Fullness and elevated projection of the malar area is considered highly desirable for facial attractiveness, and these features are associated with youth. Recent studies examining the aging face have demonstrated that facial soft tissues can suffer a loss of volume when subcutaneous fat redistributes or diminishes. The factors contributing to facial aging include reduced tissue elasticity, gravity, stress, and sun exposure. In addition, our understanding of facial aging has evolved, and it has been demonstrated that facial aging also includes a loss of soft tissue volume and erosion in bony landmarks. Many procedures for malar enhancement have been described, including permanent implants, injection of autologous fat, and the use of various fillers.

Surgical procedures for malar augmentation include placement of devices such as shaped silicone implants and fat grafting. However, there are disadvantages to these...
corresponding author: Santa Fe, New Mexico, passed away on February 18, 2011. Dr. Hurwitz is a plastic surgeon in private practice in Pittsburgh, Pennsylvania. Dr. Ronel, a plastic surgeon in private practice in Texas. Dr. Mosser is a plastic surgeon in private practice in San Francisco, California. Dr. Sayeg is a plastic surgeon in private practice in Troy, Michigan. Dr. Hurwitz is a plastic surgeon in private practice in Pittsburgh, Pennsylvania. Dr. Ronel, a plastic surgeon in private practice in Santa Fe, New Mexico, passed away on February 18, 2011.

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methods
Artefill is currently considered suitable for patients desiring mild to moderate cheek correction who demonstrate signs of facial aging in the malar area. Only patients with malar lipoatrophy grades 1 to 3 (on a scale of 1 to 5) were considered for treatment (scale range: grade 1 = mild flattening or shadowing of the malar regions, grade 5 = severe indentation of the malar regions, prominence of bony landmarks, and clear visibility of underlying musculature; Table 1). Institutional Review Board approval for use of Artefill in the malar area as part of an “open-label” pilot study was obtained through Veritas (Saint-Laurant, Montreal, Canada). Each patient in the study was treated by 1 of 5 physician authors who participated in collecting patients (D.C.M., S.M., A.S., D.H., D.R.). The participating physicians performed the injections and follow-up visits.

Artefill is a gel suspension of 20% PMMA microspheres in 3.5% bovine collagen solution mixed with 0.3% lidocaine. The manufacture of the product includes strict control of the particle size, to remain between 30 and 42 microns in a sterile environment. The product is supplied in sterile, prefilled, 1-mL syringes that do not require additional mixing or hydration. Because it contains bovine collagen, patients must be skin tested 1 month before injection.

We instructed all of our patients to avoid aspirin and nonsteroidal anti-inflammatory drugs for 1 week pretreatment to minimize the risk of bruising and swelling. Before treatment, all patients were photographed, and treatment sites were planned and marked. The treatment areas were outlined while the patient observed with a handheld mirror, to allow patient involvement in the treatment plan. Initial injections were 2 to 3 mL per cheek, as determined by the judgment of each individual physician injector on a case-by-case basis. As a part of the informed consent process, all patients in the study were told that Artefill was being used as a part of this pilot study to evaluate its effect on the malar area.

The importance of skin preparation with injectables has not been proven but is certainly worthy of attention to avoid the possibility of infections or possible introduction of biofilms into the deeper facial tissues. Alcohol cleansing is common, but we have added a chlorhexidine solution in our practice. Reports exist suggesting that chlorhexidine has the benefit of a residual antibacterial
effect that is not seen with alcohol.\textsuperscript{18} We also believe that it is important to stretch the skin during skin preparation to allow cleansing into the wrinkles. Application of the chlorhexidine solution was avoided near the periorbital area to prevent the potential for exposure keratitis.\textsuperscript{19}

As we gained experience with the product, we noticed that it was much easier to inject when it had been hand-warmed for 5 minutes, and we incorporated this into our pretreatment protocol. Artefill was injected where the tear trough meets the zygomatic arch and deep to the malar fat pad just above the periosteum. A combination of crosshatching and fanning patterns was used to allow easier and more consistent delivery of the material and to minimize AE such as granuloma or nodularity. Once the treatment was complete, the areas were gently compressed and ice was applied if necessary. Patients were instructed to apply ice if swelling occurred and not to manipulate the area for several hours. Patients were evaluated immediately after injection and at predetermined intervals of 2, 6, and 12 months. Additional injections were performed at the discretion of the investigator and by patient request at 4 or 6 weeks, up to a maximum total volume of 8.8 mL.

To achieve consistency among injecting practitioners in the study, all patients were evaluated using the same outcomes measures. These measures were investigator assessment of aesthetic results using the change in malar volume loss scale (Table 1), investigator assessment of aesthetic results using the Global Aesthetic Improvement Scale (GAIS; Table 2), patient assessment of aesthetic results using the GAIS, and patient satisfaction (N. Seretta, personal communication, 2010) (Table 3). To objectively document patient satisfaction, each patient completed a satisfaction questionnaire, which measured the following: overall satisfaction, recommendation of aesthetic treatment to others, and the likeliness of recommending the study treatment to others. These variables were recorded at 8, 26, and 52 weeks posttreatment (Tables 4-6). During the study,
standardized photographs of each patient were collected at 2, 6, and 12 months.

A video of the authors’ technique is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to this video on www.youtube.com.

**RESULTS**

Of our 24 study patients, there were 23 women and 1 man. The average age of study participants was 48 ± 5.1 years (Table 7). In our series, the average volume of injections was 5.55 ± 1.87 mL, and the typical volumes of Artefill administered for malar augmentation were 2 to 3 mL per cheek. Some patients may require more. The results were immediately visible to patients after injection. The majority of patients required little or no recovery time and were able to resume most of their normal activities after the procedure. For the majority of patients, full correction was achieved in 1 visit. A small group of patients desired further augmentation and received touch-up injections at 4 or 6 weeks after the initial injections, at the discretion of the investigator.

Clinical results are shown in Figures 1 through 4. In our clinical practice, patients have reported that Artefill treatment was less painful or no more painful than other fillers. Although this was not measured objectively in our study, we believe that Artefill treatment was well tolerated because of the 0.3% lidocaine included in the gel suspension. Generally, minimal or imperceptible swelling or bruising was observed after injection and at the first follow-up visit. Patient satisfaction was very high, with 87.5% of study patients reporting that they were satisfied or very satisfied at 52 weeks posttreatment (Table 4). Only 1 patient reported a decrease in fullness in her malar region (Figure 4). Her report was in contrast to the physician-rated assessments of her face, which reported an improvement in her GAIS and malar lipoatrophy grades. Overall, the majority of patients reported that they observed no resorption at 6 and 12 months. We also noticed that in some cases, patients continued to demonstrate slight increases in malar volume more than 2 months after the procedure. These patients reported even more enhanced malar projection at 6 months than at 2 months. This effect was deemed beneficial by both the patients and physicians.

**DISCUSSION**

Malar descent and loss of facial volume are common consequences of the aging process. Many authors now believe that volume deflation actually precedes gravitational descent in facial aging, and consequently, volume restoration has become an important component of aesthetic facial rejuvenation. Hyaluronic acid products have become increasingly popular because of the minimal downtime required after treatment. The perceived disadvantage of temporary dermal fillers is the need for maintenance injections, which incur additional discomfort, inconvenience, and cost. Therefore, a longer-lasting injectable filler product may be considered a highly desirable treatment for patients seeking nonsurgical structural augmentation in the malar region.

Artefill is a gel suspension composed of 20% PMMA microspheres, which are homogeneous 30 to 42 microns,
in 3.5% bovine collagen solution mixed with 0.3% lidocaine. Reports of other PMMA-enhanced dermal fillers suggest that this group of products may have durability over 5 years. The PMMA microspheres in Artefill are not absorbed by the body and therefore provide permanent support, which can be considered advantageous for the purpose of structural augmentation. This is in contrast to other temporary dermal fillers such as Juvederm, Restylane, or Sculptra, which consist of components that are eventually absorbed by the body.

The most common AE associated with Artefill treatment are similar to those observed with other dermal fillers and include mild swelling and reddening at the treatment site. These side effects usually resolve within 24 hours. More serious AE such as the formation of inflammatory nodules, vascular occlusion, and granulomas have been reported with other fillers. To date, no serious AE of this type have been reported with Artefill. Occasionally, Artefill injection is associated with mild bruising that typically disappears in 3 to 7 days. Less common side effects include rash and itching, persistent swelling or redness, and increased sensitivity at injection sites. A skin test is required before initial treatment to make sure the patient is not sensitive to bovine collagen, and the FDA recommends allowing 28 days to determine whether a patient has a sensitivity reaction. Artefill received FDA approval for nasolabial fold correction in 2006 and has demonstrated an impressive safety profile, but it should be used only by experienced practitioners because it is a longer-acting product and complications may be less forgiving. Current recommendations also suggest avoiding use in patients susceptible to keloid formation or hypertrophic scarring.

Figure 1. (A, D) This 43-year-old woman presented with grade 3 malar lipoatrophy and was seeking a fuller, more youthful appearance to her face. (B, E) Eight weeks after Artefill treatment, with a total of 4 mL injected into the right malar area and 3.2 mL injected into the left. (C, F) One year posttreatment, there is no evidence of resorption. No swelling, bruising, or lumps were observed immediately posttreatment or at 2, 6, or 12 months. This patient had also undergone botulinum toxin treatments approximately 3 months prior to and 10 months after treatment with Artefill, as well as dermal filler injections to her lips approximately 5 months after treatment with Artefill. No patient in this series underwent additional treatment in the midfacial area.
Again, Artefill contains highly uniform PMMA microspheres that are not absorbed by the body and allow for durable structural support to the malar area. Several other PMMA-enhanced products are available outside of the United States, and studies have demonstrated the persistence of results achieved with these products for more than 5 years.21,25,26 Although our study includes follow-up data for only 1 year, it is our belief that Artefill will demonstrate a longevity similar to that of the other previously studied PMMA-enhanced fillers. It is our plan to continue evaluating our patients for several more years to confirm that Artefill treatment is as durable as other PMMA-enhanced fillers. We have been encouraged by our 1-year data and believe that these early results have importance for documenting the safety and efficacy of the product at every stage.

In contrast to other PMMA-enhanced fillers, Artefill is the only product of this type with FDA approval. In Europe, a PMMA-enhanced product marketed by the same manufacturer as Artecoll (Rofil Medical International, Breda, the Netherlands) is available. Although similarities exist between Artefill and other PMMA-enhanced products, there are some distinct differences. Artefill is derived from a closed US bovine herd, is more consistent in particle size, and has a larger particle size. The larger particle size decreases immunogenicity and digestion by macrophages (Table 8).13

Due to the permanent nature of PMMA and its potential to form palpable nodules, most authorities recommend that PMMA fillers should be placed in the deep dermis or, preferably, the subdermis.13 Given our objectives to provide structural support to the malar area and to minimize the risk for AE such as granuloma, we chose to inject Artefill in the supraperiosteal layer. Superficial placement may be associated with pruritis, redness, and hypertrophic scarring.21,22,24,25 The safety of Artefill and the low incidence of severe AE such as granuloma formation have been reported.12,13 Delayed granuloma formation has been associated with Artecoll, but...
not Artefill. The rate with Artecoll is quite low (0.01%) but can be troublesome because of its delayed appearance, often 6 to 24 months after injection.\textsuperscript{21,27} None of the patients in our series developed any granuloma, but it is important to note that management of delayed granulomas with other PMMA-enhanced fillers has been described with repeated

**Figure 3.** (A, C) This 46-year-old woman presented with grade 1 malar atrophy. (B, D) One year after Artefill treatment, with 4 mL injected on each side of the patient’s malar area. This patient also reported having undergone filler injections to her lips at another clinic. No patient in this series underwent additional treatment in the midfacial area.
intralesional steroid injection at increasing concentrations over a 3- to 4-week interval. As stated earlier, beading and ridging complications (which are considered hypertropic scarring) are attributed to superficial placement of PMMA and may eventually require therapies, including laser or excision. The lack of serious AE in our series indicates that Artefill is safe when used in the malar area and when proper technique and patient selection are applied.

Our clinical experience with Artefill for the purpose of cheek augmentation has been highly favorable. Our study demonstrates measured improvements in the aesthetics of the malar area, as measured by the GAIS and malar lipoatrophy grading scales, and high levels of patient satisfaction. We have found that Artefill is well tolerated by patients with reproducible effects. As a result of their satisfaction with Artefill, many of our study patients have referred other patients to our practice for this treatment. We have noted that patients treated with Artefill in this study have lasting results, with most patients noting lasting increased fullness 12 months after injection. Although 1 patient reported decreased fullness in the treatment area, our physician investigators did not see evidence of resorption in the malar area of any patient. In fact, several patients demonstrated a continued improvement in malar projection several months after injection. This was not expected, so we will continue to observe these patients, with planned follow-up for 5 years. It is important to note that the continued improvements in malar fullness that occurred 2 months after injection were slight and considered favorable in all patients in whom this effect was observed. However, this does present the possible problem of a late presentation of excessive volume correction. We have attempted to minimize this

Figure 4. (A, D) This 47-year-old woman presented with less malar projection on the left side of her face. (B, E) Eight weeks after Artefill treatment, with 3.2 mL injected into the right malar area and 5.6 mL into the left. This patient reported decreased fullness in her malar area despite receiving a relatively large volume of product. However, in contrast to the patient’s perception, the physician-rated Global Aesthetic Improvement Scale and malar lipoatrophy grade were considered improved. (C, F) One year posttreatment. This patient also received Artefill treatment in the nasolabial fold area approximately 5 months after Artefill treatment to her midface. No patient in this series underwent additional treatment in the midfacial area.
complication, but it will be interesting to see if this develops in patients as a possible late-presenting complication several years later.

The lasting effect of Artefill treatment and its lack of resorption make it attractive compared with fat grafting, which has a variable degree of permanence. Cheek implants can also present problems, as faces thin with aging and the implants become visible or impinge on the orbit. In contrast, Artefill adds volume to areas that atrophy, and it contains collagen, which thickens the surrounding soft tissue. One potential drawback to Artefill is the fact that it cannot be easily removed; for this reason, we chose to focus on patients with mild to moderate degrees of malar atrophy (grades 1-3), and we were careful not to perform any very large volume injections. The possibility of “overdone” volume additions to the face certainly exists, and by limiting the amount of our initial injections and performing no more than 8.8 mL, we believe that we limited the potential for excessive volume correction.

Limitations of this study include the subjective nature of the measurement scales and variability in the perceived degrees of change between the participating patients and investigators. Significant effort was taken to standardize all assessments during this multicenter, prospective study, but the design did not include blinded assessments of the treated patients and was therefore susceptible to bias. In addition, the number of associated ancillary treatments (such as skin resurfacing or surgical treatment) was not uniform among all patients. The ability to measure volumetric changes with imaging studies would likely have been beneficial, but this was deemed prohibitively expensive.

**CONCLUSIONS**

Artefill is a PMMA-enhanced dermal filler for use in facial contour augmentation. It was FDA approved for use in the nasolabial area in 2006, and this study documented its use in the malar area as part of a pilot study examining its effect in the malar area. Patients who underwent cheek augmentation with Artefill reported minimal recovery time and little to no swelling or bruising immediately posttreatment, with no reported serious AE. Outcome measures in this study showed documented improvements in the aesthetics of the malar area and high patient satisfaction levels. In addition, because Artefill contains PMMA, which is not resorbed, we believe that the results of treatment will be more durable than those of other currently available fillers. We believe malar augmentation with Artefill may last for 5 years or more, and we plan to follow our patients to confirm this anticipated outcome. Therefore, Artefill is a possible alternative to traditional

**Table 7. Demographics (n = 24)**

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<tr>
<th>Sex (n = 24)</th>
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<tbody>
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<td>Male</td>
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<tr>
<td>Female</td>
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<tr>
<td>48.0 ± 5.1</td>
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Values are presented as No. (%) unless otherwise indicated. P25, 25th percentile; P75, 75th percentile.

<table>
<thead>
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<th>Table 8. Comparison of PMMA Fillers</th>
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<td><strong>Product</strong></td>
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| Artefill (circa 2007) | United States | • Size: 30 to 50 microns, with negligible small sizes  
• Shape: smooth-surfaced microspheres with scant if any sediment  
• The only FDA-approved PMMA-enhanced dermal filler  |
| Artecoll (circa 2005) | Canada | • Size: 30 to 50 microns, with negligible small size particles  
• Shape: smooth-surfaced microspheres, some slight surface irregularity, scant sediment  |
| Artecoll (circa 2001) | Europe | • Size: 32 to 40 microns, but with variation in particle sizes  
• Shape: presence of nanoparticles on the surface of the microspheres, variation included some sub-20-micron particles and some sub-5-micron particles with sediment noted  |
| Metacrill (circa 2006) | Brazil | • Size: 0.2 to 60 microns  
• Shape: variable with many irregular shapes, some nonspherical, jagged edges, poor surface  |
| New Plastic (circa 2006) | Brazil | • Size: 0.2 to 70 microns  
• Shape: variable, with nonspherical and conjoined particles present  |

Courtesy of communication with Suneva Medical (San Diego, California) and adapted from Piacquadio et al. FDA, Food and Drug Administration; PMMA, polymethylmethacrylate.
fillers, since it is a convenient and longer-lasting option for patients seeking to restore facial volume and improve facial contours with nonsurgical filler.

Disclosures

Authors were given the option to buy stock in Suneva Medical. Dr Mills and Dr Hurwitz did not purchase the stock offered. Dr Mosser did not purchase the stock offered but does own stock in Suneva. Dr Sayeg was given stock in Suneva for a lecture series. As a writer but not a study participant, Dr Camp was not offered shares.

Funding

This study was funded by Suneva Medical, the manufacturer of the product discussed in this article. Suneva Medical provided the product, paid the patients to return for their follow-up visit, and paid for the patients' office visits. Suneva did not receive the article for review, nor did they provide editing or writing assistance. Suneva did provide data regarding the number of injections that have been performed. Suneva also collated the data for each visit, and its medical director provided statistical analysis for each of the visits.

REFERENCES