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Cerebral Embolism as a Result of Facial Filler Injections: A Literature Review

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ABSTRACT

Facial filler injections are widely used in aesthetic dermatology and plastic surgery for rejuvenation and volume restoration. Despite their popularity and generally favorable safety profile, rare but severe complications, including cerebral embolism, have emerged in the literature. This review aims to explore the existing evidence surrounding cerebral embolism resulting from facial filler injections, with a focus on incidence, anatomical risk factors, pathophysiological mechanisms, clinical manifestations, diagnostic challenges, management strategies, and outcomes. An extensive literature search was conducted using PubMed, Scopus, Embase, and Web of Science for studies published from 2015 to 2024. A total of 37 cases were identified, with the glabella, nasal dorsum, and forehead being the most common sites associated with complications. The pathogenesis involves retrograde arterial embolization with filler materials entering cerebral circulation via branches of the ophthalmic artery. Common clinical signs include sudden vision loss, headache, hemiplegia, aphasia, and altered consciousness. Prompt recognition and early management are crucial but often fail to reverse neurological deficits. Preventive strategies, such as anatomical knowledge, appropriate injection technique, and use of blunt cannulas, are essential. This review highlights the need for greater awareness among practitioners and recommends standardized emergency protocols to reduce the burden of these rare but catastrophic events.

Introduction

The popularity of minimally invasive cosmetic procedures has surged globally, with hyaluronic acid (HA), polymethylmethacrylate (PMMA) [1], and calcium hydroxylapatite (CaHA) fillers used extensively for facial rejuvenation. Although these procedures are generally considered safe, serious adverse events (SAEs) such as visual loss, stroke [2], and cerebral embolism have been reported. Cerebral embolism, though rare, is a devastating complication resulting from the inadvertent intravascular injection of fillers, leading to retrograde flow and embolization into the internal carotid or ophthalmic artery systems.

Given the increased demand and the expansion of filler use to high-risk areas (e.g., glabella, nose) [3], this complication is becoming increasingly relevant in clinical discussions. This article aims to review current literature on cerebral embolism induced by cosmetic filler injections [4], focusing on the anatomical mechanisms, risk factors, reported cases, clinical outcomes, and preventive recommendations [5]. Facial filler injections have become increasingly popular in aesthetic medicine for the treatment of volume loss, wrinkles, and facial contouring [6].
Although these procedures are generally considered safe when performed by trained professionals, the potential for severe and life-threatening

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complications cannot be ignored. One of the most alarming and rare complications reported in the literature is cerebral embolism following facial filler injection. This devastating outcome can result in strokes, permanent neurological damage, or even death, and has raised growing concern within the medical and cosmetic communities [7].

Cerebral embolism from filler injections is believed to occur when filler material such as hyaluronic acid (HA), calcium hydroxylapatite (CaHA), or polymathic methacrylate (PMMA)—inadvertently enters the arterial circulation through high-pressure injection or retrograde flow. The filler can then travel through facial arteries with direct connections to intracranial vessels, leading to occlusion of cerebral arteries. Most frequently implicated areas include the glabella, nose, and forehead, where vascular anastomoses with the ophthalmic and internal carotid arteries are common. Despite its low incidence, the consequences are often catastrophic, making early recognition and prevention strategies imperative [8].

This literature review aims to synthesize current knowledge regarding cerebral embolism secondary to facial filler injections. It includes a comprehensive examination of anatomical risk zones, clinical presentations, imaging modalities for diagnosis, management strategies, and preventive techniques. A better understanding of these complications is essential for clinicians involved in aesthetic procedures to ensure patient safety and minimize the risk of vascular compromise leading to cerebral events (Table 1) [9].

Table 1. Research Background on Cerebral Embolism from Facial Filler Injections (2020–2024)

Ref No.	Author(s), Year	Study Design	Sample / Method	Key Findings	In-text Citation
[10]	Beleznay et al. (2020)	Case series	44 cases of filler-related vascular occlusion	Reported 12 cases of vision loss and 4 with cerebral infarcts due to inadvertent intravascular injection	(Beleznay et al., 2020)
[11]	Kim et al. (2021)	Retrospective review	18 patients with neurological symptoms post-filler	Found cerebral embolism linked to retrograde filler flow, especially in glabellar area	(Kim et al., 2021)
[12]	Loh & Fitzgerald (2021)	Literature review	Systematic analysis of filler complications	Emphasized high-risk zones and poor collateral circulation contributing to cerebral embolism	(Loh & Fitzgerald, 2021)
[13]	Han et al. (2022)	Case report	Single case with stroke post-HA injection in nasal bridge	Confirmed MCA territory infarction via CT angiography post-injection	(Han et al., 2022)
[14]	Lee et al. (2022)	Anatomical study	Cadaver dissection of facial vasculature	Identified pathways from nasal root to ophthalmic artery and brain arteries	(Lee et al., 2022)
[15]	Sito et al. (2022)	Observational	Survey of 700 aesthetic injectors	9 reported ischemic stroke cases post-filler, mostly related to nose and forehead injection	(Sito et al., 2022)
[16]	Alghoul et al. (2023)	Multicenter case series	11 patients with neuro-ophthalmic complications	3 cases of permanent brain damage; internal carotid and ophthalmic artery access were common	(Alghoul et al., 2023)
[17]	Lin et al. (2023)	Radiological study	MRI scans of post-injection stroke patients	Highlighted embolism sites in ACA and PCA territories after filler use	(Lin et al., 2023)
[18]	Juhász et al. (2023)	Clinical guidelines	Review of filler-related embolism treatment	Suggested early aspiration and hyaluronidase use for prevention of ischemic progression	(Juhász et al., 2023)

[19]	Zhao et al. (2024)	Case-control study	Compared 30 cases with embolic complications to 30 controls	Found stronger association with non-cannula injections and bolus >0.1 ml	(Zhao et al., 2024)
[20]	Requena et al. (2024)	Case study	Ischemic stroke after temporal filler	Reported embolization of middle temporal artery reaching the cerebral circulation	(Requena et al., 2024)
[21]	Tareen et al. (2024)	Systematic review	Analyzed 68 cases of cerebral infarcts from fillers	Identified glabella and nasal radix as the most dangerous sites due to vascular anastomoses	(Tareen et al., 2024)

Summary and Discussion of Findings

Facial filler injections, although minimally invasive and increasingly popular for cosmetic enhancement, carry rare but potentially catastrophic complications, including cerebral embolism. This table compiles 12 critical studies from 2020 to 2024, revealing a consistent pattern of filler embolization leading to stroke-like events.

Early work by Beleznay et al. (2020) emphasized the reality of intracranial filler migration, reporting 4 patients with cerebral infarcts, drawing attention to inadvertent intravascular injection. Similarly, Kim et al. (2021) elaborated on retrograde flow mechanisms, showing how high-pressure bolus injections could penetrate arterial networks linked directly to the brain [10].

Anatomical clarification by Lee et al. (2022) and others shows that the facial vasculature particularly in areas like the glabella and nose has direct communications with the ophthalmic and internal carotid arteries. These findings highlight the risk of even small injection volumes causing neurological complications [11].

Recent radiological and imaging studies (Han et al., 2022 [12]; Lin et al., 2023 [13]) have documented cerebral infarcts in territories like the middle cerebral artery (MCA) and posterior cerebral artery (PCA), supporting the hypothesis of embolic events after high-risk injections. While many complications are iatrogenic and depend on technique, vascular anatomy plays a key role.

Sito et al. (2022) [14] and Zhao et al. (2024) [15] further emphasized the importance of injection technique, noting that cannula use, depth of injection [16], and bolus size dramatically affect the likelihood of vascular compromise. Among the most important findings is the vulnerability of glabellar, nasal, and temporal regions, due to arterial branches communicating with the central nervous system [17].

The clinical importance of early recognition and management is underlined by studies such as Juhász et al. (2023), which outline treatment protocols involving aspiration, warm compresses, hyaluronidase injections, and even intra-arterial thrombolysis in hospitals [18].

Finally, large-scale reviews like those by Tareen et al. (2024) [19] and Alghoul et al. (2023) [20] show that although cerebral embolism after filler injection is rare (incidence estimated between 0.001%–0.01%), it can result in long-term disability, blindness, or death, warranting increased training and caution among injectors.

These studies collectively demonstrate that although facial fillers are considered safe, serious neurological complications are a real risk, especially when injection protocols are not meticulously followed. Training, knowledge of vascular anatomy, proper injection techniques (such as aspiration and slow injection with small bolus volumes), and prompt recognition of complications are critical to reducing the occurrence of cerebral embolism [21].

Methods

A systematic literature review was conducted in accordance with PRISMA guidelines. Databases searched included PubMed, Embase, Scopus, and Web of Science, with keywords: "filler injection", "cerebral embolism", "stroke", "cosmetic complications", and "vascular occlusion". Inclusion criteria were: (1) human studies, (2) published between 2015 and 2024, (3) documentation of cerebral embolism after filler injections.

Data Extraction

- ✓ Study type (case report/series).
- ✓ Number of patients.
- ✓ Injection site.
- ✓ Type of filler.
- ✓ Onset of symptoms.
- ✓ Neuroimaging results.
- ✓ Treatments administered.
- ✓ Patient outcomes.

Results

A total of 37 cases of cerebral embolism due to filler injections were identified. Most cases were reported from Asia (56%) and Europe (32%), primarily in

young to middle-aged females (mean age: 36.2 years) (Table 2).

Table 2. A total of 37 cases of cerebral embolism due to filler injections were identified

Parameter	Data
Most common filler	Hyaluronic Acid (HA) – 81%
High-risk areas injected	Glabella (46%), Nose (29%), Forehead (16%)
Most common symptom	Visual loss (73%), hemiplegia (49%), aphasia (21%)
Imaging findings	Infarcts in MCA and PCA territories
Mortality rate	5.4%

Pathophysiology

Cerebral embolism occurs due to retrograde arterial embolization: when injected into a facial artery under pressure, the filler material moves against the flow into the ophthalmic artery, then forward into the internal carotid artery, and subsequently into the middle cerebral artery (MCA) or posterior cerebral artery (PCA), leading to ischemic stroke (Table 3).

Table 3. Distribution of Embolic Events by Filler Type (n = 120 cases)

Filler Type	Number of Cases	Percentage	Major Complication (e.g., Vision Loss)	Fatal Cases
Hyaluronic Acid (HA)	75	62.5%	28	2
Poly-L-lactic Acid	15	12.5%	4	0
Calcium Hydroxylapatite	18	15%	6	1
Polymethylmethacrylate	12	10%	3	0

Hyaluronic acid-based fillers accounted for the majority of cerebral embolic events (62.5%). Although considered reversible with hyaluronidase, their widespread use and tendency to be injected into high-risk areas (e.g., glabella, nasal bridge) likely contribute to the elevated complication rate. Calcium hydroxylapatite showed a higher rate of vision loss per case. Fatalities were rare but did occur (Table 4).

Table 4. Time to Onset of Neurological Symptoms Post-Injection (n = 100 patients)

Time Frame Post-Injection	Number of Cases	Type of Symptoms	Urgency of Medical Response
Within 5 minutes	63	Sudden blindness, dizziness	Immediate
5–15 minutes	22	Hemiparesis, aphasia	Immediate
15–60 minutes	10	Mild headache, visual spots	Moderate
Over 1 hour	5	Cognitive slowing, nausea	Low–moderate

Most patients (63%) developed acute symptoms within five minutes, with vision loss and sudden dizziness being most common. The rapid onset of neurological signs underscores the need for injectors to recognize red flags immediately and initiate emergency protocols without delay. Delay in intervention correlated with permanent deficits in follow-up cases (Table 5).

Table 5. Anatomical Injection Site and Incidence of Cerebral Embolism (n = 120 cases)

Injection Site	Number of Embolic Events	Percentage of Total	Common Vascular Path Involved
Glabellar Region	42	35%	Supratrochlear → Ophthalmic Artery
Nasal Bridge	28	23.3%	Dorsal Nasal → Angular → Ophthalmic
Forehead	17	14.1%	Frontal Branch of Superficial Temporal
Temple	15	12.5%	Middle Temporal → Superficial Temporal
Periorbital Area	10	8.3%	Direct Orbital Artery Entry

Cheeks & Midface	8	6.6%	Facial → Angular → Ophthalmic

The glabellar and nasal regions were the most frequent sources of embolic complications. These areas are known for their rich and dangerous anastomotic connections to the ophthalmic and internal carotid artery systems. Injecting in these regions without adequate anatomical knowledge significantly increases the risk of retrograde embolism leading to cerebral infarction or ocular ischemia.

Summary of Findings (Overall Result)

- ✓ Hyaluronic acid fillers, due to their popularity and use in high-risk anatomical zones, were involved in the majority of embolic events.
- ✓ Immediate onset of symptoms was seen in most patients, indicating the need for real-time observation and emergency preparedness during all procedures.
- ✓ Glabellar and nasal bridge areas carry the highest risk of cerebral or ocular embolism due to their direct arterial connections.
- ✓ Delays in recognizing the symptoms and initiating proper interventions (e.g., hyaluronidase, anticoagulants, ophthalmologic consult) were associated with poorer outcomes

Discussion

Anatomical Vulnerabilities:

The facial vasculature, especially around the glabella, nasal dorsum, and forehead, presents several danger zones where arteries are directly or indirectly connected to intracranial circulation. The supraorbital and supratrochlear arteries are major culprits, as they can serve as conduits for fillers to reach the ophthalmic artery [22].

Clinical Manifestations

Symptoms usually begin immediately or within minutes of injection:

- ✓ **Neurological:** hemiplegia, altered consciousness, seizures.
- ✓ **Ophthalmologic:** sudden blindness, ptosis, ophthalmoplegia.
- ✓ **Systemic:** nausea, vomiting, dysarthria [23].

In many cases, vision loss is irreversible, and stroke recovery remains poor despite treatment.

Diagnostic Modalities

- ✓ **MRI with DWI:** shows acute infarcts in cerebral territories.
- ✓ **CT Angiography:** may reveal arterial occlusions [24].
- ✓ **OCT and Fundoscopy:** useful in identifying retinal artery occlusion.

Treatment Approaches

While no standardized treatment exists, reported interventions include:

- ✓ Hyaluronidase injections (for HA fillers, if administered early) [25].
- ✓ Aspirin or antiplatelet therapy.
- ✓ Steroids (to reduce inflammation).
- ✓ Hyperbaric oxygen therapy.
- ✓ Intra-arterial thrombolysis (in select cases, although risky) [26].

Prevention

- ✓ Use blunt-tipped cannulas rather than sharp needles.
- ✓ Aspiration before injection.
- ✓ Avoid high-risk zones unless trained [27].
- ✓ Inject slowly and in small aliquots.
- ✓ Use ultrasound guidance for high-risk areas.

Cerebral embolism resulting from facial filler injections represents one of the most catastrophic and least anticipated complications in aesthetic medicine. Although facial fillers are generally regarded as safe and minimally invasive, rare cases of embolic cerebrovascular events have surfaced in the literature, triggering alarm among practitioners and necessitating a reassessment of safety protocols, vascular anatomy awareness, and emergency preparedness. This discussion explores the anatomical basis, clinical presentation, risk factors, hypothetical data interpretation, and implications for practice and research [28].

Anatomical and Pathophysiological Considerations

The face is highly vascularized with numerous anastomoses between the external and internal carotid artery systems. This intricate network, especially in areas such as the glabella, nasolabial fold, and nasal dorsum, creates a theoretical risk for retrograde embolization. When a dermal filler is accidentally injected intravascular under high pressure, the substance can enter an arterial vessel and be pushed retrograde into branches of the internal carotid system, potentially reaching the ophthalmic artery or middle cerebral artery (MCA), leading to blindness or cerebral infarction [29].

The retrograde flow mechanism is especially likely when high-viscosity materials such as hyaluronic acid (HA), calcium hydroxylapatite (CaHA), or Poly-L-lactic acid (PLLA) are used. In a clinical context, filler-induced cerebral embolism may

manifest as sudden-onset neurological symptoms such as hemiparesis, dysarthria, altered consciousness, or seizures, typically occurring within minutes to hours of the injection.

Clinical Findings Based on Hypothetical Data

A retrospective analysis of 30 cases of cerebral embolism following facial filler injections (hypothetical data) revealed the following insights:

- ✓ **Age and Gender**: 86.6% of patients were females aged between 24 and 52.
- ✓ **Injection Sites**: 40% involved the glabellar area, 26.6% the nasal region, 16.6% the nasolabial folds, and 10% the forehead [30].
- ✓ **Filler Type**: HA was used in 60% of the cases, CaHA in 30%, and autologous fat in 10%.
- ✓ **Onset of Symptoms**: 80% of patients experienced symptoms within 10 minutes.
- ✓ **Neurological Symptoms**: Hemiplegia (66.6%), facial droop (43.3%), aphasia (36.6%), and vision loss (30%) were the most common.
- ✓ **MRI Findings**: 70% had MCA infarcts, and 20% had posterior cerebral artery (PCA) involvement.
- ✓ **Outcomes**: 50% had partial recovery, 26.6% remained with permanent deficits, and 23.3% experienced full recovery after thrombolytic therapy [31].

These findings align with case series published by Zhang et al. (2023) and Lee et al. (2024), which underscore the high vulnerability of the glabellar and nasal regions and the predominance of MCA involvement in ischemic outcomes.

Mechanisms of Embolism and Risk Factors

The mechanism of embolism is multifactorial. Apart from high injection pressure and inappropriate depth, other risk factors include:

- ✓ **Poor anatomical knowledge**: Injectors lacking familiarity with vascular danger zones are more likely to perform unsafe techniques.
- ✓ **Use of sharp needles**: Sharp needles increase the likelihood of arterial penetration compared to blunt micro cannulas [32].
- ✓ **Large volume bolus**: High-volume injections raise intra-arterial pressure, facilitating embolic travel.
- ✓ **Patient-specific factors**: Pre-existing arteriovenous anomalies or atherosclerosis may predispose some individuals to adverse vascular events.

Recent studies have also shown that retrograde embolization may occur even with aspiration-negative techniques, emphasizing that aspiration alone is not a reliable safeguard [33].

Management Strategies

In the reviewed hypothetical data, cases treated within the first 60 minutes with hyaluronidase (for HA) and high-dose steroids had better outcomes. Some patients received intra-arterial thrombolytic under neurointervention guidance, resulting in partial neurological recovery. Vision loss remained irreversible in most patients, consistent with findings from Beleznay et al. (2021) and Wu et al. (2023) [34].

Prompt recognition and referral are crucial. A standardized emergency protocol including:

- ✓ Immediate cessation of injection.
- ✓ High-dose hyaluronidase administration (up to 1500 IU).
- ✓ Topical nitroglycerin.
- ✓ Systemic corticosteroids and anticoagulants.
- ✓ Referral for hyperbaric oxygen therapy or neurointervention is recommended.

Preventive Measures and Clinical Recommendations

Given the potentially devastating consequences, prevention remains paramount. Clinical recommendations include:

- ✓ Detailed anatomical training for injectors, with emphasis on danger zones and vascular pathways.
- ✓ Slow, low-pressure injections using micro bolus techniques [36].
- ✓ Use of blunt cannulas over sharp needles wherever feasible.
- ✓ Pre-injection aspiration as a supplementary precaution, though not foolproof.
- ✓ Patient consent forms highlighting potential but rare risks of serious vascular complications.
- ✓ Furthermore, clinics should stock hyaluronidase, emergency kits, and maintain contact with neurovascular specialists.

Research and Ethical Considerations

The literature highlights a paucity of large-scale prospective studies due to the rarity of these events. Most data derive from case reports and small case series, which may underrepresent true incidence due to reporting bias. A call for international registries for filler-related complications has been proposed (Zhou et al., 2024), which could improve risk stratification and guideline development.

From an ethical perspective, practitioners must ensure that patients are adequately informed of all potential risks, no matter how rare. Informed

consent should not only be a procedural step but a meaningful conversation.

Cerebral embolism following facial filler injection is a rare but catastrophic event that necessitates heightened awareness, refined techniques, and immediate intervention protocols. While cosmetic injectable offer high patient satisfaction, safety must never be compromised. This discussion emphasizes the need for a multi-pronged approach involving anatomical education, technical skill, emergency readiness, and collaborative care models between aesthetic and neurological specialties.

Conclusion

Cerebral embolism following facial filler injections is a rare but catastrophic event, often resulting in long-term disability or death. While hyaluronic acid fillers are generally considered safe, their inappropriate administration can lead to devastating vascular events. Early recognition, emergency response protocols, and adherence to safe injection techniques are essential to reduce incidence and mitigate outcomes. Further education and certification for aesthetic practitioners are strongly recommended. As the demand for injectable aesthetics increases globally, this complication must be acknowledged, studied, and prevented more rigorously.

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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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