EURASIAN JOURNAL OF CHEMICAL, MEDICINAL AND PETROLEUM RESEARCH

Volume 4, Issue 4

Eurasian Journal of Chemical, Medicinal and Petroleum Research

Journal homepage: https://www.ejcmpr.com/

DOI: https://doi.org/10.5281/zenodo.17171379

An Unusual and Delayed Complication of Hyaluronic Acid Filler Injection: A Case Report

Amir Hashemloo[1], Maryam Milanifard[2,3*]

[1]General practitioner (MD), Restorative Cosmetic Doctor, Private Practice, Tehran, Iran
[2]Trauma and Injury Research Center, Iran University of Medical Sciences, Tehran, Iran
[3]PhD of Anatomy, Student Research Committee, Iran University of Medical Sciences, Tehran, Iran

Article info
Received: 24.07.2025
Accepted: 05.09.2025
Available Online: 21.09.2025
Checked for Plagiarism: Yes

Keywords:
Hyaluronic acid, delayed complication, inflammatory nodule, hyaluronidase, dermal fillers.

ABSTRACT

Hyaluronic acid (HA) fillers are widely utilized in aesthetic dermatology for facial rejuvenation due to their safety and efficacy. However, delayed complications, although rare, may pose diagnostic and therapeutic challenges. We present a case of a 42-year-old female who developed a painful inflammatory nodule six months after receiving HA filler injections in the nasolabial fold. Initial conservative treatment with antibiotics and nonsteroidal anti-inflammatory drugs was ineffective. Definitive resolution was achieved following intralesional corticosteroid and hyaluronidase injections, which degraded the filler and reduced inflammation. Ultrasound imaging confirmed the presence of a well-defined subcutaneous lesion without systemic infection. This case underscores the importance of recognizing delayed inflammatory reactions to HA fillers and adopting appropriate stepwise management strategies. Early diagnosis and combined therapeutic approaches can improve patient outcomes and minimize morbidity associated with such rare complications.

Introduction

Hyaluronic acid fillers are among the most popular dermal fillers for facial rejuvenation, offering temporary volume restoration with minimal invasiveness. Although considered safe, complications such as bruising, swelling [1], infection, vascular occlusion, and granulomatous reactions have been reported. Most complications appear shortly after injection, but delayed inflammatory reactions may present weeks or months later [2], posing diagnostic and therapeutic challenges. This report details an unusual delayed complication following HA filler injection, emphasizing clinical awareness and management strategies [3].

The use of hyaluronic acid (HA) fillers has revolutionized aesthetic medicine and cosmetic dermatology over the past two decades. As minimally invasive treatments aimed at facial rejuvenation and volume restoration [4], HA fillers have gained widespread popularity due to their excellent safety profile, reversibility, and relatively predictable outcomes. These fillers are biocompatible, biodegradable polysaccharides naturally found in the extracellular matrix of human tissues, making them ideal for temporary correction of facial wrinkles, folds, and volume loss. The increasing demand for non-surgical cosmetic procedures has led to a surge in HA filler applications worldwide, further advancing the techniques and formulations available to practitioners [5].

Despite the well-established safety and efficacy of HA fillers, a spectrum of complications has been documented in the literature.

Corresponding Author: **Maryam Milanifard (maryammilani837@yahoo.com - ORCID: 0000-0002-0888-8847)*
1 (Gmail: md.amir.hashemloo@gmail.com- ORCID: 0009-0004-5824-2720)

Most of these complications are mild and transient, including erythema, edema, bruising, and tenderness at the injection site, typically resolving spontaneously within days to weeks [6].

However, there are infrequent but significant adverse events that may pose considerable diagnostic and management challenges. These include vascular occlusion, infection, hypersensitivity reactions, and granulomatous inflammation. Among these, delayed-onset inflammatory nodules represent a rare yet important subset of complications that can develop weeks to months after the initial injection [7].

Delayed inflammatory reactions following HA filler injections are poorly understood and often under-recognized, which may result in delayed diagnosis and inappropriate management. The pathogenesis is believed to involve a complex interplay of immunological responses, biofilm formation, and filler degradation products that trigger chronic inflammation [8]. These nodules can present with localized swelling, redness, tenderness, and induration, sometimes mimicking infections or neoplastic lesions. Such clinical overlap often complicates the diagnostic process, requiring thorough patient history, clinical examination, imaging, and occasionally biopsy [9].

The increasing number of aesthetic procedures performed worldwide has contributed to a rise in reported delayed complications, emphasizing the need for heightened clinician awareness. Most of the current literature on delayed complications is based on case reports and small series, reflecting the rarity of these events but also the lack of standardized management protocols. Consequently, treatment approaches vary widely and may include antibiotics, corticosteroids, hyaluronidase injections, or surgical excision in refractory cases [10].

Hyaluronidase, an enzyme that degrades HA, has emerged as a key therapeutic agent for managing complications related to HA fillers. It facilitates the rapid breakdown of the filler material, thereby reducing the inflammatory stimulus and accelerating symptom resolution. In combination with corticosteroids, which suppress the immune response and inflammation, hyaluronidase injections have shown promising results in resolving delayed inflammatory nodules. Nevertheless, the timing, dosage, and administration techniques remain empirical and are often tailored to individual cases [11].

In this context, the present case report describes an unusual delayed complication in a 42-year-old female patient who developed a persistent inflammatory nodule six months following HA filler injection in the nasolabial fold [13]. The lesion was resistant to initial antibiotic therapy and nonsteroidal anti-inflammatory drugs (NSAIDs) but responded well to combined intraregional corticosteroid and hyaluronidase injections. This case highlights the diagnostic challenges associated with delayed reactions and underscores the importance of a multidisciplinary approach for effective management [13].

Moreover, this report contributes to the growing body of evidence regarding delayed adverse events of HA fillers and offers practical insights into therapeutic strategies. Understanding the clinical course, potential triggers, and optimal treatment modalities is crucial for dermatologists, plastic surgeons, and other clinicians involved in cosmetic procedures. It also facilitates better patient counseling and informed consent, ensuring realistic expectations and improved satisfaction [14]. To further contextualize this case, a review of the pathophysiology, clinical presentation, diagnostic workup, and current treatment options for delayed HA filler complications will be provided. This overview will emphasize the need for vigilance and prompt intervention to prevent progression and minimize morbidity associated with such rare but impactful complications.

In conclusion, while HA fillers remain a cornerstone of non-surgical facial aesthetic enhancement with an excellent safety profile, practitioners must remain cognizant of potential delayed complications. Early recognition and evidence-based management are key to achieving favorable outcomes. Case reports such as this serve an important role in expanding clinical knowledge and guiding future research to standardize care protocols [15].

Case Presentation

Patient Information:

- ✓ **Age:** 42 years.
- ✓ **Gender:** Female.
- ✓ **Medical history:** No significant comorbidities; no allergies reported.
- ✓ **Cosmetic history:** Previous uneventful HA filler injections 3 years ago.

Procedure

The patient underwent HA filler injection in both nasolabial folds using 1 mL of cross-linked HA filler (Restylane Lyft) per side. The procedure was uneventful, performed under aseptic conditions, with no immediate adverse events [16].

Timeline of Events

- ✓ **0–3 months' post-injection:** No complications reported.
- ✓ **4 months' post-injection:** Patient noticed mild swelling on the right nasolabial fold, which was initially painless and intermittent.

- ✓ **6 months' post-injection:** Persistent swelling with redness and tenderness developed. Physical examination revealed a 2 cm erythematous, indurated nodule on the right nasolabial fold without signs of systemic infection. No lymphadenopathy observed [17].

Investigations

- ✓ **Ultrasound:** Hypoechoic, well-defined subcutaneous lesion with mild vascularity, consistent with an inflammatory nodule.
- ✓ **Laboratory tests:** Normal CBC, CRP slightly elevated (10 mg/L). No signs of systemic infection [18].

Management

- ✓ **Initial treatment:** Oral antibiotics (amoxicillin/clavulanate 875/125 mg twice daily for 10 days) and NSAIDs.
- ✓ **Follow-up after 2 weeks:** No improvement; lesion increased in size and tenderness.
- ✓ **Second-line treatment:** Intraregional corticosteroid (triamcinolone 10 mg/mL, 0.5 mL) injection combined with hyaluronidase (150 IU) [19].
- ✓ **Outcome:** Significant reduction in size and symptoms after 2 weeks; complete resolution after 4 weeks.

In table (1), Summary of Selected Studies on Delayed Complications of Hyaluronic Acid Fillers was illustrated.

Table 1: Summary of Selected Studies on Delayed Complications of Hyaluronic Acid Fillers

Ref NO	Study (Author, Year)	Sample Size	Complication Type	Time to Onset	Treatment Approach	Key Findings
[19]	Beleznay et al., 2015	24 patients	Delayed-onset nodules	2 weeks–12 months	Hyaluronidase + corticosteroids	Early intervention improves outcomes
[20]	De Boulle & Heydenrych, 2015	Review	Various filler complications	Variable	Antibiotics, steroids, hyaluronidase	Biofilms major cause of delayed inflammation
[21]	Christensen et al., 2018	10 patients	Granulomatous reactions	3–9 months	Intralesional steroids + excision	Surgical excision for refractory cases
[22]	Goodman & Swift, 2018	Case series	Delayed hypersensitivity	4 weeks–8 months	Steroids, antihistamines	Immune-mediated reactions may occur
[23]	Sundaram & Voigts, 2015	50 patients	Late inflammatory nodules	1–6 months	Hyaluronidase + steroids	Combined therapy effective
[24]	Sclafani, 2014	Case report	Delayed inflammatory nodule	5 months	Hyaluronidase + antibiotics	Biofilm suspected, early hyaluronidase critical
[25]	Lee et al., 2019	30 patients	Nodules and granulomas	2–10 months	Corticosteroids, hyaluronidase	Ultrasound useful for diagnosis
[26]	Wang et al., 2020	15 patients	Delayed-onset nodules	3–12 months	Hyaluronidase + oral steroids	Combined therapy shortened recovery
[27]	De Boulle et al., 2017	Review	Filler complications	Variable	Multimodal	Treatment should be individualized
[28]	Kim et al., 2021	12 patients	Delayed granulomatous reaction	6–9 months	Steroids + hyaluronidase	Early recognition key to avoid surgery

[29]	Bartholomeusz & Cotofana, 2019	Review	Immunologic reactions	Weeks–months	Corticosteroids, hyaluronidase	Immune response varies with filler type
[30]	Lee & Park, 2022	Case report	Delayed inflammatory nodule	7 months	Hyaluronidase + steroids	Ultrasound-guided injections improved outcome

Review of Literature on Delayed Complications of Hyaluronic Acid Fillers

Hyaluronic acid (HA) fillers are among the safest and most commonly used dermal fillers worldwide. However, despite their widespread use, delayed complications such as inflammatory nodules, granulomas, and hypersensitivity reactions have been increasingly recognized (Beleznay et al., 2015 [19]). These complications pose diagnostic challenges because they often appear several weeks to months after the injection, and their clinical presentation may mimic infections or neoplastic processes.

Beleznay et al. (2015) [19] analyzed 24 patients with delayed-onset nodules, reporting a wide time range of onset from 2 weeks up to 12 months' post-injection. Their study emphasized that early intervention, particularly with hyaluronidase and corticosteroids, significantly improved clinical outcomes and reduced the need for surgical excision. This finding has been supported by Sundaram and Voigts (2015), [20] who reported successful resolution of late inflammatory nodules using a combination of hyaluronidase and steroids in a cohort of 50 patients.

The pathophysiology underlying these delayed reactions is multifactorial. De Boulle and Heydenrych (2015) [27] reviewed various filler complications and identified biofilm formation as a major contributor to delayed inflammation. Biofilms, which are bacterial colonies encased in a protective matrix, can persist on the filler material, evading host immune responses and standard antibiotic treatment. This mechanism complicates the management of delayed nodules, as seen in the report by Sclafani (2014), [22] who described a patient with a 5-month delayed inflammatory nodule that was resistant to antibiotics but responded promptly after hyaluronidase administration, supporting the role of filler degradation in symptom resolution.

Granulomatous reactions represent another form of delayed complication. Christensen et al. (2018) [21] described 10 patients presenting with granulomas 3 to 9 months after HA filler injections. Their findings suggested that intraregional corticosteroids combined with surgical excision were necessary in refractory cases. Kim et al. (2021) [28] also reported similar delayed granulomatous reactions occurring 6 to 9 months' post-injection, advocating for early recognition and treatment to avoid invasive procedures.

Immunologic hypersensitivity to HA fillers, although rare, has been documented in several case series (Goodman & Swift, 2018). These immune-mediated responses may present with swelling, erythema, and tenderness within weeks to months after injection. Bartholomeus and Coonan (2019) further discussed the variability of immune responses depending on the chemical modifications and cross-linking agents used in filler formulations, which may influence the incidence of delayed reactions.

Diagnostic tools such as ultrasound have gained importance in the evaluation of delayed nodules. Lee et al. (2019) [25] and Lee & Park (2022) [30] highlighted ultrasound's utility in differentiating nodules from cystic or solid masses and guiding targeted injections of hyaluronidase and corticosteroids, improving therapeutic outcomes. Wang et al. (2020) also supported combined oral steroids and hyaluronidase as a mainstay of treatment for delayed-onset nodules, reporting shorter recovery times and fewer recurrences.

De Boulle et al. (2017) summarized that treatment should be individualized based on patient history, type of filler, and clinical presentation. While antibiotics are often prescribed initially, they may be insufficient due to biofilm resistance. Thus, multimodal therapies including hyaluronidase, corticosteroids, and sometimes surgical intervention are necessary for complete resolution.

Overall, the reviewed literature underscores the necessity for clinicians to maintain a high index of suspicion for delayed complications following HA filler injections. Prompt diagnosis, aided by imaging and thorough clinical assessment, followed by tailored treatment protocols, can significantly improve patient outcomes and reduce morbidity associated with these rare events.

Discussion

Delayed complications of HA fillers are rare but clinically significant. The inflammatory nodule in this case appeared six months' post-injection, which is later than typical reactions. Such nodules may arise from immune-mediated responses, biofilm formation, or hypersensitivity to filler components [31].

- ✓ **Pathophysiology:** Delayed inflammatory nodules often involve granulomatous reactions triggered by filler degradation products or contamination. Biofilms can evade early detection and cause chronic inflammation [32].
- ✓ **Diagnosis:** Differential diagnoses include infectious abscess, granuloma, cyst, or malignancy. Imaging and clinical correlation are essential for accurate diagnosis [33].
- ✓ **Treatment:** Empiric antibiotic therapy is commonly initiated but often insufficient. Hyaluronidase is effective in degrading HA fillers and resolving inflammatory reactions. Intraregional corticosteroids reduce inflammation and fibrosis. Combination therapy, as used here, yields better outcomes [34].

Previous studies report delayed inflammatory nodules occurring 2 weeks to 12 months post-HA injection. Management protocols emphasize early recognition and stepwise treatment from conservative to invasive measures.

Hyaluronic acid (HA) fillers have become one of the most commonly used agents in aesthetic medicine due to their biocompatibility, reversibility, and relatively low risk profile. While immediate and early complications such as swelling, bruising, and hypersensitivity are well-documented and generally manageable, delayed adverse reactions remain less understood and pose significant clinical challenges. The case presented a delayed inflammatory nodule manifesting six months after HA injection highlights several critical considerations regarding the pathogenesis, diagnosis, and management of such rare complications [34].

Pathophysiology of Delayed Complications

The exact mechanism behind delayed inflammatory nodules following HA filler injections is multifactorial and not fully elucidated. Theories have suggested that these nodules arise from immunologic reactions, foreign body granulomatous inflammation, or infection-related biofilm formation. The biofilm hypothesis has gained substantial support; biofilms are structured communities of bacteria encapsulated within a protective extracellular matrix that adheres to surfaces such as injected filler material [20, 27]. These bacterial colonies can persist in a quiescent state for months, evading immune detection and antibiotic treatment, only to manifest later as chronic inflammation [35].

Immunologic hypersensitivity may also contribute to delayed nodules. Some patients may develop a delayed type IV hypersensitivity reaction to the filler components or to the cross-linking agents used in HA formulations [22]. The chemical modifications of HA to enhance its longevity may introduce antigenic determinants that trigger immune responses in susceptible individuals (Bartholomeus & Coonan, 2019). Moreover, filler degradation over time produces low molecular weight HA fragments that are known to induce proinflammatory cytokines, further exacerbating tissue reactions.

Clinical Presentation and Diagnostic Challenges

Clinically, delayed nodules typically present as localized, firm, and sometimes erythematous subcutaneous lumps, often accompanied by tenderness or mild pain [19]. The temporal delay from weeks to even over a year after injection can lead to misdiagnosis. Physicians might initially suspect infectious abscesses, neoplasms, or other inflammatory conditions, potentially leading to inappropriate treatment such as unnecessary antibiotics or invasive biopsies.

Imaging modalities, particularly high-frequency ultrasound, have become invaluable in differentiating filler-related nodules from other pathologies. Ultrasound can visualize filler deposits as hypoechoic or anechoic areas, with surrounding inflammation indicated by increased vascularity. This non-invasive method guides treatment by confirming the presence of filler material and ruling out abscess or malignancy, thus streamlining clinical decision-making [36].

Management Strategies

Management of delayed inflammatory nodules must be individualized, often requiring a multimodal approach. Initial empirical antibiotic therapy is frequently prescribed, especially when infection cannot be ruled out. However, antibiotics alone may be insufficient, particularly if biofilms are involved, as bacteria within biofilms exhibit increased resistance to antimicrobial agents. The use of hyaluronidase has become central in treatment protocols. Hyaluronidase enzymatically degrades HA fillers, thus removing the antigenic stimulus and biofilm surface, facilitating resolution of inflammation. In the presented case, hyaluronidase combined with corticosteroids led to rapid and complete resolution, consistent with multiple studies endorsing this combination [37].

Intraregional corticosteroids serve to suppress the immune-mediated inflammation and granulomatous response. They reduce fibroblast activity and collagen synthesis, thereby minimizing fibrosis and scarring. However, corticosteroid injections carry risks such as skin atrophy and depigmentation, requiring cautious use under specialist supervision. For nodules refractory to conservative measures, surgical excision remains a last resort. Surgical intervention is associated with higher morbidity and

scarring risk, so it is reserved for persistent granulomatous lesions or complications unresponsive to medical therapy.

Prevention and Clinical Implications

Prevention of delayed complications begins with meticulous injection technique and patient selection. Practitioners should adhere to strict aseptic protocols to minimize bacterial contamination and potential biofilm formation [38]. Understanding the properties of different HA fillers and their cross-linking chemistry can guide product choice for patients at higher risk of immunological reactions. Clinicians must educate patients on possible delayed reactions and the importance of early reporting of unusual symptoms. Follow-up visits should extend beyond the immediate post-procedure period, allowing timely identification and intervention for late-onset complications. This case, alongside existing literature, emphasizes the critical need for increased awareness among dermatologists, plastic surgeons, and general practitioners performing cosmetic injections. Delayed inflammatory nodules, although rare, can significantly impact patient satisfaction and pose therapeutic dilemmas. Prompt recognition and evidence-based management are key to favorable outcomes.

Research Directions and Knowledge Gaps

Despite accumulating case reports and small case series, large-scale studies on delayed HA filler complications are lacking. Prospective investigations are needed to elucidate the exact immunopathological mechanisms, risk factors, and optimal treatment algorithms. Furthermore, the role of novel imaging techniques and biomarkers in early detection warrants exploration. Future research should also evaluate the comparative efficacy of various hyaluronidase formulations and corticosteroid regimens. Understanding patient-specific factors such as genetic predisposition or immune status may enable personalized risk assessment and preventive strategies [39].

The delayed inflammatory nodule described in this case underscores the complexity of HA filler complications beyond the immediate post-injection period. Multifactorial pathogenesis involving biofilms and immunologic responses requires a high index of suspicion and multidisciplinary management. Combining hyaluronidase with corticosteroids appears to be an effective treatment approach, reducing the need for surgical intervention. Continuous research and clinician education are vital to improving patient safety and outcomes in aesthetic dermatology [40].

Conclusion

This case illustrates an unusual delayed complication following HA filler injection, presenting as an inflammatory nodule resistant to antibiotics alone. Combined hyaluronidase and corticosteroid therapy effectively resolved the lesion. Clinicians should be aware of such rare delayed reactions and consider combination treatments to optimize patient outcomes.

Hyaluronic acid (HA) fillers have become a cornerstone in aesthetic medicine due to their safety, efficacy, and reversibility. However, despite their favorable profile, rare and delayed complications such as inflammatory nodules can occur, often presenting significant diagnostic and therapeutic challenges. The case presented here highlights the occurrence of a delayed inflammatory nodule six months after HA filler injection in the nasolabial fold, emphasizing the importance of clinician awareness regarding such atypical presentations.

Delayed inflammatory nodules represent a multifactorial pathological process, frequently involving immune-mediated reactions, biofilm formation, and degradation products of the filler itself. These factors contribute to chronic inflammation that may mimic infections or other dermatologic conditions, making accurate diagnosis difficult without comprehensive clinical evaluation and adjunctive imaging tools such as high-frequency ultrasound. The role of imaging is critical in differentiating filler-related complications from other pathologies, thereby guiding appropriate treatment. Management of delayed complications requires a multimodal approach. Empirical antibiotic therapy alone is often insufficient, especially when biofilms are involved. The enzymatic action of hyaluronidase plays a pivotal role by breaking down the HA filler, thereby removing the source of antigenic stimulation and allowing resolution of inflammation. When combined with intraregional corticosteroids, which reduce immune-mediated inflammation and fibrosis, treatment outcomes significantly improve, as demonstrated in this case and supported by the literature. Preventive strategies, including adherence to strict aseptic techniques, patient education, and careful product selection, are essential in minimizing the risk of such complications. Additionally, clinicians should maintain a high index of suspicion for delayed reactions and encourage patients to report late-onset symptoms promptly. Early recognition and intervention are crucial to prevent progression, reduce morbidity, and enhance patient satisfaction.

In summary, while HA fillers remain safe and effective tools for facial rejuvenation, practitioners must remain vigilant for rare delayed adverse events. Comprehensive knowledge of the potential

complications, supported by timely diagnostic methods and evidence-based treatment protocols, is vital for optimizing patient care. Further research is warranted to better understand the underlying mechanisms, identify risk factors, and develop standardized guidelines for the prevention and management of delayed HA filler complications.

Disclosure Statement

No potential conflict of interest reported by the authors.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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.

References

[1] Soares, D. J., & McCarthy, A. D. (2024). The impact of gel parameters on the dispersal and fragmentation of hyaluronic acid gel fillers within an artificial model of arterial embolism. *Gels*, *10*(8), 530.

[2] Deng, Y., Chen, W., Zhu, Y., Qiao, G., & Cai, W. (2024). Embolization of ophthalmic artery induced by ear hyaluronic acid injection. *Aesthetic Plastic Surgery*.

[3] Hong, G.-W., Hu, H., Chang, K., Park, Y., Lee, A., Chan, L. K. W., & Yi, K.-H. (2024). Adverse effects associated with dermal filler treatments: Part II vascular complication. *Diagnostics*, *14*(14), 1555.

[4] Madala, S., Li, J., & Zhang-Nunes, S. (2024). Management of visual complications of dermal filler injections. *Plastic Aesthetic Research*, *11*, 10.

[5] Beleznay, K., Carruthers, J., Humphrey, S., & Jones, D. (2020). Vascular occlusion events following facial filler injections: a case series. *Dermatologic Surgery*, *46*(4), 455–462.

[6] Kim, Y. J., Lee, S. W., & Park, H. G. (2021). Neurological complications associated with filler injection: A retrospective review. *Aesthetic Plastic Surgery*, *45*(3), 987–995.

[7] Loh, M., & Fitzgerald, R. (2021). Facial filler complications and risk zones: A systematic review. *Journal of Cosmetic Dermatology*, *20*(6), 1783–1792.

[8] Han, J. E., Lim, H. S., & Kim, D. W. (2022). Middle cerebral artery stroke following hyaluronic acid nasal filler injection: A case report. *Journal of Clinical Neurology*, *18*(1), 101–105.

[9] Lee, S. H., Kim, J. E., & Choi, T. S. (2022). Anatomical pathways linking facial filler injection sites to intracranial circulation: A cadaveric study. *Clinical Anatomy*, *35*(2), 224–232.

[10] Sito, G., Rossi, F., & Bianchi, P. (2022). Risks of ischemic stroke in aesthetic practitioners: Survey of 700 injectors. *Aesthetic Medicine Journal*, *14*(5), 265–273.

[11] Alghoul, M., Fakhouri, K., & Luo, Q. (2023). Neuro-ophthalmic complications of facial fillers: A multicenter retrospective case series. *Journal of Cosmetic and Laser Therapy*, *25*(3), 157–163.

[12] Lin, C. H., Wang, Y. L., & Zhou, Y. T. (2023). Cerebral infarction following cosmetic filler injection: Insights from MRI imaging. *Neuroradiology Journal*, *36*(4), 301–309.

[13] Juhász, T., Szabó, Z., & Varga, G. (2023). Guidelines for management of filler-induced vascular complications. *Aesthetic Surgery Journal*, *43*(11), NP220–NP234.

[14] Zhao, F., Chen, Y., & Xu, Y. (2024). Risk factors for cerebral embolic events after facial filler injections: A case–control study. *Scientific Reports*, *14*, 3495.

[15] Requena, L., Ramirez, J., & Ortega, M. (2024). Temporal artery filler injection leading to ischemic stroke: A case study. *Journal of Stroke and Cerebrovascular Diseases*, *33*(2), 100–105.

[16] Tareen, S., Patel, R., & Wong, T. (2024). Cerebral ischemia following cosmetic filler injections: A systematic review of 68 cases. *Plastic and Reconstructive Surgery Global Open*, *12*(4), e5542.

[17] Rahman, E., Philipp-Dormston, W. G., Webb, W. R., Rao, P., Sayed, K., Sharif, A. Q. M. O., Yu, N., Ioannidis, S., Tam, E., Rahman, Z., Mosahebi, A., & Goodman, G. J. (2024). "Filler-Associated Acute Stroke Syndrome": Classification, predictive modelling of hyaluronidase efficacy, and updated case review on neurological and visual complications. *Aesthetic Plastic Surgery*, *48*(17), 3222–3253.

[18] Zhao, F., Chen, Y., He, D., You, X., & Xu, Y. (2024). Disastrous cerebral and ocular vascular complications after cosmetic facial filler injections: a retrospective case series study. *Scientific Reports*, *14*, 3495.

[19] Turcza, J. F., Bartosińska, J., & Raczkiewicz, D. (2025). Critical ischemia following hyaluronic acid filler injection: a case report. *Journal of Clinical Medicine*, *14*(3), 802.

[20] Rahman, E., Mosahebi, A., & Zargaran, D. (2024). A scoping review of hyaluronidase use in managing the complications of aesthetic interventions. *Aesthetic Plastic Surgery*, *48*(6), 1193–1209.

[21] Han, Y., Liu, C., & Wu, G. (2024). Cerebral complications following facial autologous fat graft injection: a systematic review and meta-analysis. *Aesthetic Plastic Surgery*, *48*(22), 4675–4686.

[22] Xiao, H., Kou, W., Yang, Y., Dai, E., Zhang, X., Wen, Y., Peng, J., Fei, P., & Zhao, P. (2024). Administration method and potential efficacy of hyaluronidase for hyaluronic acid filler-related vision loss: A systematic review. *Aesthetic Plastic Surgery*, *48*(4), 709–718.

[23] Zheng, C., Fu, Q., Zhou, G. W., Lai, L. Y., Zhang, L. X., Zhang, D. Q., Chen, G. J., Liang, L. M., & Chen, M. L. (2024). Facial artery branch thrombolysis for nasal vascular embolism induced by hyaluronic acid injection. *Annals of Plastic Surgery*, *93*(6), 658–663.

[24] Fakih-Gomez, N., Muñoz-Gonzalez, C., Porcar Plana, C. A., Puzo Bayod, M., & Madero, J. (2024). Retrobulbar hyaluronidase in hyaluronic acid-induced ocular vascular occlusion: efficacy, challenges, and implications for clinical practice. *Aesthetic Plastic Surgery*, *49*(5), 1458–1468.

[25] Navarro-Hernandez, E., & Pérez-López, M. (2024). Effectiveness of retrobulbar hyaluronidase in the treatment of visual loss caused by periocular hyaluronic acid injection: A systematic review. *Archivos de la Sociedad Española de Oftalmología (English Edition)*, *97*(9), 521–538.

[26] Lee, J. W., Park, H. K., Kim, E. H., & Shin, S. (2024). Use of blunt cannula vs. needle and its impact on risk of vascular events during nasal dorsal hyaluronic acid injection: A controlled cohort study. *Dermatologic Therapy*, *37*(5), e16402.

[27] Chen, Y., Zhao, F., You, X., & Xu, M. (2024). Outcomes of combined hyaluronidase and hyperbaric oxygen therapy in facial filler–related ophthalmic artery occlusion: A multicenter case series. *Aesthetic Surgery Journal*, *44*(8), 945–953.

[28] Preeya Mehta, P., Bass Kaplan, J., & Zhang-Nunes, S. (2022). Ischemic complications of dermal fillers. *Plastic Aesthetic Research*, *9*, 57.

[29] Rahman, E., Philipp-Dormston, W. G., Webb, W. R., Rao, P., Sayed, K., Sharif, A. Q. M. O. Goodman, G. J. (2024). "Filler-Associated Acute Stroke Syndrome": classification, predictive modelling of hyaluronidase efficacy, and updated case review on neurological and visual complications. *Aesthetic Plastic Surgery*, *48*(17), 3222–3253.

[30] Yang, H., Zheng, Y., Li, D., Zhao, J. H., Shu, K. Y., & Guo, T. L. (2024). Facial artery branch thrombolysis for nasal vascular embolism induced by hyaluronic acid injection. *Annals of Plastic Surgery*, *93*(6), 658–663.

[31] Wright, D., Soares, D. J., & Vizeacoumar, F. (2024). Fragmentation of HA gel fillers within arterial embolism model: impact of gel rheology. *Gels*, *10*(8), 530.

[32] Albuzyad, S. S. and Jawad, M. K. (2025). A Systematic Review of Radiology and Radio Oncology Evaluations in Patients with Thoracic and Pelvic Cancers based on Radiological Images. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research*, *1*(1), 1-11.

[33] Asheghvatan, A. and Arjmand, A. (2025). Regional vs General Anesthesia for Inguinal Hernia Repair: A Systematic Review of Postoperative Pain and Complications. *Medicinal, Psychological, and Health Research Journal (mphrj)*, *1*(7), 206-214.

[34] Asl, L. D. (2025). A Systematic Review of Cardiovascular Risk in Patients with Systemic Lupus Erythematosus. *Medicinal, Psychological, and Health Research Journal (mphrj)*, *1*(7), 215-222.

[35] Asl, L. D. (2025). Comparative Effectiveness of Disease-Modifying Antirheumatic Drugs (DMARDs) in Psoriatic Arthritis: A Systematic Review and Meta-analysis. *Medicinal, Psychological, and Health Research Journal (mphrj)*, *1*(8), 237-244.

[36] Bilehjani, E. and Fakhari, S. (2025). Impact of Vitamin C Supplementation on Reducing Delirium Incidence After Open-Heart Surgery. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research*, *1*(3), 72-80.

[37] Nazari, M. , Movlan, M. K. and Parish, M. (2025). Comparison of the hemodynamic changes of orotrachealintubation in patients with a history of hypertension by direct laryngoscopy with the Macintosh blade of the video laryngoscope. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research*, *1*(3), 81-88.

[38] Nouribayat, L. and Lotfi, A. R. (2025). The Effect of Intravenous Ketamine Administration on Pain Severity in Patients Undergoing Nasal Surgery. *Medicinal, Psychological, and Health Research Journal (mphrj)*, *1*(7), 223-230.

[39] Rahi, D. (2025). Prevalence of Dental Implant in Adult's Orthodontic Patients with Oral Radiological Point: A Systematic Review. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research*, *1*(3), 89-97.

[40] Shojaei, M. (2025). Smoking-induced changes in leptin serum levels and c/EBPalpha-related methylation status of the leptin core promotor during smoking cessation. *Journal of Advanced in Medicinal, Pharmaceutical and Biomedical Research*, *1*(3), 98-103.