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ADVANCES IN COSMETIC SURGERY

Injectable Fillers

Comparison of Materials, Indications, and Applications

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KEYWORDS
- Injectable fillers • Hyaluronic acid (HA) fillers • Facial rejuvenation • Facial volumization
- Minimally invasive aesthetics

KEY POINTS

- Treating facial aging continues to be a challenge for cosmetic surgeons and aesthetic physicians, but increased knowledge of the anatomic changes that occur with age and improved tools for rejuvenation enable achieving excellent aesthetic results in a minimally invasive way.
- There are 3 general classes of injectable fillers available: autologous (fat, dermis, and fascia), biologic (hyaluronic acid and bovine and human collagen), and synthetic (calcium hydroxyapatite, poly-L-lactic acid, and polymethylmethacrylate).
- Variations in the rheologic properties—elasticity, flexibility, viscosity, hydrophilicity, particle size, particle concentration, and cross-linking—have an impact on the clinical indications and applications of a particular filler.
- Facial volumization should be performed deep to superficial and cephalad to caudad, and the appropriate filler should be selected based on anatomic site, patient-specific goals and soft-tissue dynamics, and the properties of the filler.
- There must be awareness of the adverse effects and immediate, early, and late complications of injectable fillers and how to avoid and treat those complications.

INTRODUCTION

The approach to the aging face provides significant complexity and, at times, confusing challenges to the aesthetic physician and surgeon. As such, approaches have rapidly evolved throughout the recent decades. Cadaver and advanced imaging studies have demonstrated that skin, soft tissue, and bony modifications and volume loss are principal causes of facial aging. With the increasing popularity of noninvasive facial rejuvenation options, it has become essential for aesthetic practitioners to be knowledgeable and facile with soft tissue fillers [1]. This article discusses the most common types of fillers, their unique characteristics, and specific clinical indications. This article focuses on technical considerations and pearls for rejuvenating specific aspects of the face, breaking them into thirds: the upper face, midface, and lower face. Finally, potential complications and how to avoid and treat them are reviewed.

HISTORY OF INJECTABLE FILLERS

Physicians have treated facial aging and volume loss for more than a century, as fat grafting to the face has been

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reported as early as 1893 [2]. In the early 1900s, surgeons in Vienna injected liquid paraffin for facial rejuvenation but stopped soon after given the public backlash regarding the high rate of complications [2]. Throughout the 1900s, multiple synthetic fillers, including silicone oil and polytetrafluoroethylene, were explored with minimal success [3–6].

In the 1970s, dermal fillers made of viscous fluids or polymer particle suspensions were injected to treat acne scars, rhytides, congenital and traumatic soft tissue defects, Romberg disease, and HIV-associated lipodystrophy [7–13]. In 1981, a major step toward modern-day fillers occurred with the FDA approval of Zyderm and Zyplast (Inamed, Santa Barbara, CA), both bovine collagen fillers designed for cosmetic use [2]. Despite its success in treating fine rhytides, bovine collagen caused hypersensitivity reactions, which required preinjection skin testing and had a short duration of effect [2,14]. These disadvantages, coupled with the increasing awareness and fear of bovine spongiform encephalopathy, led to these injections only performed on a small subset of highly affluent patients [2,14]. The latest generation of facial fillers is composed of hyaluronic acid (HA), calcium hydroxyapatite (CaHA) and poly-L-lactic acid (PLLA). Continued innovations in facial fillers are aimed at developing longer-lasting and more natural products with fewer adverse effects and improved patient-reported outcomes.

Classification and Mechanical Properties of Fillers

Currently, there are 3 general classes of injectable fillers available: autologous, biologic, and synthetic. Autologous fillers include fat, dermal, and fascial fillers; however, this class of filler is not discussed in this article. The most commonly used biologic fillers worldwide are HA fillers. Other biologic fillers include bovine and human collagen. Synthetic fillers include CaHA, PLLA, and polymethylmethacrylate (PMMA), which is the only permanent filler (Table 1).

Although rheologic properties are primarily used to characterize HA fillers, all fillers can be characterized according to the following intrinsic properties: elasticity, flexibility, viscosity, hydrophilicity, particle size, particle concentration, and cross-linking. Variations in these parameters between fillers have an impact on the clinical indications and applications of a particular filler (Table 2). Elasticity (G') is a material's ability to resist compression and is a proxy for gel hardness, how much the gel is displaced given a degree of stress. Fillers with a high G' are typically firmer than those with low G' and are considered superior at lifting and deep volumization. Because they feel firmer, however, high G' fillers may cause more tissue disruption in thin tissues. Fillers with a low G' commonly feel softer and thus are considered better for the treatment of thin tissues and superficial rhytides. Flexibility (xStrain) refers to how much strain a material can withstand and still be reversible before deformation, much like the flexibility of a rubber band before snapping. Highly flexible fillers with a high xStrain tend to be softer and diffuse more easily, making them ideal for use in thinner and more superficial tissues. Viscosity (n^*) is a material's ability to flow, spread, and resist shearing forces and have an impact on a filler's clinical effect in a manner similar to but distinct from that of G'. Finally, hydrophilicity is the product's capacity to attract water and expand, contributing to the degree of volumization and swelling.

There are 2 general classes of HA fillers, namely, monophasic and biphasic gels. Monophasic gels are cross-linked in 1 process to produce a stabilized smooth gel without particles. Biphasic gels are composed of cross-linked HA suspended in a liquid. For particulate fillers, particle size is determined by the polymerization of the glycosaminoglycan chains and straining techniques. Particle size contributes to the filler's lifting and filling power as well as to swelling capacity. Large particle fillers are better at filling deep folds and creating volume, whereas small particle fillers are better for moderate folds and areas of thinner skin. The particle size of the filler further contributes to minimum size of the injection needle. Some fillers are composed of small and large particle size cross-linked in a proprietary manner, whereas others are composed of a consistent particle size. Finally, increasing particle concentration and the degree of cross-linking both strengthen the durability of the filler and longevity of effect due to better resistance to enzymatic breakdown by the endogenous enzyme hyaluronidase. Rheological and particle properties all contribute to the clinical behavior of an HA filler and underscore the complexity of filler injection in relation to patient anatomy and tissue quality. Therefore, these factors must be understood by the injector for optimal, natural results.

TYPES OF BIOLOGIC FILLERS

Hyaluronic Acid

The most commonly used fillers today are temporary HA fillers. HA is a naturally occurring polysaccharide that is a critical component of the dermis and other tissues, and its depletion with advancing age contributes to the aging face phenotype. One of the benefits of an HA filler is that it increases soft tissue volume as a