



International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

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

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
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ARTICLE TITLE

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THE USE OF DERMAL FILLERS- IDENTIFICATION, SEVERITY,
CLINICAL MANAGEMENT, AND REDUCING THE RISK - A
NARRATIVE REVIEW

DOI

[https://doi.org/10.31435/ijitss.3\(51\).2026.6066](https://doi.org/10.31435/ijitss.3(51).2026.6066)

RECEIVED

30 July 2026

ACCEPTED

23 September 2026

PUBLISHED

28 September 2026

LICENSE



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COMPLICATIONS FOLLOWING AESTHETIC PROCEDURES WITH THE USE OF DERMAL FILLERS- IDENTIFICATION, SEVERITY, CLINICAL MANAGEMENT, AND REDUCING THE RISK - A NARRATIVE REVIEW

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ABSTRACT

Dermal filler procedures have gained widespread popularity in aesthetic medicine due to their accessibility, relatively low cost, and minimal recovery time. However, with increased demand, reports on complications and adverse reactions have also risen. They range from mild, self-limiting cases to rare, severe, and potentially irreversible outcomes. This article reviews the various types of dermal fillers, their mechanisms of action, and details the spectrum of complications—including local site reactions, complications of aesthetic character, infectious, immune-mediated, and vascular events—while highlighting the importance of correct technique, patient selection, and the constant need for ongoing clinician education. The need for evidence-based protocols and clear guidelines is emphasized to enhance patient safety and optimize outcomes in filler-based aesthetic procedures.

KEYWORDS

Dermal Fillers, Hyaluronic Acid, Side Effects, Adverse Reactions, Vascular Complications, Contraindications

CITATION

Porażko, M. M., Habirek, K. S., Żurakowska-Zadrożna, A. K., Wiązania, K. A., Wilczyński, R., Krupska, A., Czarnecka, J. A., Marcinkowska, Z. M., Gugulska, J. Z., Kropiwnicka, A., Kieres, M., Wójcik, K. K., Kierys, A. K., & Parus, M. M. (2026). Complications following aesthetic procedures with the use of dermal fillers - identification, severity, clinical management, and reducing the risk - a narrative review. *International Journal of Innovative Technologies in Social Science*, 3(51). [https://doi.org/10.31435/ijitss.3\(51\).2026.6066](https://doi.org/10.31435/ijitss.3(51).2026.6066)

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Introduction

The demand for aesthetic procedures continues to grow—especially for those that are easily accessible, have a short or no recovery time, and are less expensive than surgical procedures. Treatments with dermal fillers meet these criteria and have been used in numerous aesthetic procedures, including midface sculpting and volumization, non-surgical nose reshaping, lip augmentation, and correction of facial asymmetry and aging-associated changes [1].

Along with growing popularity, the number of reported complications and adverse effects is increasing, which both practitioners and patients should be aware of. There are also arguments for moving away from calling these procedures “minimally invasive,” as this may lead to underestimating the seriousness of complications; even though such events remain rare, their effects can be irreversible [2,3]. Continually expanding one's knowledge of adverse effects, including their recognition, treatment, and prevention, should be an integral part of clinical education [4]. There is still a need to develop evidence-based protocols and guidelines that enable rapid response, thereby increasing the safety of filler-based aesthetic procedures [2].

Types of Fillers

Fillers available on the market differ in their mechanism of action and composition. The most commonly used and FDA- approved fillers are hyaluronic acid (HA), calcium hydroxylapatite (CaHA), poly-L-lactic acid (PLLA), and polymethylmethacrylate (PMMA) [5]. CaHA and HA both naturally occur in the human body; CaHA works by stimulating fibroblasts to produce collagen and elastin fibers [6]. HA additionally binds water molecules, leading to hydration, stabilization, and increased tissue volume [7]. Its low immunogenicity, long-lasting effects, reversibility with the use of hyaluronidase, and wide range of possible applications in aesthetic procedures [5] have made it the gold standard among dermal fillers [8]. PMMA and PLLA are synthetic fillers, and both promote collagen deposition by causing an inflammatory response to the synthetic molecules contained in the formula [5].

Adverse Reactions

Adverse reactions associated with dermal filler procedures are infrequent and self-limiting. They mostly manifest as edema, bruising, pain, mild bleeding, and a site reaction.

It is difficult to achieve a unified categorization of complications caused by filler injections. Most of the literature reviewed for this article classifies them by timing. Anvisa and the WHO consider the time to onset, permanence, and intensity when categorizing the adverse effects of using biomaterials, grouping them into mild, moderate, and severe [2]. Other authors propose focusing on the causality of side effects [4]. In this article, all those categories are taken into account, and the complications are addressed comprehensively, with management discussed.

1. Mild site reactions

Dermal filler injections are associated with disruption of tissue continuity; hence, the most common adverse reaction is a local inflammatory response to a foreign body [9]. It can manifest itself as edema, pain, bruising, and redness. Those are usually self-resolving and require no treatment other than symptomatic.

1.1 Bruising and hematoma

Also described as ecchymosis, it is one of the most prevalent occurrences after injections [2]. Effective compression of the injected area with an ice pack can help prevent extensive bruising [5]. Some authors suggest including lidocaine and epinephrine for vasoconstriction [10]. There is no consensus on whether the use of any topical agent is supported by sufficient evidence to be recommended. Injection into areas where vessels are situated more deeply and are more difficult to compress may result in hematoma formation and have a delayed onset [11]. Certain factors, like the needle size, injection technique, and the treated area (especially rich in blood vessels), also have an impact on the intensity of bruising and can be modified; however, patient-specific factors, such as age, vascular health, chronic conditions, especially associated with blood coagulation, need a more cautious approach [10]. Overall, a slow, gentle manner during the procedure, combined with injecting low volumes of filler, is recommended in all situations, as is adequate compression before each needle entry [12,13]. Discontinuing unnecessary anticoagulant medication 1 week prior to treatment, as well as avoiding high-intensity exercise for the next 24 hours, is advised [14].

1.2 Edema

Certain fillers have a greater tendency to cause edema, especially those containing a higher percentage of hyaluronic acid due to its high water-retention properties; nevertheless, it is typically transient and subsides after several days [10]. Persisting edema may result from T-lymphocyte-mediated hypersensitivity and may last for months [1,15]. In some cases, steroid treatment, laser therapy, or resolving the filler may be necessary [1]. More severe cases, such as antibody-mediated edema, have been described in additional paragraphs of this article.

2. Complications due to inappropriate injecting technique

The volume of the injected filler and the depth of the injection matter. Both too deep and too shallow injections can cause various complications. Specific fillers need to be administered to an adequate depth; for PMMA and collagen, injections that are too superficial can result in hypersensitivity or hypertrophic scarring, while CaHA may cause small white nodules when not administered deep enough [4,16].

2.1 Asymmetry and nodules

Lumpiness, beading, and small, non-inflammatory nodules are adverse effects of aesthetic nature and result from excess filler accumulation [2]. Contractions of surrounding muscles can displace the filler, forming lumps [14]. Intervention includes massaging the injected area during the procedure, drainage, or dissolving with hyaluronidase for hyaluronic acid-based formulations, while, in the case of CaHA- and PLLA-induced nodules, laser therapy and saline solution injections may be required [4,17]. An inflammatory basis of the nodule needs to be excluded [3].

2.2. Tyndall effect

The Tyndall effect, also described as Rayleigh scattering, is a rarely reported complication of aesthetic outcome [18]. It manifests as bluish skin discoloration, sometimes with a concurrent bumpy skin texture, resulting from an overly superficial injection of hyaluronic acid filler; however, other fillers have also been reported to cause this occurrence [11]. To avoid this unwanted effect, the patient's skin should be assessed for thickness - thinner skin of the injected area is more prone to this reaction [19]. The practitioner's experience and correct placement of the formula are crucial, as the right technique is paramount for avoiding this issue [18].

2.3 Contour irregularities

Not only the practitioner's experience, filler's specific properties and the amount of filler used contribute to the end result and potential irregularities, but also the treated area. Certain parts require a more deliberate approach due to the surrounding muscles responsible for facial animation, the varying longevity of HA depending on the area, skin thickness, and the possibility of filler migration to surrounding areas [20, 21]. Examples of such facial regions are: the nasal dorsum, canine fossa, forehead, medial malar and zygomatic region, pretarsal roll, lips, infraorbital area, and the glabella [10]. Overcorrection of the above can, respectively, create a broadened appearance of the nose, dysproportion of the malar cheeks, and an undesired "monkey-like" appearance, a bulbous surface of the forehead, visible clumping of the filler, dysproportion and imbalance of the appearance [10, 22, 23, 24, 25]. Delicate and thin skin, such as in the preorbital area or the nasal dorsum, might not carry the intensity of HA's water absorption properties [10]. It is on the physician's side to keep the balance between the patient's expectations and a safe, sensible approach to them. Follow-up visits are necessary to differentiate transient swelling from patent irregularities [10]. The use of ultrasound during the injections is a part of the prevention of this complication, as it allows a precise evaluation of skin thickness, condition of the tissue and disparities, and increases the safety of the procedure [26].

3. Infection

Any treatment associated with tissue disruption is at risk of developing an infection. It can appear as a site infection, abscess, cellulitis, rarely erysipelas and phlegmon, and ultimately, if untreated, infection affecting surrounding tissues and organs; cases of neuroinfections derived from midfacial and periorbital infection have been reported [1, 32]. Purulent site infections, such as abscesses, usually respond well to oral antibiotics and incision and drainage [27, 28]. Effective prophylaxis can substantially reduce the risk of infection. Every performer should be trained to carry out the procedure with minimal risk of contamination and to sterilize reusable materials. There is no obligation to use surgical gloves, but it is highly recommended [29, 30, 31]. Injections should not be performed in any area adjacent to an infected site [4]. Patients should be advised to undergo dental treatment to eliminate potential sources of infection if caries or plaque is present.

3.1 Biofilm infection

The polymers in the injected filler create a surface on which bacteria adhere and form an antibiotic-resistant biofilm [1, 33, 34]. Most often, these are bacteria present on the skin and mucous membranes, such as *Cutibacterium acnes*, *Streptococcus oralis*, and *Staphylococcus epidermidis* [35]. Further tissue disruption during subsequent procedures can spread bacteria from the biofilm, triggering an immune response in macrophages and leukocytes [36]. The biofilm can manifest itself as a red, hardened surface or a persistent nodule; it should also be suspected if an infection is recurrent or resistant to antibiotic therapy [37]. The treatment includes removal of the filler, broad-spectrum antibiotics such as quinolones and macrolides, 5-Fluorouracil, and laser therapy [1].

Any infection treatment should be administered gradually to reduce the risk of biofilm formation [1]. Other prophylactic steps include precise disinfection of the skin and avoidance of injection into the mucosa and previously damaged tissue [1]. Depth of the injection, needle diameter, filler duration, its purification, and decreased immunity should also be recognized as risks [10].

3.2 Herpes

Filler treatments have also been reported to activate latent herpes infection. Patients with decreased immunity and with recurrent herpetic infection after dermal filler procedures are especially at risk [10]. Vesicles and crusts, with an incidental burning or tingling sensation, may be present in a herpetic outbreak and need to be differentiated from skin necrosis [10, 38]. Valacyclovir is usually effective in treatment. Routine anti-herpes prophylaxis using valacyclovir is not recommended, except for patients who have experienced recurrent herpes after dermal filler injections [39, 40].

4. Immune response

Various hypersensitivity reactions after dermal filler injections have been described in the reviewed literature, differing in time of onset, severity, pathomechanism, and cause. The characteristic symptoms of allergy result from IgE-mediated mast cell degranulation, resulting in the release of histamine, cytokines, prostaglandins, proteases, heparin, leukotrienes, and platelet-activating factor [1]. Type I hypersensitivity reactions can occur within minutes to hours, whereas type IV reactions may not appear until several weeks after the procedure [41].

They result from the immune response of the organism to additives in fillers, such as collagen, lidocaine, carboxymethylcellulose, dextran, mannitol, or the product contamination with bacterial nucleic acid and proteins; furthermore, unbound cross-linking agents in HA fillers have also been reported to trigger an inflammatory response [7, 42, 43, 44]. Another culprit is the use of high-concentration HA fillers in large quantities, which can compress surrounding tissues, disrupt blood flow, and interfere with the body's natural pH, triggering an inflammatory reaction; eventually, this may lead to granuloma formation due to a prolonged foreign body reaction [10, 45].

4.1 Histamine-release edema

In principle, edema after a filler injection is transient and due to histamine release, especially in patients with a history of dermatographism and a predisposition to type I hypersensitivity reactions, but the water-retention properties of HA, if used, can also explain swelling [46]. There is a correlation between the extent of the tissue disruption and the size of edema; using smaller quantities of filler at a time and avoiding rough maneuvers can reduce this risk [7].

4.2 Angioedema

Angioedema is a type I hypersensitivity reaction, typically, but not necessarily, limited to the infected area [1]. It may appear just hours after the procedure and last up to weeks [47]. The cause cannot always be precisely detected. Most cases are self-resolving; mast-cell-mediated reactions respond well to antihistamines [1]. More prevalent reactions can be treated with the smallest effective dose of oral steroids [1]. While localized angioedema can be treated with cold compression and H1-receptor antagonists, a generalized and rapid reaction should prompt an immediate response in the performer, as it carries a high risk of anaphylaxis [48].

4.3 Inflammatory reactions of late onset

Fillers can trigger late-onset hypersensitivity reactions within days to years after the procedure. Delayed reactions in the reviewed literature have been classified differently, depending on the source and/or the authors' clinical experience. The exact frequency is not known. Among the presented clinical cases were ASIA (Autoimmune Syndrome Induced by Adjuvants), also known as Shoenfeld's Syndrome, PIH (Post-Inflammatory Hyperpigmentation) and granulomatous foreign body reaction. Symptoms included severe swelling, granulomas, erythema, pain, itching sensation of the treated area, myalgia, arthralgia, chronic fatigue, connective tissue, and respiratory system conditions in the case of ASIA [10]. These were evoked by an inflammatory trigger, which ranged from common infections, such as streptococcal tonsillitis, sinusitis, acne breakouts, flu, or herpes, to reactions to vaccination, dental treatment, or stress [10]. Patients who previously experienced hypersensitivity reactions are more prone to develop them after following treatment [10]. A genetic predisposition to delayed hypersensitivity has also been reported [49].

The pathomechanism has not been unambiguously explained. The reactions are considered to be caused by contamination of the formula by bacterial DNA; however, in many cases, inflammation biomarkers were negative, the tissue alteration was distant from the primary injection site, and patients responded well to dissolution of the filler, which enforces the proof that fillers are immunogens themselves or act as a superantigen [2, 7, 43]. In both cases, the immunogen induces a transition from infection to a hypersensitivity state via toll-like receptors (TLRs), leading to the release of inflammatory cytokines [2, 50]. The risk seems to be associated with the permanence of filler remaining in the tissues. Diagnostics include blood tests, polymerase chain reaction tests, excision and histopathological examination, and ultrasonography and biopsy [7].

In the treatment process, it is important to remove the filler to stop further development of the reaction. Pharmacological treatment includes antibiotics, systemic corticosteroids, and non-steroidal anti-inflammatory agents [7]. Other methods include laser therapy, 5-FU treatment, and surgical excision, as well as skin-lightening agents for PIH [7, 10, 37].

To minimize the risk of a delayed-onset immune response, unregistered fillers should not be used, as they pose a greater risk of administering unknown immunogenic additives or antigens [7]. Patients should not

undergo filler procedures during infections; physicians should warn about the possibility of developing an autoimmune response after the procedure, especially in individuals who have experienced post-vaccination reactions, have a history of autoimmune diseases, allergies (this applies to the family history as well), or have previously experienced hypersensitivity after dermal filler injections [7].

5. Vascular-mediated events

Vascular-mediated events are among the most severe and irreversible complications, despite being rare. Reported incidents vary from tissue ischemia, ptosis, to vision loss, pulmonary embolization, and cerebrovascular accidents [1,2]. They all share the same pathogenesis: vascular obstruction, either by lumen occlusion or by external compression [51]. Vessel lumen occlusion can be caused by embolic or filler material, or due to arteriospasm in case of a local inflammation [51]. Too intense pressure, induced by the procedure itself, excessive amounts of filler, or muscle contractions, leads to external obstruction [51]. Tissue necrosis may be a result of filler injection into vessels supplying the mucosa or skin, or may be a complication of edema [52]. The symptoms appear during the procedure and sometimes a few hours after [51]. Patients can experience sudden pain, skin blanching, livedo, further erythema, neovascularisation, and eventually necrosis [2].

No filler and no injection area is free of risk, though so-called “danger zones” have been distinguished. They are to be handled with exceptional caution due to their proximity to vessels that have insufficient collateral circulation; hence, the tissue of such areas is more prone to ischemia [4]. Those areas include the glabella, nasal folds, and temple; they are vascularised by potential anastomoses of the ophthalmic artery with the facial, supratrochlear, supraorbital, and zygomatic-orbital arteries [53]. Retinal artery occlusion is a complication that may happen if the embolic material or dermal filler disrupts the blood flow in such an anastomosis of the ophthalmic artery [54]. Vision loss or impairment might be immediate [1].

Any signs of vascular occlusion should have an immediate reaction and the injections must be stopped. Attempts to lower intraorbital pressure should be made [53]. Other methods reported in the reviewed articles included corticosteroid therapy, hyperbaric oxygen, hyaluronidase administration, and thrombolysis [53, 54].

Nevertheless, the emphasis should be on recognizing the risk and avoiding it in advance. Inexperienced performers need constant training and should not undertake procedures that carry a higher risk of severe or irreversible complications; similarly, such procedures should not be performed outside appropriate clinical settings [56]. Since anatomical distinctions preclude exact mapping of “danger zones”, ultrasonography is a useful tool for monitoring the entire procedure [51].

To decrease the probability of vascular occlusion, deep and high-volume injections should be avoided; if the injection pressure exceeds the vessel pressure, it is more likely to cause anterograde flow [1]. Less-dense fillers in small volumes can reduce the risk of skin necrosis, especially in the glabella, nasolabial folds, and temporal area [4].

Paying attention to symptoms, both visible and subjective and reported by patients, should not be ignored; a distinct reaction minimizes delays in necessary treatment [2].

Periprocedural Recommendations and Contraindications

Universal recommendations for dermal filler treatments include timing and overlap with other aesthetic procedures to avoid exacerbation of mild adverse reactions and to prevent hypersensitivity reactions and infection. Patients should be advised not to undergo the treatment shortly after other medical procedures, such as vaccination [37]. The interval between dental procedures and filler injections should be at least 2 weeks; chlorhexidine mouthwash is recommended to eliminate naturally occurring bacteria on the skin and mucosa, which can be a potential source of infection [57]. The performer should instruct the patient to avoid touching the injected area and to avoid applying any unnecessary products, especially using nonsterile tools [48]. Follow-up visits allow assessment of the effect and observation for any adverse reactions [48].

Major contraindications include a past allergic reaction to a filler or its additives, or an active infection at the planned injection site [4]. Some authors list certain chronic diseases as contraindications, including Crohn’s disease, ulcerative colitis, allergies, atopy, autoimmune diseases, immunosuppression, and coagulation disorders [2, 16, 58]. The safest approach seems to be arranging a consultation before the procedure, during which the patient’s medical history is thoroughly reviewed, including previous aesthetic treatments, current and past illnesses, medications, supplements, and vitamins [2, 59]. Another mandatory component of the consultation should be a physical exam to assess the skin for potential contraindications, such as thinning, infectious lesions, dermatitis, or atrophy [14]. This will allow the clinician to assess the

patient's health condition and inform the patient about potential risks, on the basis of which both sides should make the decision. There is still insufficient evidence or a clear position on contraindications for dermal filler procedures; thus, knowledge must be continually expanded, and vigilance maintained.

Each case needs an individual approach and should be based on clear communication between the performer and the patient. This is essential for achieving the desired effect while maintaining a safe and reasonable approach, especially in case of mental health issues and body dysmorphia [60, 61].

Conclusions

The rapid expansion of the beauty procedure market is accompanied by an increase in reported adverse reactions. Most complications are mild, self-limiting reactions resulting from the procedure itself, but severe and potentially irreversible complications have been reported, and the number of them is increasing. Modern dermal fillers provide significant benefits in facial aesthetics and are generally considered safe when used by experienced practitioners, but no procedure is without risks.

Fillers should be approved by pharmaceutical organizations and sourced from legal suppliers to eliminate the risk of injecting contaminated or otherwise unknown-composition formulas.

Some authors warn that the term “minimally invasive” may be misleading. Performing procedures involving even minimal intervention in the body requires knowledge of facial anatomy or proficiency with ultrasound, as well as familiarity with potential complications and their risks, especially those that may require immediate medical intervention. Every aesthetic medicine clinic should be equipped with resuscitation and first-aid kits, and practitioners should be trained in first-aid procedures.

The patient's expectations and wishes should be respected, but the final decision to proceed with the procedure rests with the physician and should be based on a thorough medical history, physical examination, and risk assessment, especially for certain patient groups. Each patient requires an individualized approach, and some may also need preparation before the procedure, such as discontinuing certain medications or taking other medications prophylactically. Contact with the patient should not be limited to the procedure itself, as some complications may arise long after the treatment.

Performing aesthetic medicine procedures requires constant expansion of knowledge and skills. The more case reports, analyses, and experience sharing in the medical literature, the better the foundation for developing management guidelines for complications and safe procedure performance.

Ultimately, a patient-centered and safety-focused approach ensures optimal outcomes and helps build trust in aesthetic medicine.

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