Synthetic Fillers for Facial Rejuvenation

Johnson C. Lee, MD[a,*], Z. Paul Lorenc, MD[b]

KEYWORDS

• Fillers • Injectables • Synthetic • PLLA • CaHA • PMMA • Silicone

KEY POINTS

- Calcium hydroxyapatite is a versatile semipermanent filler with a high elastic modulus for composite lifting.
- Poly-L-lactic acid can continue to induce local collagen formation for several months to years after injection for significant long-term results.
- Polymethyl methacrylate is effective for distensible atrophic acne scars.
- Silicone oil is a permanent filler with vitreoretinal indications, but is considered off-label use for facial injections, with potential serious complications.
- Synthetic fillers can provide long-lasting results through biostimulation of neocollagenesis.

INTRODUCTION

According to the American Society of Plastic Surgeons' 2014 Plastic Surgery Statistics Report, soft tissue filler procedures were the second most common minimally invasive procedures with 2.3 million procedures performed.[1] This number represents a 3% increase from the previous year. Since the start of the century, soft tissue filler procedures have increased 253%, whereas cosmetic surgical procedures overall have decreased 12%.

With the boom in the soft tissue filler industry, patients and physicians in the United States are encountering an increasing number of available products to choose from (**Box 1**). Soft tissue filler materials can be naturally (animal) sourced or synthetically produced. Mechanisms of action include volume replacement and biostimulation of autologous collagen production by native fibroblasts. Volume replacement occurs primarily through the use of hyaluronic acids, in which the hydrophilic biomaterial acts as a spacer within the tissue planes. Synthetic fillers such as calcium hydroxyapatite (CaHA), polymethyl methacrylate (PMMA), and poly-L-lactic acid (PLLA), and silicone provide initial volume replacement but have an additional biostimulatory effect to supplement volumization. This article specifically addresses synthetic fillers in the management of facial aging.

CALCIUM HYDROXYAPATITE

CaHA was first approved as an injectable implant by the US Food and Drug Administration (FDA) as a soft tissue radiographic marker in 2001 before quickly expanding its indications to include vocal fold augmentation, repair of oromaxillofacial defects, and soft tissue augmentation for stress urinary incontinence. In 2006, the FDA approved Radiesse (Merz Aesthetics, Raleigh, NC) as a CaHA filler for augmentation of moderate to severe nasolabial folds (NLFs) and human immunodeficiency virus (HIV)–associated facial lipoatrophy. Most recently, in 2015, Radiesse was approved for hand rejuvenation.[2]

Radiesse is considered a semipermanent filler composed of nonimmunogenic synthetic bone (CaHA) with microspheres 25 to 45 μm in diameter within a 70% carboxymethylcellulose carrier gel.

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[a] Private Practice, Enhance Medical Center, 462 North Linden Drive, Suite 333, Beverly Hills, CA 90212, USA;
[b] Lorenc Aesthetic Plastic Surgery Center, 983 Park Avenue, New York, NY 10028, USA
* Corresponding author.
E-mail address: JCLMD@enhancemedicalcenter.com

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Box 1
Soft tissue fillers

Collagen
Cymetra
Fascian

Polymethyl methacrylate
Bellafill

Hyaluronic acid
Restylane-L
Restylane Lyft
Restylane Silk
Belotero
Juvederm Ultra XC/Plus XC
VOLUMA XC
Prevelle Silk

Calcium hydroxyapatite
Radiesse
Radiesse+

Poly-L-lactic acid
Sculptra

Silicone
Silikon 1000
Sil-Ol 5000

Autologous cell therapy
Platelet-rich plasma
LaViv

Within several weeks after injection, the carrier gel is absorbed and net neutral volume replacement occurs through neocollagenesis. Because an immune response is not elicited, no skin testing is needed. The CaHA degrades into calcium and phosphate ions over time and is excreted slowly from the body, creating lasting volume for an average of 12 to 18 months.[3]

Radiesse has a particularly high elastic modulus (G'). G' is the measure of the gel's ability to resist deformation when pressure is applied. The higher the G' of a substance, the greater its stiffness, and the less likely the substance is to deform under pressure from its surroundings. In a study by Sundaram and colleagues,[4] the G' of Radiesse was measured to be 1407 Pa compared with a range of 28 to 863 Pa in hyaluronic acid products. This property results in a greater amount of lift when injected under the skin envelope.

Because of its unique chemical composition, safety profile, and lifting properties, Radiesse has become an increasingly popular filler option. Its versatility extends to treatable facial zones, depth of injection, and delivery method. Radiesse has been used in marionette lines, the prejowl sulcus, oral commissures, and the posterior mandible.[5–7] There are also reports of positive clinical results from injections in the temple and malar/submalar areas, which are considered off-label uses.[8–11]

Although early instructions for the use of CaHA were limited to the mid-dermis to target rhytids, practitioners have steadily expanded injection depths to the deep dermis and down to the supraperiosteal to structurally lift and contour the face[12,13] (**Fig. 1**). This composite lift can be visualized under high-resolution ultrasonography, with which CaHA appears as hyperechoic deposits with variable degrees of posterior acoustic shadowing (**Fig. 2**).

CaHA can be further modified by combining lidocaine in a mixing process rather than using the established protocol of preanesthetization of the treatment site before injection.[14] The senior author (ZPL) recommends a 3-tiered dilution approach depending on associated areas of treatment and depth of injection (**Table 1**). The amount of lidocaine varies according to facial zones, whereas the volume of CaHA remains steady to facilitate ease of preparation and for consistent clinical results.

Rare complications of CaHA injections include palpable nodules and vascular occlusion. Although there is no reversal agent or enzyme for CaHA, small nodules can be broken up with digital massage. Larger nodules can be treated with an injection of 5-fluorouracil and lidocaine 1:1 to reduce fibroblastic activity in these sites while breaking up the nodule. This technique is preferred to steroid injection because of potential chronic atrophic effects on overlying skin. For the exceedingly rare instances of vascular occlusion, the same protocols are advised as with other filler agents, including the use of hyaluronidase.[2]

POLY-L-LACTIC ACID

PLLA has been in clinical use for more than 20 years as a major component of some absorbable sutures, such as Vicryl (Ethicon Inc, Somerville, NJ) and in surgical screws, pins, and staples used in maxillofacial and orthopedic procedures. It was FDA approved as an injectable implant in 2004 under the name of Sculptra (Galderma, Fort Worth, TX) for restoration or correction of the signs of facial fat loss in patients with HIV with facial lipoatrophy.[15] More recently, in 2009, Sculptra Aesthetic was approved for immunocompetent