

Ischaemic strokes from facial injections of dermal fillers: Clinico-radiological features and outcomes

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ABSTRACT

Introduction: Ischaemic stroke is a severe complication of dermal filler injections that remains poorly described and understood. This study aims to characterise the clinical features and outcomes of patients who experience strokes following facial dermal filler injections.

Methods: A systematic review and retrospective analysis of ischaemic strokes caused by dermal filler injections and reported over the past 3 decades, were conducted. Cases involving autologous fat were also compared against those that did not.

Results: Fifty-five cases from 45 studies were analysed. Their median age was 32 years (18–61), and most were women (49/55, 89%). Injections frequently occurred at the glabella (17/53, 32%) and temples (12/53, 23%), and autologous fat was most often used (33/55, 60%). Half (29/55, 53%) had ocular symptoms at presentation. Hemiparesis/hemiplegia (30/55, 55%) and confusion/reduced consciousness/alertness (26/55, 47%) were the predominant stroke symptoms. Most infarcts were unilateral (45/54, 83%) and large (32/48, 67%). Treatment primarily involved corticosteroids (12/41, 29%) and antiplatelet agents (11/41, 27%), while hyaluronidase injections (3/41, 7%) and hyperbaric oxygen therapy (2/41, 5%) were rarely used. Less than half (22/55, 40%) experienced good functional recovery. Those injected with autologous fat were likelier to be symptomatic from their strokes (100% versus [vs] 68%, $P=0.0012$), develop larger strokes (93% vs 24%, $P<0.0001$) and experience non-ambulatory outcomes (44% vs 73%, $P=0.0381$).

Conclusion: Strokes are rare complications of dermal fillers. Injections using autologous fat risk larger strokes and worse ambulatory outcomes. An hour of post-procedural observation appears reasonable, and those with ocular complications should undergo brain imaging even in the absence of stroke symptoms.

Keywords: autologous fat, dermal fillers, hyaluronic acid, neurology, stroke

CLINICAL IMPACT

What is New

- The glabella and temples were the 2 most common sites in strokes from dermal fillers.
- Injections with autologous fat are likelier to cause symptomatic strokes, larger strokes and poorer ambulatory outcomes.

Clinical Implications

- Caution should be practised, especially when injecting at the glabella or temples, and when using autologous fat.
- Brain imaging should be performed in patients with ocular complications, even in the absence of neurological deficits.
- As most strokes occur immediately or shortly after filler injections, an hour of post-procedural observation is a prudent measure.

INTRODUCTION

Facial injections of dermal fillers have gained prominence as a popular non-surgical method for achieving facial volumisation and contouring,

providing significant aesthetic and clinically relevant benefits, such as its non-invasiveness, enhanced convenience, reduced procedural morbidity and expedited recovery.^{1,2} Various materials have been used over the past decades, each boasting unique rheologic properties (particle size, elasticity, viscosity, cohesivity and flexibility) and advantages.² Alongside their growing popularity, complications from these procedures are increasingly recognised and reported.³ While comparatively uncommon, ischaemic strokes are concerning, given their potential for long-lasting disability and mortality.⁴ Despite these concerns, the clinico-radiological features, treatments and outcomes of affected patients remain insufficiently described in the literature, resulting in significant knowledge gaps. Therefore, a comprehensive review of literature spanning the past 30 years was conducted to better characterise the clinico-radiological features, treatment approaches and clinical outcomes of ischaemic strokes from filler injections to the facial region, with the goal

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Accepted: 13 October 2025

Published Online First: 22 October 2025

of informing current clinical practice and improving treatment outcomes.

METHODS

Search strategy

A search string was designed to identify original studies reporting the clinico-radiologic features of patients with radiologically-proven ischaemic strokes after facial injections of dermal fillers. On 1 April 2024, both authors (YJT, LHC) systematically searched PubMed and Google Scholar for relevant articles published over the past 3 decades (April 1993–March 2024). A period of 30 years was chosen to ensure that the findings remain clinically current for present-day use. MeSH terms, free text and related search terms included “facial filler or dermal filler or cerebral stroke or autologous fat or hyaluronic acid (HA)”, “collagen or poly-d,l-lactic acid or PDLLA or poly-D-lactic acid or PDLA or poly-L-lactide or PLLA” and “stroke or cerebrovascular accident”. The systematic search followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The search was performed by both authors, who reviewed the article titles and abstracts. References identified from database searches were exported to EndNote. Both authors also manually searched the references of included studies/records to identify additional articles. After removing duplicates, full-text articles were retrieved if at least 1 of the 2 authors considered the abstract potentially eligible. Each full-text article was independently assessed for final inclusion, with disagreements resolved by consensus (96% overall agreement [459 of 478 articles; $\kappa=0.815$]).

Study inclusion criteria

The following inclusion criteria were used when selecting relevant articles: (1) original articles and case reports/series involving patients with ischaemic strokes affecting their cerebrum, brainstem or cerebellum; (2) demonstrated brain magnetic resonance imaging (MRI) or computed tomography (CT) and that (3) the occurrence of stroke symptoms or the detection of ischaemic strokes on brain imaging studies in otherwise asymptomatic patients were within 7 days from the injection to regions, including the forehead, temple, glabella, periorbital area, nasal bridge/nose, nasolabial fold, cheek, lips and the chin. Despite their proximity, the glabella was considered separate from the forehead due to important differences in their arterial anatomy and propensity for vascular complications.⁵ An interval of 7 days was arbitrarily chosen to account for potential delays in the performance of brain scans, especially in cases of asymptomatic strokes. This is further supported by a recent review of dermal filler-related vascular complications, which found that most strokes occurred or were identified within a week.⁶

Laboratory-based research, animal studies, reviews, commentaries, editorials, clinical guidelines, book chapters, conference abstracts/posters and articles written entirely in languages other than English, and those without full texts or with incomplete descriptions of clinical and/or radiological features were excluded from this study. Cases of venous infarcts from cerebral venous thrombosis were also omitted, as their pathogenesis and treatment measures are different from those of ischaemic strokes. Included studies were then subjected to methodological quality assessment by both authors using the Joanna Briggs Institute Critical Appraisal Checklist for case series and case reports (Supplementary Tables S1 and S2).

Data extraction and statistical analysis

Heterogeneity among the included studies—particularly in the reporting of clinical features, diagnostic approaches and treatment outcomes—is a key concern, especially in a review composed primarily of case reports and series. To address this, clearly defined inclusion criteria (see above) were applied to enhance consistency across studies. In addition, a standardised data extraction table was used to systematically capture relevant clinico-radiologic information, including demographic data, medical history, clinical symptoms, neurological deficits, brain imaging findings, treatments administered and eventual outcomes. All data were manually extracted and entered by both authors. Filler-related data were also extracted, including the material used, the facial areas where the fillers were injected, the person injecting the filler, the volume of material used, and the methods of injection. Statistical analyses were performed using SPSS Statistics software version 30.0.0.0 (172) (IBM Corp, Armonk, NY, US). The clinical features of identified cases were retrospectively analysed together with an illustrative case described herein, after which statistical analysis was performed using Mann-Whitney U test, unpaired t-test, Pearson's chi-squared test and Fisher's Exact test as appropriate, with a two-tailed alpha of 0.05.

RESULTS

The search process is represented by a PRISMA flow diagram (Fig. 1). A total of 472 records published between April 1993 and March 2024 were identified (437 on Google Scholar and 35 on PubMed). After removing 4 duplicates, the titles and abstracts of 468 records were screened, and 416 were excluded. A total of 297 did not involve cases of ischaemic strokes of the cerebrum, cerebellum and brainstem; 113 were not primary research (86 clinical guidelines, 18 meta-analyses/systematic reviews and 9 commentaries); 2 were animal studies; 3 were written in languages other than English and 1 was a conference abstract. Full-text articles from 51 reports were

retrieved and assessed for eligibility, which, together with an additional study identified through backward citation search methods, yielded a total of 55 cases from 45 articles (6 cases series, 39 case reports) that met the inclusion criteria.⁷⁻⁵² Most articles involved patients in East Asia (43/55, 78%), while 5 cases were reported in Europe, 3 in the US and another 3 in the Middle East.

Patient characteristics, filler materials and injection sites

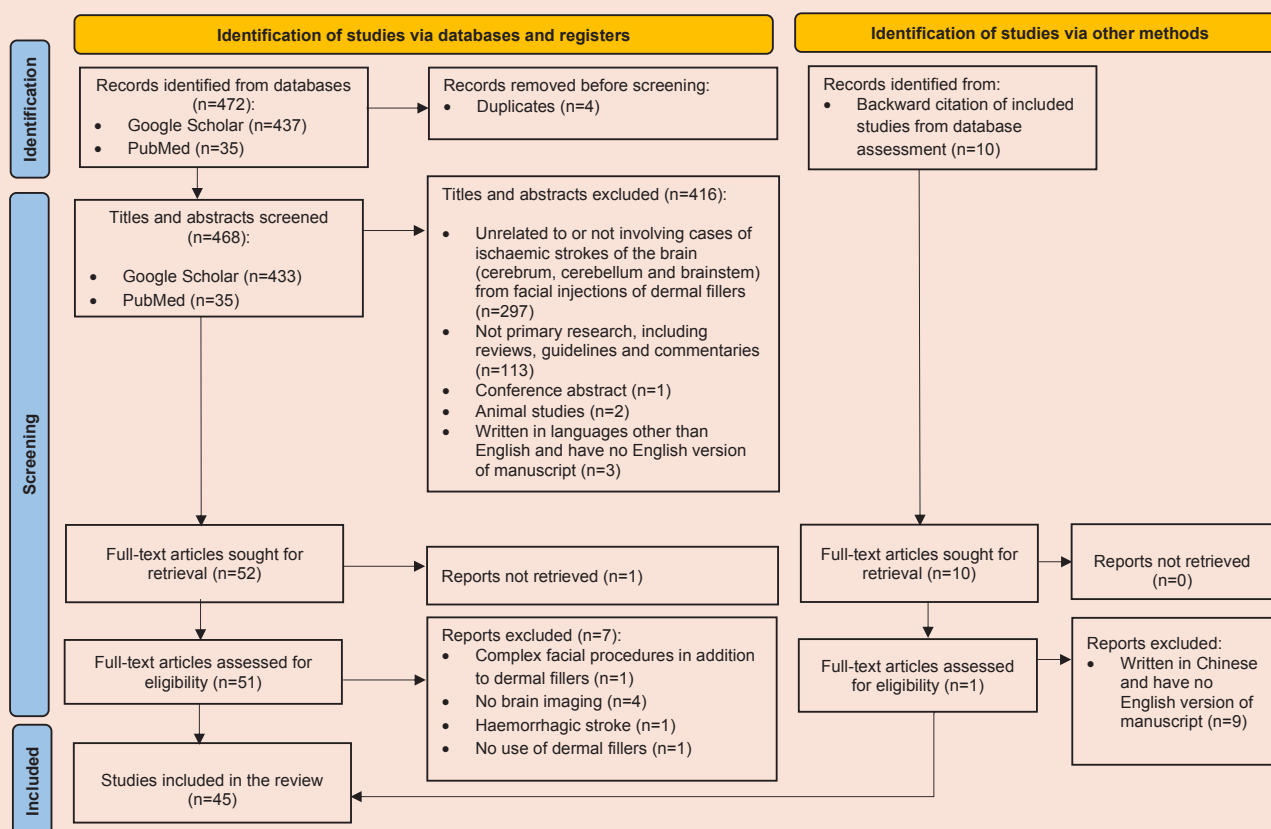
Patients' median age was 32 years (18–61 years), and most were women (49/55, 89%; female-to-male ratio 8.2:1) (Table 1 and Fig. 2). Nearly all (49/55, 89%) had no prior medical history. Of the remaining 6, 3 had pre-existing cardiovascular risk factors—1 with hypertension; another with hypertriglyceridemia and the third with hypertension, hyperlipidaemia and a history of smoking.^{20,48,49} Other clinical history included hepatitis B carrier status in one; retinoblastoma in another; and a Baker's cyst, patent foramen ovale and a previous deep vein thrombosis in 1 patient.^{34,47,50} Autologous fat was the most commonly used material (33/55, 60%), followed by HA (17/55, 31%) and poly-D,L-lactic acid (PDLLA)-containing fillers (3/55, 5%), including one case

in whom a mixture of HA and PDLLA was used.⁴⁸ Calcium hydroxylapatite was injected into 1 patient, and an unnamed collagen-based filler was used in another.^{34,45} Excluding 2 cases that did not specify the exact sites, injections were most often at the glabella (17/53, 32%) and temples (12/53, 23%).^{21,42} They were followed in decreasing frequency by the forehead (excluding the glabella; 9/53, 17%), nose and/or nose bridge (9/53, 17%), periorbital area (7/53, 13%), cheeks (5/53, 9%), nasolabial fold (4/53, 8%), chin (2/53, 4%) and the lower lip (1/53, 2%). Concurrent injections at multiple sites within a single session occurred in at least a fifth of the cases (11/53, 21%). Unfortunately, descriptions of the modes of administration such as the use of the needle or cannula, the brand and volume of the fillers used, and the professional background of the persons injecting the fillers (i.e. plastic surgeons, aestheticians or beauticians) were infrequent, precluding meaningful analysis.⁵³

Clinical features

Stroke symptoms and ocular complaints were the 2 most common features at presentation (Table 1). Around half presented with ocular complaints (29/55, 53%), of which nearly all had either monocular blurring

Fig. 1. PRISMA flow diagram.



Reference: Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Int J Surg* 2021;88:105906.

Table 1. Characteristics and clinico-radiological features of cases included in this study.

Characteristics	Patients	References
Median age, years (range)	32 (18–61)	[6–51]
Female sex, no. (%)	49 (89)	[6–25, 28–37, 39–45, 49–51]
With CVSRF, no. (%)	3 (5)	[19, 12, 48]
Injection site, ^a no. (%)		
• Forehead	9 (17)	[13, 16, 18, 21, 29, 36, 37, 45, 51]
• Glabella	17 (32)	[13, 15, 19, 25, 27, 30, 33, 35, 37, 39, 40, 46, 47, 49]
• Temple	12 (23)	[8, 9, 14, 16–18, 23, 24, 28, 31, 36, 42]
• Periorbital area	7 (13)	[6–8, 26, 27, 43, 46]
• Cheek	5 (9)	[10, 18, 24, 37]
• Nose or nasal bridge	9 (17)	[6, 11, 19, 22, 32, 34, 38, 44]
• Nasolabial fold	4 (8)	[7, 12, 48, 50]
• Lower lip	1 (2)	[48]
• Chin	2 (4)	[31, 48]
Multiple injection sites, ^b no. (%)	11 (20)	[7, 8, 13, 18, 19, 31, 36, 37, 46, 48]
Injection material, no. (%)		
• Autologous fat	33 (60)	[8–10, 14, 16–18, 20, 21, 23, 24, 26–28, 30, 31, 35–37, 41–43, 45–51]
• Hyaluronic acid ^c	17 (31)	[6, 11–13, 15, 19, 22, 25, 32, 34, 37–40]
• PDLA ^c	3 (5)	[7, 12, 29]
• Calcium hydroxyapatite	1 (2)	[33]
• Unspecified collagenous material	1 (2)	[44]
Stroke features		
Stroke symptoms and signs at presentation, no. (%)	43 (78)	[6–11, 13–24, 26–32, 34–36, 38, 41–43, 46–51]
• Hemiparesis/hemiplegia	23 (42)	[9, 14, 15, 17, 18, 20, 23, 24, 26–30, 36, 41, 42, 47, 48, 51]
• Confusion, reduced consciousness/alertness	19 (34)	[8–10, 14, 16, 18, 23, 24, 27, 28, 30, 31, 42, 46, 47, 49, 50]
• Giddiness/dizziness, nausea, vomiting	11 (20)	[6, 7, 10, 11, 13, 19, 21, 22, 29, 34, 38]
• Aphasia	6 (11)	[14, 23, 30, 42, 47, 48]
Stroke deficits after initial presentation, no. (%)	5 (9)	[16, 33, 37, 45]
Stroke symptoms and signs, total no. (%)	48 (87)	[6–11, 13–24, 26–38, 41–43, 45–51]
• Hemiparesis/hemiplegia	30 (55)	[6, 9, 10, 13–18, 20, 21, 23, 24, 26–31, 36, 37, 41, 42, 47–49, 51]
• Confusion, reduced consciousness/alertness	26 (47)	[8–11, 13–18, 22–24, 27–30, 31, 42, 46, 47, 49, 50]
• Giddiness/dizziness, nausea, vomiting	11 (20)	[6, 7, 10, 11, 13, 19, 21, 22, 29, 34, 38]
• Aphasia	10 (18)	[14, 23, 30, 36, 37, 42, 46–48]
• None	7 (13)	[6, 12, 25, 39, 40, 44]
Stroke onset immediately after the injection, no. (%)	14 (35)	[7, 14, 15, 19, 21, 23, 27, 29, 38, 42, 49–51]
Stroke onset within an hour of injection, ^{d,e} no. (%)	23 (58)	[7, 11, 13, 15, 19–23, 26, 27, 29, 30, 33, 38, 42, 46, 47, 50, 51]
Other features, no. (%)		
• Ocular complications	38 (69)	[6, 7, 9–15, 19, 21, 22, 25, 29–41, 43–45, 47, 49–51]
• Skin necrosis	19 (35)	[9–12, 19, 22–25, 29, 34–36, 38, 40, 43, 44, 51]
Radiological features of stroke		
Strokes in anterior circulation territory, ^f no. (%)	54 (100)	[6–26, 28–51]
Strokes in posterior circulation territory, ^e no. (%)	12 (22)	[6, 11, 14, 15, 17, 19, 22, 35, 40, 41, 50]
Unilateral strokes, ^f no. (%)	45 (83)	[6, 8–10, 12–14, 16–24, 26–33, 35–38, 40–45, 47–51]
Multifocal strokes, ^f no. (%)	32 (56)	[6, 7, 10–12, 14, 15, 19, 22, 25, 26, 29, 30, 32–35, 37–41, 44, 46, 50, 51]
Large strokes, ^g no. (%)	32 (67)	[6, 8–11, 14–18, 21–23, 26–28, 30, 31, 35, 36, 40–43, 46–50]
LVO on angiography, ^h no. (%)	16 (40)	[6, 8, 17, 20, 24, 27, 28, 30, 31, 36, 42, 46, 48]
• Intracranial LVO	12 (30)	[6, 17, 20, 24, 27, 28, 30, 36, 42, 48]
• Extracranial LVO	4 (10)	[8, 27, 31, 46]

Table 1. Characteristics and clinico-radiological features of cases included in this study. (Cont'd)

Characteristics	Patients	References
Treatmentⁱ		
• Corticosteroids, no. (%)	12 (29)	[10, 13, 15, 20, 22, 25, 29, 39, 41, 42, 45, 47]
• Antiplatelet, no. (%)	11 (27)	[10–13, 20, 25, 31, 39, 40, 42, 44]
• Anticoagulant, no. (%)	1 (2)	[10]
• Intravenous thrombolysis, no. (%)	6 (15)	[9, 14, 24, 30, 33, 38]
• Mechanical thrombectomy, no. (%)	6 (15)	[8, 24, 27]
• Hyaluronidase injections, no. (%)	3 (7)	[7, 13, 19]
• Hyperbaric oxygen, no. (%)	2 (5)	[19, 42]
• Intravenous mannitol, no. (%)	7 (17)	[13, 17, 18, 22, 36, 42, 43]
• Decompressive hemicraniectomy, no. (%)	12 (29)	[16–18, 23, 27, 28, 31, 36, 38]
Neurological outcomes		
Haemorrhagic transformation, no. (%)	5 (9)	[15, 16, 18, 37, 38]
mRS score ≤2, no. (%)	22 ^j (40)	[7, 9, 12, 13, 15, 17–20, 24, 25, 28, 29, 32, 34, 35, 39, 40, 43, 44, 49, 50]
Capable of ambulating with or without assistance, no. (%)	32 ^k (56)	[6, 7, 11–15, 17–20, 24, 25, 28–30, 32, 34, 35, 37–40, 43, 44–50]
Deaths, no. (%)	5 (9)	[8, 16, 22, 27, 47]

CVSRF: cardiovascular risk factors; LVO: large vessel occlusion; mRS: modified Rankin Scale; PDLLA: poly-D,L-lactic acid

^aUnspecified in 2 cases [20, 41].

^bMultiple injection sites refer to the injection of dermal filler at multiple areas on the ipsilateral face.

^cIncludes a case that involves a mixture of 25% hyaluronic and 75% PDLLA.

^dExcludes 7 cases without stroke symptoms [6, 12, 25, 39, 40, 44].

^eExcludes 8 cases in whom the time of onset was undescribed [6, 9, 17, 18, 28, 37].

^fExcludes patient 3 from Huo et al.'s series [27].

^gExcludes 7 cases in whom the size of infarcts was undescribed [13, 20, 24, 27, 38, 45, 51].

^hAngiographies were unperformed/unreported in 15 cases [13, 21, 23, 25, 26, 32, 34, 35, 37–40, 43, 45, 47].

ⁱMissing data in 14 cases [6, 16, 26, 32, 34, 37, 46, 48, 49, 51].

^jAt least 22 cases [7, 9, 12, 13, 15, 17–20, 24, 25, 28, 29, 32, 34, 35, 39, 40, 43, 44, 49, 50].

^kAt least 31 cases [6, 7, 11–15, 17–20, 24, 25, 28–30, 32, 34, 35, 37–40, 43, 44, 46, 48–50].

or loss of vision (27/29, 93%), and more than a third experienced ocular or peri-ocular pain (11/29, 38%). Stroke symptoms were the presenting features in most cases (43/55, 78%). Among these symptoms, hemiparesis/hemiplegia occurred in at least 23 (42%); confusion or reduced consciousness/alertness in 19 (34%); giddiness/dizziness, nausea and/or vomiting in 9 (16%) and aphasia in 6 (11%). After the onset of their initial symptoms, 5 cases (9%) subsequently developed new neurological deficits, while 9 (16%) experienced additional ocular symptoms, resulting in a total of 48 (87%) and 38 cases (69%) with stroke-like symptoms and ocular complaints, respectively. However, the interval from their presentation to the development of new neurologic/ocular symptoms was undescribed by most authors. Overall, hemiparesis/hemiplegia remained the most common stroke feature during their initial period of hospitalisation (30/55, 55%), followed by confusion or reduced consciousness/alertness (26/55, 47%); giddiness/dizziness, nausea and/or vomiting (11/55, 20%) and aphasia (10/55, 18%). A significant portion of patients (7/55, 13%) continued to exhibit/experience no stroke-like deficits, with ischaemic strokes being incidentally detected by brain imaging.^{7,13,26,40,41,45}

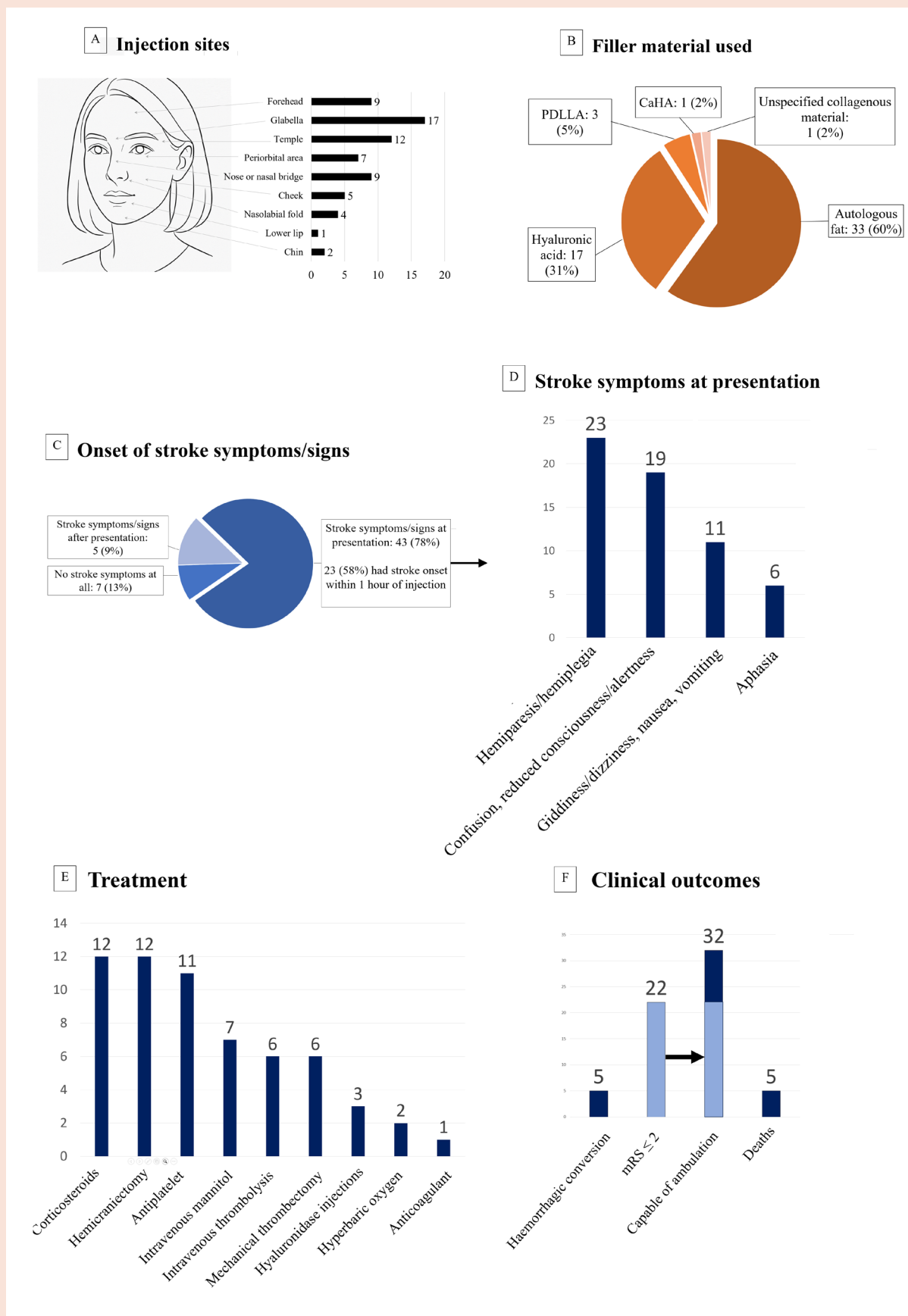
The interval between their injections and stroke onset is another area of interest. Excluding 7 patients who had no stroke symptoms and 8 with unknown

stroke onset time, more than half (23/40, 58%) developed neurological deficits soon after receiving their injections—immediate in 14, shortly after in 3, within 10 minutes in 2 patients, within 30 minutes in another 2, and within an hour in 1 patient. Longer intervals of more than an hour were reported in 16, including 4 who developed stroke symptoms around a day after their injections.^{17,38,46}

Radiological features

Brain imaging in the form of CTs and/or MRIs was performed in all cases (Table 1). Excluding Huo et al.'s patient 3 whose infarcts were not well-detailed, all cases (54/54, 100%) had infarcts in regions supplied by the anterior circulation, of which a fifth (12/54, 22%) had concurrent infarcts in areas supplied by the posterior circulation.²⁸ Majority of the infarcts were unilateral (45/54, 83%) and were evenly split between both hemispheres (left versus [vs] right hemisphere = 1.1:1), while bilateral infarctions occurred in only a few (9/54, 17%). Multifocal strokes occurred in slightly more than half (30/54, 56%), and at least 32 patients (32/48, 67%; excluding 7 cases without descriptions of stroke size) had sizeable territorial infarcts. Other radiological findings include co-existing right occipital lobe subarachnoid haemorrhages in 1 case, and in the left frontal and parietal lobes in another.^{7,13} Vascular imaging of the intracranial and/or cervical arteries

Fig. 2. Summary of study findings.



CaHA: calcium hydroxylapatite; mRS: modified Rankin Scale; PDLA: poly-d,l-lactic acid
 Note: Refer to Table 1 for details.

was performed in nearly three-quarters of the cases (73%, 40/55). Among these, magnetic resonance angiography was performed in 18 patients (18/55, 33%), CT angiography in 13 patients (13/55, 24%), digital subtraction angiography in 12 patients (12/55, 22%), transcranial Doppler sonography in 2 patients (2/55, 0.03%), and carotid ultrasound in another 2 patients (2/55, 0.03%). Among them, large vessel occlusions were identified in 16 (40%), involving the intracranial arteries in 12 and extracranial arteries in 4.

Treatment and outcome

Treatment was documented in only 41 (75%) patients, including corticosteroids in 12 (12/41, 29%), antiplatelet agents in 11 (27%), intravenous mannitol in 7 (17%), intravenous thrombolysis in 6 (15%), mechanical thrombectomy in 6 (15%), hyaluronidase injections in 3 (7%; retrobulbar and forehead in 1 case, peribulbar in another, and the glabella and forehead in a third), hyperbaric oxygen therapy in 2 patients (5%), an unspecified anticoagulant in 1 patient, and decompressive hemicraniectomies in 12 (29%) (Table 1). Sixteen patients (39%) received at least 2 of these aforementioned treatment modalities. Excluding 1 patient whose infarct size was unknown, all who underwent decompressive hemicraniectomy had large infarcts.³⁹ Haemorrhagic transformations were uncommon, occurring in only 5 (5/55, 9%).^{16,17,19,38,39} Notably, only 1 in 6 patients who received intravenous thrombolysis and none of those who underwent thrombectomy developed haemorrhagic transformation.³⁹

Clinical outcomes were inconsistently reported, and the evolution of neurological deficits, in most cases, was either left undescribed or incompletely detailed. Based on the available data, 5 patients died (5/55; 9%) at different time points (the 4th, 6th and 16th day from presentation; unknown in 2), and all except 1 (patient 3 from Huo et al.'s series whose radiological features were inadequately detailed) had large unilateral anterior circulation infarcts.^{9,17,23,28,48} Less than half who survived (22/55, 40%) achieved good functional recovery, with modified Rankin Scale (mRS) scores of ≤ 2 over periods of up to 5 years. However, most (32/55, 58%) were capable of ambulating, whether independently or with assistance.

Differences in stroke features and outcomes in patients who received autologous fat vs HA and/or PDLLA.

The stroke features and outcomes of patients who received autologous fat were then compared against those injected with HA and/or PDLLA (Table 2).^{54,55} While there were no differences in their median age, sex or mortality events, those injected with HA and/or PDLLA had higher incidences of cutaneous (53% vs 26%, $P=0.0037$) and ocular complications (100% vs

48%, $P=0.0001$), while those who received autologous fat tended to be symptomatic from their strokes (100% vs 68%, $P=0.0012$), have large strokes (93% vs 24%, $P<0.00001$), and were likelier to end up incapable of walking (41% vs 84%, $P=0.0024$). The latter group was also likelier to have received injections at their temples (41% vs 0%, $P=0.0008$).

DISCUSSION

Over the past 30 years, the landscape of filler injections has transformed significantly with advances in both materials and technology.^{2,58,59} The introduction of hyaluronic acid revolutionised the field, offering safer, reversible and more versatile options. Since then, the industry has expanded to include biostimulatory fillers like poly-L-lactic acid and PDLLA, which promote collagen regeneration for longer-lasting, natural-looking results. Alongside synthetic fillers, autologous fat grafting has experienced a resurgence, appealing to patients seeking natural, long-term volume restoration using their own tissue. Improvements in procedural techniques and anatomical understanding have since enhanced safety and precision, marking a shift from simple wrinkle correction to full facial rejuvenation and contouring.^{2,58,59} This research on filler-related strokes is therefore timely, as facial injections of dermal fillers become increasingly popular and accessible.

This study reaffirms the rarity of derma filler-related strokes and depicts affected patients as typically young women in their thirties. While this female predominance aligns with both previous and current trends in dermal filler use, these patients were notably younger than those reported in the literature.^{56,57} Unsurprisingly, cardiovascular risk factors were exceedingly rare. Most strokes, especially in older reports, involved the use of autologous fat, perhaps reflecting its well-established role as a dermal filler and a more recent shift towards the use of other materials, such as HA and PDLLA.^{58,59} The findings also reveal important features and characteristics of strokes from dermal fillers. First, the glabella and temples were the 2 most common injection sites leading to strokes when compared to other facial regions. The underlying pathomechanism likely involves the inadvertent injection of filler material into an extracranial artery, which then enters the ophthalmic and intracranial arterial systems due to (1) anastomoses between these vessels and intracranial arteries, (2) the application of positive pressure during these injections and (3) Poiseuille's law favouring retrograde flow in narrow distal arteries.⁷ Injections to the glabella are well-associated with higher risks of ocular and skin complications.⁶⁰ These were ascribed to the intricate arterial network (central and paracentral arteries, and supratrochlear arterial branches) at varying skin depths

Table 2. Comparison of clinical features in patients with strokes from dermal filler injections with autologous fat against hyaluronic acid and/or PDLLA.

	Autologous fat (n=34)	HA and/or PDLLA ^a (n=19)	P value
Median age, years (range)	30.5 (18–50)	34 (20–61)	NS
Female sex, no. (%)	29 (85)	17 (89)	NS
Sites of injections, ^b no. (%)			
• Temple	13 (41)	0 (0)	0.0008
• Nose or nasal bridge	0 (0)	8 (42)	0.0001
• Glabella	9 (28)	7 (37)	NS
• Nasolabial fold	3 (9)	2 (11)	NS
• Periorbital	5 (16)	2 (11)	NS
• Forehead	7 (22)	2 (11)	NS
• Multiple ^c	8 (25)	4 (36)	NS
Stroke symptoms, no. (%)	34 (100)	13 (68)	0.0012
Skin necrosis, no. (%)	7 (21)	10 (53)	0.0037
Ocular complications, no. (%)	16 (48)	19 (100)	0.0001
Large strokes, ^d no. (%)	27 (93)	4 (24)	<0.00001
Death	4 (12)	1 (5)	NS
Ambulatory, with or without assistance ^e	14 (41)	16 (84)	0.0024

HA: hyaluronic acid; NS: not specified; PDLLA: poly-d,l-lactic acid

^aIncludes the use of HA and P-DLLA, or both concurrently as a mixture.^bUnspecified in 2 cases [20, 41].^cMultiple injection sites refer to the injection of dermal filler at multiple areas on the ipsilateral face.^dMissing data in 7 cases in whom the size of infarcts was undescribed [13, 20, 24, 27, 38, 45, 51].^eData from 30 cases who were injected with autologous fat, HA and/or PDLLA [6, 7, 11–15, 17–20, 24, 25, 28–30, 32, 37–40, 43, 46, 48–50].Numbers in boldface indicate statistically significant *P* values.

in that region, and their short retrograde distance to the ophthalmic arteries (OAs), thereby increasing the risk of retrograde movement of material into intracranial arteries.⁵ Strokes from temporal injections can similarly be attributed to the entry of material into the intracranial arteries through the anastomotic connections between the superficial temporal artery and the OA.^{61–63}

Second, strokes invariably involved areas supplied by the anterior circulation, were often unilateral and large, and mostly occurred immediately or shortly after their injections. These are unsurprising, given that the inadvertent entry of injected material into the intracranial arteries was thought to occur via anastomotic connections with the ipsilateral OA, an explanation further supported by the frequent occurrence of ischemic ocular complications.^{5,8,61–63} In several cases, there was a notable delay between the time of injection and the onset of stroke and/or ocular symptoms, and it remains uncertain whether this reflects the delayed entry of filler material into the intracranial arterial system, or a failure to recognise stroke symptoms early, particularly those with mild neurological deficits. Regardless, a short period of

post-procedural observation appears prudent, as most strokes occurred within an hour after injection.

Third, several patients who presented with ocular symptoms had no neurological deficits, and strokes were incidentally discovered only by brain imaging. Nearly all had small strokes, which explains the absence of noticeable neurological deficits. However, given the risk of stroke progression, recurrence and disability, those presenting with ocular symptoms should therefore also undergo brain imaging even in the absence of neurological deficits. Last, the findings highlight important differences in the clinical features between different filler materials. Individuals who received autologous fat injections were at a greater risk of larger strokes and worse functional outcomes than those injected with HA and/or PDLLA. This may be due to the larger size and lower solubility of fat particles (400–1000 µm) compared to HA and PDLLA (30–70 µm), thereby increasing their likelihood of occluding the larger intracranial arteries and leading to larger strokes, more pronounced stroke symptoms, and poorer clinical recovery and outcomes.^{64–67} Taken together, the findings support the need for post-procedural observation (of an hour) after facial filler

injections, particularly when involving high-risk areas such as the glabella or temples, and when using autologous fat. While it is well-established that those with ocular complications require urgent work-up and treatment, the findings further underscore the need for early neuroimaging in the initial assessment of these patients to evaluate for strokes, even in the absence of cardiovascular risk factors or overt neurological deficits.

This study has important limitations. Its retrospective nature, small size, the inconsistent descriptions of clinico-radiological features, and the preponderance of Asian reports can limit the findings' applicability to the broader population. Key details, such as who performed the injections (e.g. doctors, nurses, unlicensed practitioners), their injection methods (cannula or needle), and the volume and brand of the fillers used, were often missing, precluding deeper analysis of the impact of these factors on the risk of stroke, clinico-radiological features and treatment outcomes. Furthermore, clinical outcomes were described at different time points, often without standardised assessments (i.e. mRS), rendering it difficult to analyse the trajectory and extent of recovery. Reporting bias was also a concern, as adverse events may be underreported due to potential commercial interests and influences. Asymptomatic strokes following filler injections could also go undetected, and the actual number of strokes is likely larger. Similarly, publication bias—where studies reporting higher incidences of adverse events such as strokes, are less likely to be published compared to those with lower rates—may contribute to a systematic underestimation of the true incidence and prevalence of strokes following filler injections. This potentially skews the perceived safety of facial fillers and confounds the findings from the comparative analysis of stroke features and outcomes between the use of autologous fat vs HA and/or PDLLA. The preponderance of Asian reports and the potential for geographical bias are also difficult to explain. Whether this reflects their greater susceptibility to dermal filler-related strokes, greater scientific interest on this issue in East Asia, differences in injection methods, or rheological differences of various filler formulations/brands used across different regions cannot be conclusively determined by the study's design.⁶⁸ While potentially relevant to Asian populations, the findings should therefore be interpreted and applied with caution in other regions of practice. Furthermore, methodological limitations also hindered the authors' attempt to study the differences in stroke risks between these materials, a question best addressed by randomised controlled trials.

Despite these limitations, the findings reinforce existing knowledge of dermal filler-related strokes,

such as the young age of affected patients, their lack of cardiovascular risk factors, the risks associated with glabellar injections, and that up to 10% of patients may have no stroke symptoms.¹⁹ These findings further add to existing descriptions of dermal filler-related strokes, including the important differences in the clinical features and treatment outcomes between autologous fat and HA and/or PDLLA injections. With dermal fillers set to stay in high demand, larger prospective studies with longer follow-up periods will be required in the future to address the aforementioned limitations and challenges.

CONCLUSION

Dermal filler-related strokes are rare but severe complications with a high risk of lasting neurological deficits and disability. Prompt recognition and intervention are therefore essential. Those injected with autologous fat tend to have larger strokes and experience non-ambulatory outcomes than those injected with HA and/or PDLLA. As most strokes occur shortly after facial injections, an hour of post-procedural observation appears reasonable, particularly when autologous fat is used, or when injecting at high-risk areas such as the glabella and temples. Given that a significant portion of cases had asymptomatic strokes, brain imaging is therefore recommended for those presenting with ocular complications after filler injections, even in the absence of obvious neurological symptoms or deficits.

Supplementary materials

Table S1. JBI risk of bias quality assessment for case series.

Table S2. JBI risk of bias quality assessment for case reports.

Ethics statement

Not applicable. This is a study on cases of dermal filler-related strokes reported in medical literature over the past 30 years. The data are publicly available. Institutional approval was therefore not needed.

Declarations

The authors declare there are no affiliations with or involvement in any organisation or entity with any financial interest in the subject matter or materials discussed in this manuscript. All authors have no conflict of interest to declare. This study did not receive funding.

Acknowledgements

The authors would like to acknowledge and thank Dr Nara Sugianto (Department of Neurology, Singapore General Hospital, Singapore) for her help in the early stages of literature search and review.

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