis, scarring, persistent granulomas.

Treatment Approach:

- ✓ Laser therapy (e.g., pulsed dye or CO2 laser) for scar modulation.
- ✓ Micro needling or PRP to promote collagen remodeling [20].
- ✓ Long-term antibiotics for persistent granulomatous inflammation.
- ✓ Surgical excision as last resort for non-responsive granulomas [21].

Table 2. Algorithm Summary

Phase	Primary Concern	Intervention
Hemostasis	Vascular occlusion	Hyaluronidase, aspirin, nitroglycerin, ophthalmology
Inflammation	Infection, hypersensitivity	Antibiotics, corticosteroids, anti-inflammatory care
Proliferation	Nodules, biofilm	Intralesional therapy, aspiration, imaging guidance
Remodeling	Fibrosis, granulomas	Laser, surgical excision, anti-scarring techniques

Discussion

Understanding filler complications through the wound healing lens helps clinicians respond in a timely, biologically congruent manner. For example, mismanaging a vascular occlusion by massaging instead of lysing with hyaluronidase could push ischemic tissue beyond salvage. Similarly, ignoring signs of biofilm in the inflammatory phase could lead to delayed granulomas. Using each healing stage as a diagnostic and therapeutic window allows for more nuanced and successful interventions [22]. Furthermore, this approach emphasizes preventive practices, such as aspirating before injection, using blunt cannulas in high-risk zones, and training in anatomical knowledge [23].

The increasing popularity of dermal filler injections for aesthetic facial enhancements has led to a corresponding rise in complications, ranging from minor to severe. While most filler-related adverse events are self-limiting or manageable with conservative treatments, some can be devastating, including vascular occlusion, skin necrosis, or even blindness. A systematic, biologically grounded approach to managing these complications is crucial for reducing morbidity and improving patient outcomes. The wound healing process, consisting of hemostasis, inflammation, proliferation, and remodeling, provides a logical framework upon which to base such a treatment algorithm [24].

Hemostasis Phase: Immediate Response

The hemostasis phase is the initial response to tissue injury, typically within minutes of trauma. In filler injections, trauma can be mechanical (needle or cannula injury) or chemical (reaction to filler material). Immediate complications such as vascular occlusion, intense pain, blanching, or livedo reticular is must be recognized and treated rapidly. If vascular compromise is suspected, urgent administration of hyaluronidase is warranted. Studies recommend high-dose pulsed hyaluronidase

(150–300 units every hour) in the affected area, even if the filler is not hyaluronic acid-based, due to its enzymatic role in enhancing tissue diffusion and mitigating ischemia [25].
Adjunctive measures include warm compresses, nitroglycerin paste, and antiplatelet agents like aspirin to improve local perfusion. These interventions should be undertaken immediately during the hemostasis phase to prevent progression to irreversible tissue necrosis [26].

Inflammatory Phase: Days 1–4 Post-Injection
During the inflammation phase, immune cells such as neutrophils and macrophages migrate to the site of injury to eliminate pathogens and initiate repair. Clinically, this may correspond to swelling, redness, and discomfort. While some degree of inflammation is normal, disproportionate or prolonged inflammation may signal infection, delayed hypersensitivity, or early granuloma formation**.**
The treatment strategy in this phase involves:

- ✓ Anti-inflammatory agents such as NSAIDs or corticosteroids for non-infectious inflammation [27].
- ✓ Antibiotics if bacterial infection is suspected (e.g., cephalexin, doxycycline, or clindamycin).
- ✓ If the filler is suspected to be contaminated or biofilm-associated, empirical broad-spectrum antibiotics and possible aspiration or removal of filler material are indicated [28].

Close monitoring during this period is essential. Inflammatory nodules may need intraregional corticosteroids or serial aspiration if they do not resolve spontaneously.

Proliferation Phase: Days 4–21
The proliferative phase is characterized by angiogenesis, fibroblast proliferation, and collagen deposition. In this phase, complications such as granulomas, induration, or persistent nodules may become apparent. These are more common with long-lasting or permanent fillers (e.g., Poly-L-lactic acid, PMMA), although late-onset granulomas can also occur with HA-based fillers.

The approach includes:

- ✓ Intraregional triamcinolone injections to reduce granuloma size.
- ✓ 5-Fluorouracil (5-FU) mixed with corticosteroids to inhibit fibroblast over activity.
- ✓ In recalcitrant cases, systemic corticosteroids or surgical excision may be necessary.

Imaging tools like ultrasound or MRI can assist in differentiating between granulomas, abscesses, or vascular occlusion remnants. Some authors recommend the use of laser therapy or radiofrequency devices to remodel the area and stimulate healthy collagen deposition [29].

Remodeling Phase: Weeks to Months
This final phase involves collagen maturation and scar formation. Chronic complications, such as atrophy, persistent discoloration, or fibrotic scarring, may develop if prior phases were inadequately managed.

Treatment at this stage aims at improving cosmetic outcomes and restoring skin integrity:

- ✓ Micro needling, platelet-rich plasma (PRP), or fractional lasers may be used to stimulate dermal remodeling.
- ✓ Autologous fat grafting can address volume deficits caused by necrosis or filler breakdown.
- ✓ In cases of hyperpigmentation or scarring, topical retinoid or pigment-suppressing agents (e.g., hydroquinone, tranexamic acid) can be initiated.

Patient education and expectations management are vital during this phase; as psychological distress may persist long after physical healing. A multidisciplinary approach including dermatologists, plastic surgeons, and mental health providers may be warranted in severe or disfiguring cases [30].

Importance of Early Diagnosis and Risk Stratification
Central to this biologically informed algorithm is the early diagnosis of filler complications. Practitioners must maintain a high index of suspicion, particularly in high-risk zones like the glabella, nose, and forehead, where anatomic proximity to critical arteries increases the likelihood of embolization.
Pre-injection risk assessment should include:

- ✓ Reviewing medical history (autoimmune disorders, keloid tendency).
- ✓ Selection of filler type and rheology suitable for the anatomical area.
- ✓ Using aspiration techniques and blunt cannulas where appropriate.
- ✓ Layered injection in appropriate tissue planes and using minimal effective filler volumes.

Documentation, patient consent, and emergency preparedness (availability of hyaluronidase, protocols for vascular occlusion) are non-negotiable safety pillars in aesthetic practice [31].

Adjunctive and Emerging Therapies
Recent advancements in managing filler complications include:

- ✓ **Hyperbaric oxygen therapy (HBOT):** Especially in vascular occlusion cases, it enhances tissue oxygenation and reduces necrosis.
- ✓ **Topical and systemic anticoagulants:** Under controlled circumstances, they may aid perfusion restoration.

Monoclonal antibodies and immunomodulatory are being explored for immune-mediated filler complications. Artificial intelligence guided imaging tools can help visualize filler location and identify complications early [32].

These innovations, while promising, require further validation through randomized controlled trials [33]. The integration of the wound healing model into a stepwise treatment algorithm for filler complications offers a structured and evidence-informed approach to clinical practice. Tailoring interventions to the stage of complication not only facilitates better outcomes but also empowers clinicians to act decisively and appropriately [34]. This biological framework underscores the importance of timing, diagnostic acumen, and multidisciplinary care in the evolving landscape of aesthetic medicine [35]. Ultimately, safety, patient education, and continuing professional training are crucial to prevent, recognize, and manage filler-related adverse events effectively [36].

Conclusion

The increasing popularity of dermal filler injections for facial aesthetic enhancement has underscored the importance of understanding and managing potential complications associated with these procedures. This study explored the development of a comprehensive treatment algorithm rooted in the principles of the wound healing process, providing a systematic and biologically sound framework to address complications arising from filler use. Our analysis indicates that recognizing the stage of wound healing hemostasis, inflammation, proliferation, or remodeling is critical in selecting the appropriate intervention. For example, early inflammatory responses such as erythema or edema can often be managed with conservative anti-inflammatory therapies, while more severe manifestations like nodules or vascular occlusion require timely and targeted intervention using agents such as hyaluronidase, anticoagulants, or even surgical debridement. The proposed algorithm integrates both clinical symptomatology and the temporal progression of wound healing to offer individualized, stage-specific treatment strategies. This approach not only facilitates better resolution of complications but may also minimize long-term sequelae such as scarring, pigmentation changes, or tissue necrosis. Furthermore, this framework encourages the proactive monitoring of patient's post-injection and reinforces the necessity for clinician preparedness, patient education, and prompt recognition of early warning signs. Adopting this model in aesthetic practice can enhance treatment safety, improve patient satisfaction, and standardize the management of adverse events across practitioners.

In conclusion, aligning complication management with the natural physiology of wound healing represents a rational and effective approach to improving outcomes in aesthetic filler therapy. Future studies and clinical validation of this algorithm are warranted to optimize its utility and ensure evidence-based refinement in real-world practice.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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