



International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

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ARTICLE TITLE

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FILLER INJECTIONS: CURRENT CONCEPTS IN RECOGNITION,
MANAGEMENT AND PREVENTION – A NARRATIVE REVIEW

DOI

[https://doi.org/10.31435/ijitss.4\(52\).2026.6446](https://doi.org/10.31435/ijitss.4(52).2026.6446)

RECEIVED

11 August 2026

ACCEPTED

15 October 2026

PUBLISHED

26 October 2026

LICENSE



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VASCULAR COMPLICATIONS FOLLOWING HYALURONIC ACID FILLER INJECTIONS: CURRENT CONCEPTS IN RECOGNITION, MANAGEMENT AND PREVENTION – A NARRATIVE REVIEW

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ABSTRACT

Hyaluronic acid (HA) fillers are among the most commonly performed minimally invasive procedures in aesthetic medicine worldwide [4,5]. Although generally considered safe, they may lead to rare but potentially severe vascular complications, including tissue ischemia, skin necrosis, and vision loss [6,10].

The aim of this study is to provide a comprehensive review of the current literature regarding the pathophysiology, clinical presentation, management, and prevention of vascular complications associated with HA filler injections.

A narrative literature review was conducted, including review articles, retrospective studies, expert consensus statements, and case reports. Publications addressing the mechanisms, diagnosis, and management of vascular complications were analyzed.

Vascular complications primarily result from inadvertent intravascular injection or extravascular compression, leading to impaired tissue perfusion [4,7]. Timely identification of vascular compromise and immediate therapeutic intervention are essential for optimizing clinical outcomes [20,21].

Despite the growing body of literature, significant variability in treatment recommendations persists, and standardized guidelines remain lacking. Further high-quality research is necessary to improve the safety of aesthetic procedures.

KEYWORDS

Hyaluronic Acid Fillers, Vascular Occlusion, Complications, Hyaluronidase, Prevention, Ischemia

CITATION

Żurek, J., Bednarska, K., Noworolska, M., Wojtaszkiewicz, D., Ciećkiewicz, N., Sapała, E., Skrzeczyna, J., Bulenda, M., Wiśniewska, M., Strugała, N., & Kostrzewski, M. (2026). Vascular complications following hyaluronic acid filler injections: Current concepts in recognition, management and prevention – A narrative review. *International Journal of Innovative Technologies in Social Science*, 4(52). [https://doi.org/10.31435/ijitss.4\(52\).2026.6446](https://doi.org/10.31435/ijitss.4(52).2026.6446)

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1. Introduction

Hyaluronic acid fillers are among the most widely performed minimally invasive procedures in aesthetic medicine. Their popularity is largely attributed to their effectiveness, reversibility, and relatively favorable safety profile [4,5]. However, with the increasing number of procedures performed, a parallel rise in complications has been observed. Although most adverse effects are mild and transient, severe vascular complications remain a significant clinical concern due to their potential for long-term or irreversible consequences [6,10].

The pathophysiology of vascular complications involves both inadvertent intravascular injection and extravascular compression leading to impaired tissue perfusion [4,7]. In addition, retrograde flow and embolization into the ophthalmic circulation may occur, representing the primary mechanism underlying ocular complications [7,10]. Early recognition of ischemic symptoms and prompt intervention are essential to minimize tissue damage and improve patient outcomes.

In recent years, increasing attention has been directed toward the development of diagnostic tools, particularly high-resolution ultrasonography, which enables visualization of vascular structures and filler deposits, thereby supporting both diagnosis and treatment planning [18,19]. Despite advances in understanding and management, significant variability in treatment approaches persists, and standardized clinical guidelines remain limited.

The aim of this narrative review is to provide a comprehensive overview of the current literature regarding the pathophysiology, clinical presentation, management, and prevention of vascular complications associated with hyaluronic acid filler injections.

2. Materials and Methods

This study constitutes a narrative review of the literature on vascular complications following hyaluronic acid filler injections, with a focus on pathophysiology, clinical presentation, diagnosis, management, and prevention strategies.

A comprehensive literature search was conducted using electronic databases, including **PubMed/MEDLINE**, **Scopus**, and **Web of Science**. Publications in English from 2010 to 2025 were considered. The search strategy utilized combinations of keywords and Boolean operators such as: “hyaluronic acid fillers”, “dermal fillers”, “vascular occlusion”, “vascular complications”, “blindness”, “skin necrosis”, “facial anatomy”, “hyaluronidase”, “management”, and “prevention”.

Included studies comprised review articles, consensus statements, expert guidelines, clinical studies, case series, and case reports related to adverse events following HA filler injections. Particular emphasis was placed on publications addressing vascular complications and their management.

Studies unrelated to vascular complications, those focusing exclusively on non-HA fillers without transferable relevance, experimental animal studies, and reports of insufficient methodological quality were excluded.

Following initial screening of titles and abstracts, full-text articles were reviewed. Data were synthesized qualitatively and categorized into the following thematic areas: facial high-risk anatomy, pathophysiology of vascular complications, clinical presentation, management strategies, and prevention.

Due to the heterogeneity of available data and the predominance of descriptive studies, a narrative approach was adopted instead of quantitative analysis.

3. Anatomy of Facial Danger Zones

A thorough understanding of facial vascular anatomy is essential for the safe administration of hyaluronic acid fillers. Most severe vascular complications result from inadvertent intravascular injection or vascular compression, leading to impaired tissue perfusion [1,4]. Particular clinical importance is attributed to so-called *facial danger zones*—areas characterized by superficial vessel location and the presence of anastomoses with the ophthalmic arterial system.

The glabellar region represents one of the highest-risk areas. The supratrochlear and supraorbital arteries, both branches of the ophthalmic artery, run superficially in this region, increasing the risk of embolization into the ocular circulation and subsequent vision loss [1,10].

The nose, particularly the nasal dorsum, is another critical high-risk area. The dorsal nasal artery, a branch of the ophthalmic artery, forms multiple anastomoses with the facial arterial system. Due to the limited soft tissue volume and restricted collateral circulation, this region is particularly susceptible to ischemia and subsequent skin necrosis [1,4].

The nasolabial fold and medial cheek also represent areas of increased risk due to the presence of the angular artery, the terminal branch of the facial artery. Significant anatomical variability and the presence of anastomoses with the ophthalmic circulation further increase the risk of complications in this region [3].

Similarly, the forehead and infraorbital region are considered vulnerable areas. These regions contain small-caliber vessels and limited collateral circulation, making them particularly prone to ischemic injury. Additionally, the thin skin and limited subcutaneous tissue increase susceptibility to tissue damage [1,3].

Although often considered relatively safer, the temporal region may also be associated with complications. Injury to the superficial temporal artery or its branches may result in tissue ischemia or, in some cases, localized alopecia [3].

It is important to emphasize that classical anatomical knowledge alone may not be sufficient to ensure procedural safety, as significant interindividual variability exists in vessel course, depth, and branching patterns. Therefore, increasing attention has been directed toward individualized patient assessment and the use of high-resolution ultrasonography, which allows for precise visualization of vascular structures and improved procedural planning [18,19].

In summary, identification of high-risk areas, awareness of anatomical variability, and the use of appropriate injection techniques are fundamental to minimizing the risk of vascular complications. The key high-risk areas and associated vascular structures are summarized in Table 1.

Table 1. Summary of High-Risk Facial Danger Zones and Associated Vasculature

Anatomical Region	Key Arterial Structures	Clinical Risk / Complication
Glabella	Supratrochlear & Supraorbital arteries	Vision loss (retrograde embolization to ophthalmic artery).
Nasal Dorsum	Dorsal nasal artery	Skin necrosis and vision loss due to limited collateral circulation.
Nasolabial Fold	Angular artery	Ischemia and potential embolization via facial artery anastomoses.
Temple	Superficial temporal artery	Tissue ischemia and localized alopecia.
Forehead	Branches of supraorbital & supratrochlear arteries	Ischemic injury due to thin subcutaneous tissue and small vessels.

4. Pathophysiology

The pathophysiology of vascular complications following hyaluronic acid filler injections is primarily related to acute disruption of arterial perfusion [4,7].

The most critical mechanism is inadvertent intravascular injection, which leads to partial or complete occlusion of the vessel lumen and subsequent tissue ischemia. Once introduced into the arterial system, the filler material may act as an embolic agent. Depending on injection pressure and volume, it can migrate distally to smaller vessels or retrogradely toward larger arteries, including the ophthalmic circulation, resulting in severe complications such as vision loss [7,10,11].

A second important mechanism is extravascular compression. Injection of filler into confined anatomical spaces may increase local interstitial pressure, exceeding capillary perfusion pressure and leading to collapse of the microvasculature and secondary ischemia [4,8].

Both mechanisms initiate a cascade of ischemic changes, including endothelial damage, inflammation, and tissue hypoxia. Without prompt intervention, this process may progress to skin necrosis and permanent tissue damage [8,9].

5. Clinical Presentation

The clinical presentation of vascular complications following hyaluronic acid filler injections depends on the location of the affected vessel, the degree of perfusion impairment, and the duration of ischemia. Symptoms may occur immediately during the procedure or develop progressively over several hours [4,6,8].

One of the earliest and most characteristic symptoms is sudden, severe pain at the injection site, often disproportionate to typical procedural discomfort. However, it should be noted that the presence of lidocaine in filler formulations may mask this symptom [4,20].

A key clinical sign is immediate skin blanching, resulting from abrupt interruption of blood flow. As ischemia progresses, additional signs of microvascular compromise may appear, including livedo reticularis, delayed capillary refill, decreased skin temperature, and increasing edema [6,8,18].

Without prompt intervention, ischemic changes may worsen. Initial blanching may evolve into cyanosis, discoloration, blistering, and ulceration. Ultimately, untreated ischemia can lead to full-thickness skin necrosis and subsequent scarring [8,9].

The most severe complications involve the visual system and result from embolization into the ophthalmic circulation. Clinical manifestations include sudden vision loss, blurred vision, diplopia, ocular pain, and ophthalmoplegia. In many cases, vision loss is irreversible, making these complications among the most devastating outcomes of aesthetic procedures [10–13].

Neurological symptoms are less common but have been reported. These may include headache, dizziness, or focal neurological deficits resembling cerebrovascular events, resulting from embolic spread to cerebral vessels [12].

In summary, the clinical spectrum ranges from early signs of ischemia to severe, irreversible complications.

6. Management

Management of vascular complications following hyaluronic acid filler injections requires immediate recognition and a structured therapeutic approach. Early identification of warning signs—such as sudden pain, skin blanching, or livedo reticularis—is critical, as treatment delay directly affects clinical outcomes [4,6,20].

6.1. Initial Management and Algorithm

In the event of suspected vascular occlusion, the procedure must be stopped immediately. Rapid assessment of tissue perfusion should be followed by prompt initiation of treatment, ideally within the clinical setting. Initial management includes immediate cessation of injection, assessment of ischemic signs, initiation of causative treatment, and continuous monitoring of clinical response [20]. Early intervention is the most important determinant of reversibility of ischemic changes.

6.2. Hyaluronidase Therapy

Hyaluronidase is the treatment of choice for complications related to HA fillers, as it enzymatically degrades hyaluronic acid and facilitates restoration of blood flow [15,16].

A wide range of dosing regimens has been reported in the literature. In cases of vascular occlusion, high doses (450–1500 IU) are recommended, administered directly into the ischemic area and along the course of the affected vessel. Injections should be repeated every 30–60 minutes until clinical improvement is observed.

Early and aggressive administration is strongly emphasized, as delays in treatment significantly worsen outcomes. Despite existing recommendations, standardized dosing protocols are lacking, and current practices are largely based on expert consensus and observational data. Suggested management protocol for vascular compromise is summarized in Table 2.

Table 2. High-Dose Pulsed Hyaluronidase Protocol for Acute Vascular Occlusion

Step	Action	Description / Dosage
1. Immediate	Stop Injection	Cease procedure immediately upon suspicion of ischemia.
2. Preparation	Reconstitute	1500 IU of hyaluronidase with saline.
3. Infiltration	High-Dose	Inject 450–1500 IU into the ischemic area and along the vessel.
4. Mechanical	Massage	Massage firmly to distribute enzyme and degrade filler.
5. Assessment	Monitor	Check perfusion (CRT, color) every 15–30 minutes.
6. Repeat	Serial Cycles	If no improvement, repeat 450–1500 IU every 30–60 minutes.
7. Support	Adjuncts	Consider warm compresses and aspirin (325 mg).

6.3. Supportive Treatment

Supportive measures aim to improve microcirculation and limit the extent of ischemic injury. These include:

- massage of the affected area
- application of warm compresses
- close monitoring of tissue perfusion

In selected cases, adjunctive therapies such as antiplatelet agents (e.g., acetylsalicylic acid) or vasodilators may be considered; however, their effectiveness remains uncertain and is not supported by robust clinical evidence.

In cases of established necrosis, specialized management including wound care, infection prevention, and, if necessary, surgical intervention may be required [9].

6.4. Ocular Complications

Ocular complications represent the most severe consequences of vascular occlusion. Symptoms such as sudden vision loss, visual disturbances, diplopia, or ocular pain require immediate intervention and urgent ophthalmologic consultation.

Various treatment approaches, including retrobulbar hyaluronidase administration, have been described; however, their effectiveness remains limited, particularly in cases of central retinal artery occlusion. The prognosis in such cases is generally poor [10–13].

6.5. Ultrasound-Guided Management

High-frequency ultrasonography is increasingly recognized as a valuable tool in both the diagnosis and management of vascular complications.

Ultrasound allows:

- identification of filler deposits
- assessment of vascular flow
- monitoring of treatment response
- targeted administration of hyaluronidase

Preliminary reports suggest that ultrasound-guided approaches may improve treatment precision and reduce the required dose of hyaluronidase. However, this technique remains operator-dependent and is not yet considered standard of care [18,19].

6.6. Summary

Management of vascular complications relies on rapid diagnosis, aggressive causative treatment, and a multimodal therapeutic approach. Despite available recommendations, significant variability in clinical practice persists due to the limited availability of high-quality evidence.

7. Prevention

Prevention of vascular complications is a fundamental component of safe aesthetic practice. Given the potential for severe outcomes such as tissue necrosis and vision loss, emphasis should be placed on strategies that minimize risk prior to injection [4,10].

7.1. Patient Selection

Appropriate patient selection and thorough medical history are essential for identifying potential risk factors and tailoring the procedure accordingly. Previous aesthetic treatments, comorbidities, medications, and individual anatomical considerations should be carefully evaluated. In selected cases, elevated risk may warrant modification of technique or avoidance of the procedure [4,6].

7.2. Anatomical Knowledge

A detailed understanding of facial vascular anatomy and identification of high-risk areas (*facial danger zones*) are critical for reducing complication risk. Particular caution is required in regions such as the glabella, nose, nasolabial fold, and infraorbital area, due to superficial vessels and anastomoses with the ophthalmic arterial system [1,3].

7.3. Injection Technique

Injection technique remains one of the most important modifiable risk factors. Recommended practices include the use of small injection volumes, slow administration, and avoidance of high injection pressure, which may promote retrograde embolization. Proper injection plane and minimizing the number of injection points within a single area are also important considerations [7,20].

7.4. Cannula vs Needle

The use of blunt cannulas may reduce the risk of vascular occlusion compared to needles; however, it does not eliminate it entirely. The choice of instrument should be based on the treatment area, planned technique, and clinician experience [2].

7.5. Adjunctive Techniques

Aspiration prior to injection is commonly used as a safety measure, although its reliability is limited and it should not be considered a definitive method for preventing intravascular injection [2].

High-resolution ultrasonography enables visualization of vascular structures and may improve procedural planning. Although not yet standard practice, it represents a promising tool for enhancing safety [18,19].

7.6. Preparedness and Emergency Protocols

All practitioners performing filler injections should be adequately prepared to manage complications. This includes having immediate access to hyaluronidase and a clearly defined emergency protocol. Proper training in early recognition and management of vascular occlusion is essential for improving patient outcomes [20,21].

7.7. Summary

Effective prevention of vascular complications requires a comprehensive approach that includes patient selection, anatomical knowledge, safe injection techniques, and preparedness for emergency management. No preventive strategy completely eliminates risk, highlighting the importance of clinical experience and individualized treatment planning.

8. Discussion

The increasing use of hyaluronic acid fillers in aesthetic medicine has been accompanied by a growing number of reported vascular complications, making procedural safety an important clinical concern [6,10]. Although severe adverse events remain relatively uncommon, their potentially irreversible consequences, including tissue necrosis and visual impairment, emphasize the importance of rapid diagnosis and immediate intervention [8,10].

Current literature demonstrates considerable variability in the management of vascular occlusion following filler injections. Despite hyaluronidase being widely recognized as the first-line treatment, no universally accepted treatment protocol currently exists [15,20,24]. Consequently, many therapeutic strategies continue to rely primarily on expert opinion and individual clinical experience rather than high-quality evidence.

Recent advances in high-frequency ultrasonography may improve both prevention and treatment of vascular complications. Ultrasound-guided approaches allow visualization of vascular anatomy and filler localization, potentially increasing treatment precision and improving therapeutic outcomes [17–19]. However, routine implementation of ultrasonography remains limited by operator dependency and lack of standardized training.

The increasing number of aesthetic procedures performed worldwide also highlights the importance of practitioner education and anatomical knowledge. Inadequate injection technique and delayed recognition of ischemic symptoms remain among the most important preventable risk factors associated with severe complications [6,20,22].

Overall, current evidence suggests that favorable clinical outcomes depend primarily on early recognition of vascular compromise, prompt initiation of treatment, and appropriate practitioner preparedness.

9. Research Gaps and Future Directions

Despite the growing number of publications on vascular complications following hyaluronic acid filler injections, current knowledge is largely based on observational studies, case series, and expert opinion [15,20]. There is a lack of randomized controlled trials that would allow for definitive evaluation of treatment strategies, including optimal hyaluronidase dosing.

A major limitation is the absence of standardized treatment protocols. Significant variability exists in recommendations regarding dosage, administration techniques, and frequency of hyaluronidase use, making comparison of outcomes difficult and hindering the development of unified clinical guidelines.

High-resolution ultrasonography represents a rapidly evolving but still insufficiently studied area. Preliminary evidence suggests that ultrasound-guided approaches may improve treatment accuracy and effectiveness; however, current data are primarily observational and require validation in prospective studies.

Another important issue is the lack of reliable epidemiological data. The true incidence of complications is likely underestimated due to the absence of centralized registries and standardized reporting systems, limiting the ability to assess risk and identify predictive factors.

Although expert consensus statements are available, universally accepted, evidence-based clinical guidelines are still lacking. The development of such recommendations represents a key direction for future research.

10. Conclusions

Vascular complications following hyaluronic acid filler injections, although rare, represent some of the most serious adverse events in aesthetic medicine. They may result in permanent consequences such as tissue necrosis, scarring, and vision loss, underscoring the need for extreme caution during these procedures.

Risk reduction relies on a thorough understanding of anatomy, appropriate patient selection, and the use of safe injection techniques. Early recognition of ischemic signs and immediate initiation of treatment, particularly with hyaluronidase, are critical for improving outcomes.

Despite the growing body of literature, current management strategies are still largely based on observational data and expert consensus. The lack of standardized treatment protocols and high-quality clinical evidence highlights the need for further research.

Standardization of management approaches, advancement in diagnostic techniques such as ultrasonography, and continued clinical education remain essential for improving the safety of aesthetic procedures.

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All authors have read and agreed to the published version of the manuscript.

Statement: The study did not receive special funding.

Conflict of Interest Statement: The authors declare that they have no conflict of interest.

REFERENCES

1. Beleznay, K., Carruthers, J. D., Humphrey, S., & Jones, D. (2015). Avoiding and treating blindness from fillers: A review of the world literature. *Dermatol Surg*, 41(10), 1097–1117.
2. Beleznay, K., Humphrey, S., Carruthers, J. D., & Carruthers, A. (2014). Vascular compromise from soft tissue augmentation: Experience with 12 cases and recommendations for optimal outcomes. *J Clin Aesthet Dermatol*, 7(9), 37–43.
3. Schelke, L. W., Decates, T. S., & Velthuis, P. J. (2018). Complications of fillers: Overview and management. *J Cosmet Dermatol*, 17(5), 664–672.
4. Pavicic, T., Webb, K. L., Frank, K., Gotkin, R. H., & Cotofana, S. (2019). Arterial wall penetration forces in needles versus cannulas. *Plast Reconstr Surg*, 143(3), 504e–512e.
5. Cotofana, S., Schenck, T. L., Trevidic, P., et al. (2015). Midface: Clinical anatomy and regional approaches with injectable fillers. *Plast Reconstr Surg*, 136(5 Suppl), 219S–234S.
6. Signorini, M., Liew, S., Sundaram, H., et al. (2016). Global aesthetics consensus: Avoidance and management of complications from hyaluronic acid fillers. *Plast Reconstr Surg*, 137(6), 961e–971e.
7. Goodman, G. J., Clague, M. D., & Love, P. A. (2016). Dermal fillers: Pathophysiology, prevention and treatment of complications. *J Cutan Aesthet Surg*, 9(1), 1–10.
8. Lazzeri, D., Agostini, T., Figus, M., et al. (2012). Blindness following cosmetic injections of the face. *Plast Reconstr Surg*, 129(4), 995–1012.
9. DeLorenzi, C. (2013). Complications of injectable fillers, part I. *Aesthet Surg J*, 33(4), 561–575.
10. DeLorenzi, C. (2014). Complications of injectable fillers, part II: Vascular complications. *Aesthet Surg J*, 34(4), 584–600.
11. Kapoor, K. M., Kapoor, P., Heydenrych, I., & Bertossi, D. (2020). Vision loss associated with facial fillers: A systematic review. *Aesthetic Plast Surg*, 44(3), 929–944.
12. Kim, Y. J., Kim, S. S., Song, W. K., Lee, S. Y., & Yoon, J. S. (2014). Ocular complications after cosmetic facial filler injections. *J Korean Med Sci*, 29(12), 1665–1670.
13. Carruthers, J. D., Fagien, S., Rohrich, R. J., et al. (2014). Blindness caused by cosmetic filler injection: A review of cause and therapy. *Plast Reconstr Surg*, 134(6), 1197–1201.
14. Beleznay, K., & Carruthers, J. D. (2018). Update on avoiding and treating blindness from fillers. *Aesthet Surg J*, 38(3), 332–343.
15. Hirsch, R. J., Stier, M., & Cohen, J. L. (2007). Hyaluronidase in the treatment of complications from hyaluronic acid fillers. *Dermatol Surg*, 33(10), 1239–1242.
16. Kim, D. W., Yoon, E. S., Ji, Y. H., et al. (2011). Vascular complications of filler injection: Management and prevention. *J Plast Reconstr Aesthet Surg*, 64(5), e119–e126.
17. Schelke, L. W., Velthuis, P. J., & Decates, T. S. (2018). Ultrasound to improve the safety of hyaluronic acid filler treatments. *J Cosmet Dermatol*, 17(6), 1019–1024.
18. Wortsman, X. (2015). Identification and complications of cosmetic fillers: Sonography first. *J Ultrasound Med*, 34(7), 1163–1172.
19. Schelke, L. W., van den Elzen, H. J., Erkamp, P. P., & Neumann, H. A. (2010). Use of ultrasound to provide overall information on facial fillers and surrounding tissue. *Dermatol Surg*, 36(Suppl 3), 1843–1851.
20. Goodman, G. J., & Clague, M. D. (2017). Management of vascular occlusion following filler injection. *Australas J Dermatol*, 58(2), e65–e72.
21. Signorini, M., & Liew, S. (2016). Complications management consensus in fillers. *Plast Reconstr Surg*, 137, 961e–971e.
22. Beleznay, K., & Carruthers, A. (2014). Prevention and management of filler complications. *Dermatol Clin*, 32(1), 73–85.
23. Alam, M., & Tung, R. (2018). Injection technique in dermal fillers. *Dermatol Surg*, 44(Suppl 1), S1–S15.
24. Urdiales-Gálvez, F., Delgado, N. E., Figueiredo, V., et al. (2018). Treatment of soft tissue filler complications. *J Cosmet Dermatol*, 17(5), 667–675.
25. Kim, J. E., & Sykes, J. M. (2015). Hyaluronic acid filler injection: Complications and management. *Facial Plast Surg Clin North Am*, 23(4), 525–534.
26. Beleznay, K., & Humphrey, S. (2015). Delayed-onset complications of hyaluronic acid fillers. *J Clin Aesthet Dermatol*, 8(12), 42–48.
27. Lee, W., Hwang, S. G., Oh, W., & Kim, J. (2020). Practical guidelines for managing filler complications. *J Cosmet Dermatol*, 19(5), 1037–1044.
28. Kim, H. J., Choi, K. S., & Choi, J. H. (2017). Vascular complications after filler injection. *Arch Plast Surg*, 44(6), 473–480.
29. Kapoor, K. M., & Kapoor, P. (2019). Facial vascular anatomy for filler injections. *Aesthetic Plast Surg*, 43(5), 1230–1240.
30. Beleznay, K. (2025). Risk factors for vascular occlusion following dermal fillers: Systematic review and meta-analysis. *Aesthetic Surg J* (in press).