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**Review Article**

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# Facial Biopolymers and Main Imaging Findings with Their Potential Complications: A Contemporary Review

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## Abstract

The use of injectable fillers in the facial region has grown significantly in recent decades, primarily for aesthetic rejuvenation and for the treatment of facial lipoatrophy. These procedures employ a wide range of materials, including temporary fillers (such as hyaluronic acid or poly-L-lactic acid) and permanent fillers (such as calcium hydroxyapatite, collagen, liquid silicone, polytetrafluoroethylene, or polyacrylamide gel).

Although these materials are often detected incidentally in imaging studies–raising the challenge of avoiding confusion with pathological lesions–patients may also require radiologic evaluation to identify associated complications. The most frequent complications include infection, overfilling, material migration, foreign-body reactions, and fibrosis or scarring. In this regard, it is essential to be familiar with the specific imaging characteristics of each biopolymer and its potential complications, thus facilitating accurate diagnosis and timely clinical management.

**Keywords:** ***Facial biopolymers; Injectable fillers; Facial imaging; Radiologic diagnosis.***

## Introduction

The development of injectable facial fillers has marked a milestone in aesthetic and reconstructive medicine. From the first attempts with paraffin at the end of the 19th century to the introduction of modern biocompatible materials such as hyaluronic acid, calcium hydroxyapatite, and liquid silicone, the search for less invasive alternatives to aesthetic surgery has driven the widespread use of these substances [1].

Currently, the popularity of these minimally invasive procedures explains why imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound increasingly detect facial fillers, either as incidental findings or in the context of clinical complications. For radiologists, this represents the challenge of distinguishing between an aesthetic filler and true pathology, as some materials may mimic tumors, inflammatory processes, or infections. This underscores the scientific and clinical importance of characterizing the specific imaging findings of each type of biopolymer.

In practice, fillers are often incidental findings on routine MRI or CT studies performed for unrelated indications. Radiologists must be familiar with their imaging characteristics: most fillers appear similar on MRI due to their high water content (hypointense on T1, hyperintense on T2, with no diffusion restriction and no enhancement) [2].

Detailed knowledge of the anatomical sites most frequently targeted in facial and body filler procedures is essential. These include the nasolabial folds, the superficial medial and middle cheek fat compartments, the perioral region, the glabella, and, in body procedures, the gluteal subcutaneous fat. These areas are selected due to their relevance in facial harmonization and because fillers can induce perceptible volumetric changes in soft tissue support structures [3].

Complications of facial fillers can be classified into short- and long-term events, both of which have relevant pathophysiological bases. In the short term, adverse effects are often related to the application technique, the immediate biocompatibility of the material, and the aseptic conditions of the procedure. Examples include allergic reactions to collagen derivatives, where an immediate immune response can cause edema, erythema, or hypersensitivity. Similarly, the lack of sterile technique may facilitate local bacterial infections, while excessive or irregular application may lead to aesthetic asymmetries and poor distribution of the material across facial compartments [4].

In the long term, complications arise from chronic inflammatory phenomena and sustained interaction between the biopolymer and tissues. Abscesses may develop from persistent subclinical infections; foreign-body granulomas result from delayed immune responses to non-biodegradable materials such as liquid silicone or polymethyl methacrylate. Additionally, material migration to distant regions reflects poor encapsulation and the ability to spread through anatomical planes. Finally, irregular scarring and fibrosis can produce visible deformities that, in some cases, require corrective surgical treatment [4].


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## Methods

A systematic literature review was conducted to identify the available scientific evidence on the use of facial biopolymers and their imaging findings, with emphasis on computed tomography (CT). Searches were carried out in recognized academic and scientific databases, including PubMed, Scopus, SciELO, Redalyc, Google Scholar, and ResearchGate. The search terms used were: "biopolymers," "injectable fillers," "facial fillers," "computed tomography," "imaging findings," "complications," "migration," "foreign body reaction," and "granulomas," combined with Boolean operators (AND, OR) in both English and Spanish.

The search was limited to articles published between 2000 and 2024, with full-text availability and clinical relevance in the fields of aesthetic medicine, radiology, and pathology. Systematic reviews, narrative reviews, case reports, case series, and original studies reporting imaging findings related to the diagnosis and complications of facial fillers were included. In total, more than 20 scientific articles were reviewed, from which the most relevant and methodologically rigorous were selected to support the discussion of this work.

## Results

**Calcium Hydroxyapatite**

Injectable calcium hydroxyapatite was approved by the FDA in December 2006 for the treatment of facial lipoatrophy and wrinkles. The product consists of calcium hydroxyapatite microspheres suspended in a methylcellulose gel matrix. On computed tomography (CT), the filler appears as linear streaks or clusters of high attenuation, with values ranging from 280 to 700 HU (Fig. 1). On magnetic resonance imaging (MRI), it demonstrates low to intermediate signal intensity on both T1- and T2-weighted sequences (Fig. 2) [5].

Calcium hydroxyapatite is gradually resorbed, with an approximate duration of two years. Local inflammation may occur within the first week after injection. This agent is generally not injected around the lips due to its tendency to form clusters in that region. Beyond this, long-term or delayed adverse events are uncommon.

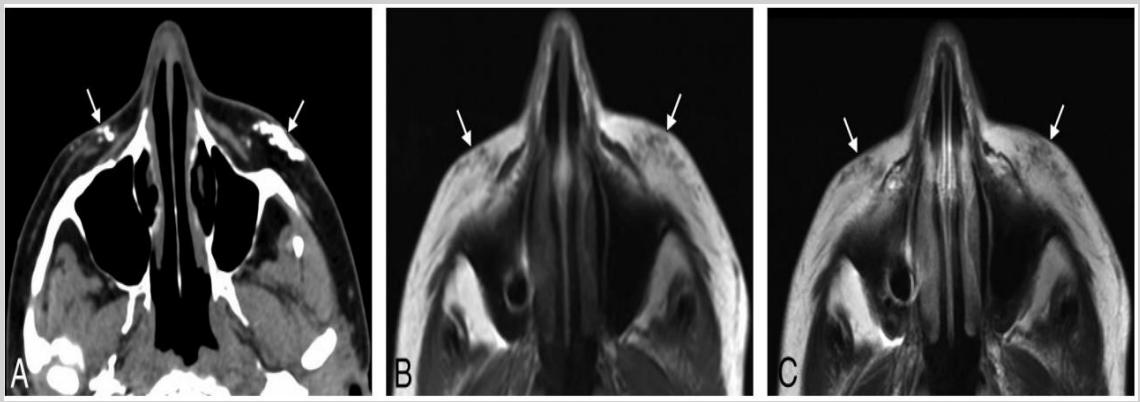


**Fig. 1. Axial non-contrast CT scan (A) shows hyperdense material within the bilateral subcutaneous tissues of the cheeks (arrows). Axial T1- (B) and T2-weighted (C) MR images demonstrate that the fillers exhibit low-to-intermediate signal intensity on both sequences (arrows).**

**Collagen and Collagen Mixed with Polymethylmethacrylate**

Collagen fillers are based on naturally occurring proteins obtained from various sources [6]. Bovine collagen has been FDA-approved since 1981 for the treatment of scars, wrinkles, and fine lines, while porcine collagen has been approved since June 2008. In addition, collagen matrices derived from human tissue, both autologous and allogeneic, have also been used [6].

On computed tomography (CT), collagen fillers demonstrate attenuation similar to that of fluid, and adjacent subcutaneous fat often appears infiltrated (Fig. 2). On magnetic resonance imaging (MRI), these fillers appear hypointense on T1-weighted sequences and hyperintense on T2-weighted sequences. They may also exhibit minimal peripheral enhancement, which can persist for up to two months [6]. The estimated duration of collagen filler effects is approximately 6 to 12 months.

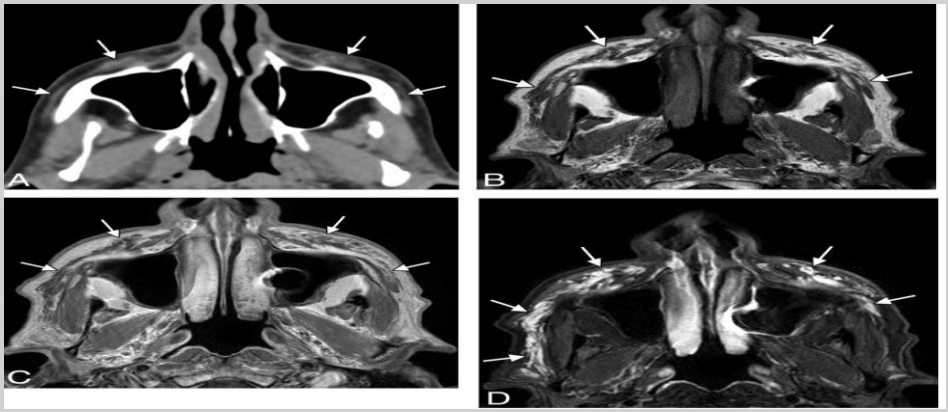


**Fig. 2. Axial CT image (A) shows filamentous formations within the subcutaneous tissues of both cheeks (arrows). Axial MR images in T1 (B), post-contrast T1 (C), and fat-saturated T2 (D) sequences demonstrate that the filler exhibits signal characteristics nearly identical to fluid (arrows).**

**Liquid Silicone**

Liquid silicone, or silicone oil, is a permanent synthetic agent that has been used for approximately 50 years in procedures for acne scar correction and aesthetic purposes. On computed tomography (CT), liquid silicone usually demonstrates attenuation similar to or slightly higher than that of soft tissue (**Fig. 3**).

On magnetic resonance imaging (MRI), silicone oil exhibits a characteristic pattern: it appears hyperintense on T1-weighted sequences and iso- to hypointense on T2-weighted sequences compared with wáter [7]. Higher-viscosity oils tend to appear more hypointense on T2 than those of lower viscosity. Additionally, chemical shift artifacts and alterations in fat-suppressed sequences may also be observed.

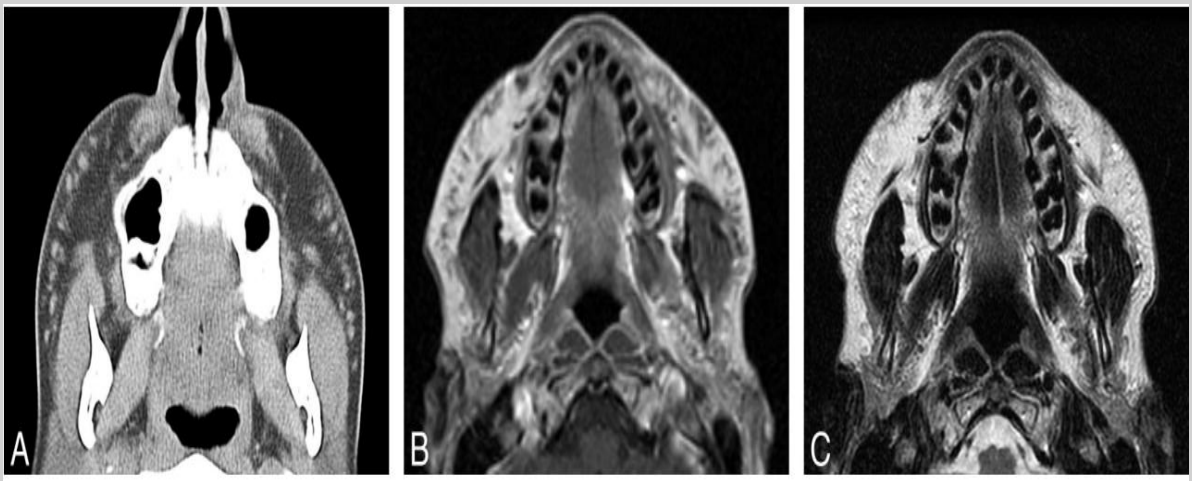


**Fig. 3. Axial CT image (A) shows multiple foci of high attenuation in the bilateral cheeks. Axial MR images in T1 (B) and T2 (C) sequences demonstrate corresponding intermediate signal intensity in both sequences.**

**Hyaluronic Acid**

Hyaluronic acid-based dermal fillers are biocompatible, biodegradable, and non-permanent materials used primarily for facial rejuvenation [8]. Commercial brands vary in their hyaluronic acid concentration and in the degree of cross-linking chemistry, which determines their viscosity. More viscous gels are suitable for correcting lipoatrophy in HIV patients, while softer, more flexible formulations are especially useful in delicate areas such as the lips, perioral region, and periorbital región [9].

On computed tomography (CT), hyaluronic acid fillers exhibit attenuation nearly equivalent to fluid, often with apparent infiltration of the adjacent subcutaneous fat [6]. On contrast-enhanced T1-weighted magnetic resonance imaging (MRI), minimal peripheral enhancement may occasionally be observed, which can persist for up to two months (**Fig. 4**). Moreover, serial MRI studies can document the progressive diffusion and degradation of the material, which serves as a useful marker for evaluating implant longevity and behavior [10].

In terms of safety, hyaluronic acid fillers present a lower incidence of complications compared to semi-permanent and permanent agents. They also have the clinical advantage of being rapidly reversible through hyaluronidase injection, making them one of the most versatile and safest materials currently available in clinical practice [8].

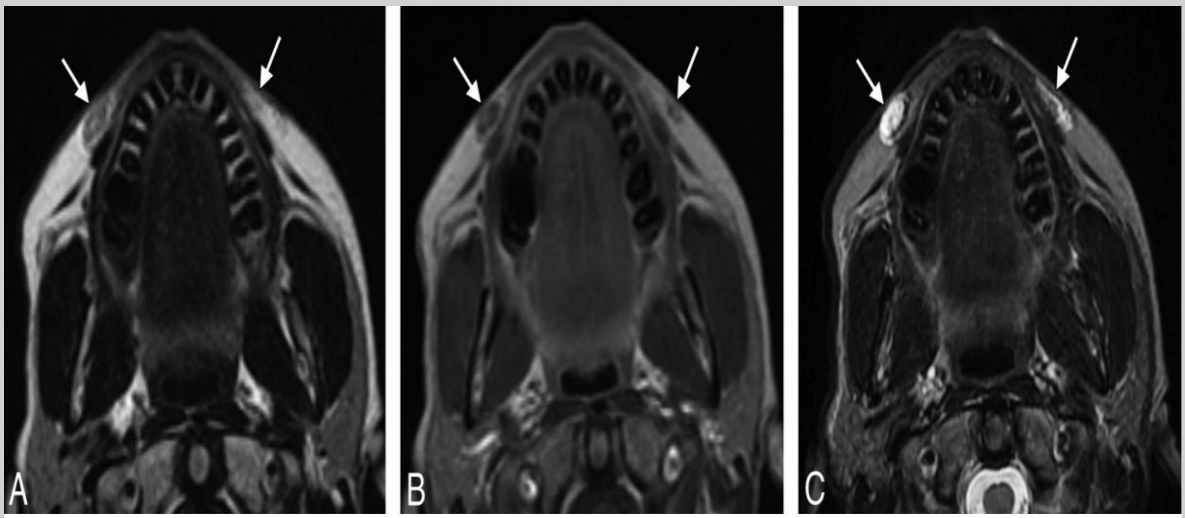


**Fig. 4. Axial post-contrast MR images in T1 (A, B) and fat-suppressed T2 (C) sequences demonstrate bilateral fluid-like accumulations in the nasolabial folds, more prominent on the right than on the left (arrows).**

**Poly-L-Lactic Acid**

Poly-L-lactic acid (Sculptra) is a biodegradable synthetic polymer that received FDA approval in August 2004 for the treatment of facial lipoatrophy in HIV patients, although it is also widely used in facial rejuvenation procedures [11] On computed tomography (CT), poly-L-lactic acid may appear as foci with soft-tissue attenuation, generally accompanied by striation of the adjacent subcutaneous fat, a finding that most likely corresponds to collagen formation induced by the material (**Fig. 5**) [6].

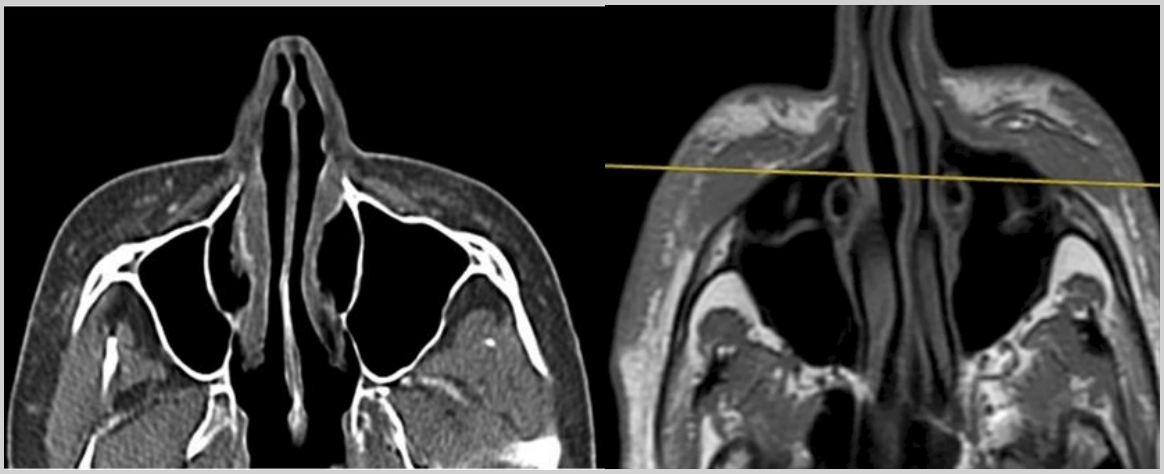

**Fig. 5. Axial CT image shows irregular bilateral soft-tissue attenuation with surrounding cystic fibrosis in the subcutaneous tissues of the cheeks. On MRI, hypointense material on T1-weighted sequences is observed within the subcutaneous cellular tissue of both malar regions.**

**Complications**

All facial fillers may cause both early and late complications. Early complications (days to weeks) include immediate hypersensitivity, infection, skin necrosis, and pigmentary alterations. Late complications (weeks to years) include infection, material migration, delayed hypersensitivity, foreign body granulomas, and scarring. In many of these scenarios, evaluation with computed tomography (CT) and/or magnetic resonance imaging (MRI) is relevant to define the extent, characterize the biomaterial, and guide therapeutic management [12].

Since the administration of facial fillers involves a certain degree of cutaneous trauma, there is a risk of introducing microorganisms into dermal tissues. Nevertheless, the incidence of infections is low when the procedure is performed in an appropriate setting under proper sterile conditions. For example, in a series of approximately 1,300 patients treated with polyacrylamide injections, an infection rate of 0.2% was reported [13].

On imaging evaluation, filler-related infection may present as cellulitis or abscess. Cellulitis typically manifests with stranding of the subcutaneous fat and enhancement of tissues adjacent to the injected material, a pattern that may overlap with sterile inflammatory reactions (**Fig. 6**).

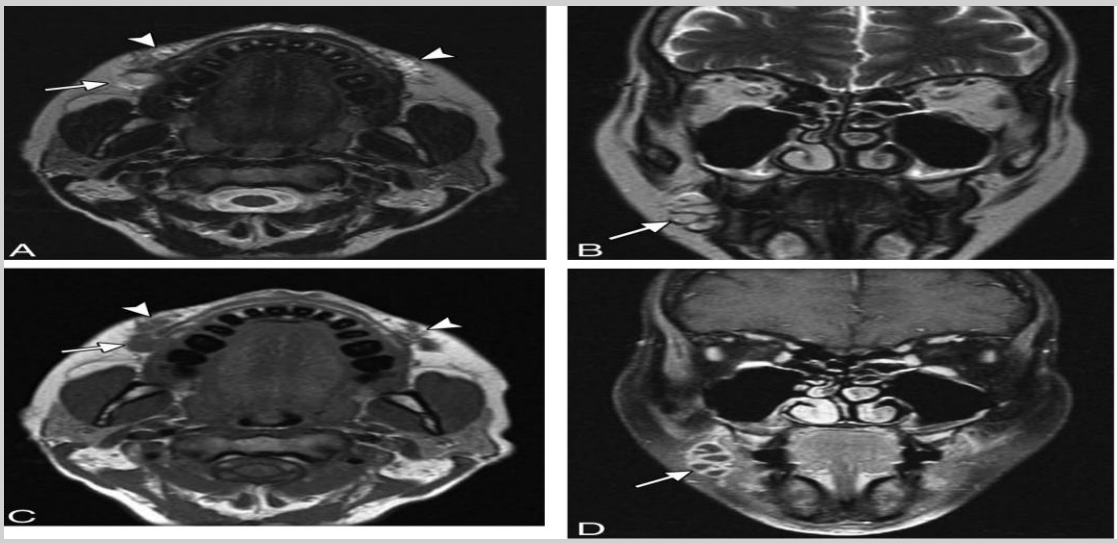


**Fig. 6. Abscess. Axial (A) and coronal (B) T2-weighted MR images, axial T1 (C), and coronal post-contrast fat-suppressed T1 (D) images demonstrate hyaluronic acid deposits within the bilateral oral cavity.**

When progressing to abscess formation, it is typical to identify collections with ring-shaped peripheral enhancement and more extensive surrounding soft-tissue edema. Differentiation from focal filler deposits-particularly hyaluronic acid, which mimics fluid on CT and MRI-can be challenging; however, abscesses usually demonstrate a thicker and more irregular wall, more intense peripheral enhancement, and, on MRI, diffusion restriction (hyperintense on DWI and hypointense on ADC), findings that support an infectious origin. The presence of gas and associated skin involvement further strengthens the diagnosis of abscess (**Fig. 6**) [6].

Chronic inflammation and, in some cases, lymphatic obstruction induced by filler materials may evolve into scar formation. This process can manifest many years after the initial procedure. Particularly intense fibrotic reactions have been reported following the use of liquid silicone [14].

On computed tomography, scarring associated with silicone injection typically appears as subcutaneous fibrous masses that present as thick bands with soft-tissue attenuation (**Fig. 7**). Retraction of the overlying skin may also be observed. This complication is often disfiguring, accompanied by limited mobility of the mimic muscles, and remains difficult to manage, even when corticosteroid infiltrations or surgical resection are attempted [15].

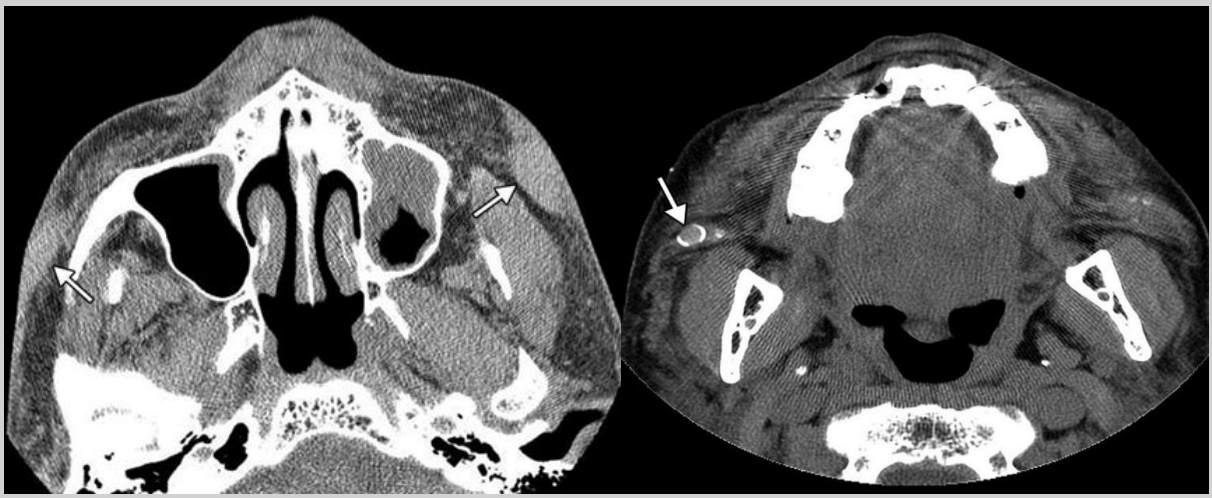

**Fig. 7. Axial CT image shows fibrotic bands within the subcutaneous tissues of both cheeks (arrows). Another axial CT image demonstrates a nodule with an eggshell calcification in the right cheek (arrow).**

## Conclusions

The use of facial fillers has become an established practice both for aesthetic rejuvenation and the management of facial lipoatrophy. Each biomaterial presents specific imaging signatures and risk profiles: hydrophilic gels (hyaluronic acid and collagen) usually behave like fluid and exhibit mild, transient peripheral enhancement; liquid silicone appears hyperintense on T1 and iso-/hypointense on T2, with chemical shift artifact and a higher rate of late complications; poly-L-lactic acid acts as a biostimulant, with findings consistent with neocollagenesis. These characteristics, together with the post-injection timeline, enable imaging to distinguish between different materials, complications, and tumor or infectious mimics.

Complications encompass a temporal spectrum: early inflammatory reactions, infection, and acute vascular events; and, in the long term, foreign body granulomas, migration, fibrosis, and disfiguring scarring, particularly with permanent materials. Computed tomography and magnetic resonance imaging are complementary: CT delineates collections, gas, calcifications, and bone involvement; MRI characterizes tissue planes, filler material, and inflammatory activity. Diffusion restriction and ring enhancement help differentiate abscesses from filler deposits, whereas the absence of enhancement suggests necrosis.

## Declarations

## Conflicts of Interest

The authors declare that they have no conflicts of interest

## Ethical Considerations

As this is a review article, no ethical approval was needed.

## Funding Statement

None

## Consent to participate

Not applicable as this is a review article

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