Injectable Calcium Hydroxylapatite for Orbital Volume Augmentation

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**Objective:** To describe a new method of augmenting orbital volume for anophthalmic enophthalmos correction.

**Methods:** A retrospective medical record review was conducted of 4 consecutive patients who had injectable calcium hydroxylapatite (Radiesse) placed in the extraconal space to augment orbital volume.

**Results:** Four patients were treated with 1 to 2 vials (1.3 mL per vial) of injectable calcium hydroxylapatite. The mean amount of preoperative enophthalmos measured by Hertel exophthalmometry was 4 mm (range, 2-7 mm). The mean follow-up was 57 weeks (range, 45-71 weeks). A reduction of enophthalmos, ranging from 2 to 5 mm (mean, 2.75 mm), was observed when comparing preoperative with postoperative measurements of the anophthalmic orbit with prosthesis in place. All patients demonstrated clinical and aesthetic improvement that was observed to continue at almost 1 year or more postoperatively. In one patient, injection was complicated by a peribulbar hemorrhage related to local anesthesia administration, which resolved without incident.

**Conclusions:** Injectable calcium hydroxylapatite provides a new, safe, simple, cost-effective technique to treat volume deficiency in the anophthalmic orbit. Augmentation achieved with this semipermanent filler has demonstrated a lasting effect in the orbit of 1 year or more with little volume loss. The filler seems to last longer in areas with less movement, blood supply, and lymphatic drainage. Injection can even be performed in an office setting using local anesthesia. The amount of volume replacement can be titrated, and the procedure is repeatable until adequate volume is obtained.

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**POSTENUCLEATION/EVISCERATION SOCKET SYNDROME (PESS)** is a well-recognized entity consisting of ptosis, enophthalmos, superior sulcus deformity, and lower eyelid laxity. The best management for PESS is prevention by adequate orbital implant volume at primary surgery; however, the placement of larger implants can result in higher extrusion rates. Even with optimal results, some orbital volume is lost. To our knowledge, we propose a previously undescribed minimally invasive technique to restore orbital volume that has proved to be effective in a pilot study. Radiesse (Bioform Medical, Inc, San Mateo, California) is a widely used filler with Food and Drug Administration approval for functional and cosmetic applications. It consists of 30% calcium hydroxylapatite microspheres (25-45 µm) in a carrying vehicle (1.3% sodium carboxymethylcellulose, 6.4% glycerin, and 36.6% sterile water for injection). In an off-label application, we have successfully injected this product into the medial, inferior, and lateral extraconal orbital space of the orbit to help restore orbital volume.

**METHODS**

A retrospective medical record review was conducted to find patients with PESS who had orbital volume augmentation by injection of calcium hydroxylapatite. The degree of enophthalmos was assessed preoperatively and postoperatively by Hertel exophthalmometry with the prosthesis in place. The sulcus deformity was graded on a scale from photographs obtained before and after the procedure, as described by Kaltreider and Lucarelli, where 0 indicates none; 1, barely perceptible (medial); 2, mild but easily detected (medial); 3, moderate, medial, and central; and 4, severe medial to lateral.

Four patients with PESS were identified who received an injection of calcium hydroxylapatite microspheres (25-45 µm) in a carrying vehicle (1.3% sodium carboxymethylcellulose, 6.4% glycerin, and 36.6% sterile water for injection). In an off-label application, we have successfully injected this product into the...
to the patients on a preoperative visit. Informed consent was obtained from each of the subjects in accord with the principles outlined in the Declaration of Helsinki. The privacy of health information was maintained as stated in the Health Insurance Portability and Accountability Act. The procedure was covered through insurance under Current Procedural Terminology code 67550, orbital implant (outside muscle cone) insertion. Because there is no Healthcare Common Procedure Coding System supply code for injectable calcium hydroxylapatite, reimbursement for the implant was more difficult, with only some insurance companies providing payment.

One of the patients was able to have the procedure performed in an office setting with retrobulbar anesthesia and no sedation. The remainder of the patients had the procedure performed in an ambulatory surgical center with the assistance of intravenous sedation. All patients received an injection of 3 mL of lidocaine hydrochloride, 2%, and 1:100,000 epinephrine directed into the lateral lower eyelid and along the orbital floor. Three patients received 1 vial (1.3 mL) of injectable calcium hydroxylapatite, and 1 patient required 2 vials.

In sockets predominated by downward displacement of the prosthesis, most of the calcium hydroxylapatite was placed inferiorly. Injection was performed using a 27-gauge needle. The needle was passed transcutaneously through the lateral lower eyelid into the extraconal space along the orbital floor (Figure 1). The calcium hydroxylapatite was dispersed in a slow continuous manner along the orbital floor. The needle was redirected several times in an attempt to distribute filler volume across the anterior three-fourths of the orbital floor, with increased volume in the portion of the orbit just posterior to the implant. If axial displacement of the prosthesis was noted, medial and lateral injections along the orbital walls were also performed. We intentionally avoided retrobulbar/intracanal placement out of concern for diminishing prosthesis motility and also avoided injection into the orbital apex for fear of causing a vasovagal response. In addition, it was important to avoid excessively posterior injection to avoid any intravascular placement into the orbital fissures, which could potentially cause a cavernous sinus thrombosis.

RESULTS

The patient group was composed of 3 women and 1 man (mean age, 36 years; age range, 20-51 years) (Table). Indications for enucleation or evisceration included choroidal melanoma in 2 patients, blind painful eye in 1, and microphthalmos in 1. The mean follow-up was 57 weeks (range, 45-71 weeks). Enophthalmos was reduced in all patients, with continued effect observed at almost 1 year or more postoperatively.

Hertel exophthalmometry measurements demonstrated a reduction of enophthalmos ranging from 2 to 5 mm (mean, 2.75 mm). This improvement represents the difference in exophthalmometry assessed at 2 different points. Another way of assessing the degree of change in enophthalmos is to compare the differences between the 2 eyes at the preoperative and postoperative assessments. Such a comparison is more appropriate for what the Hertel exophthalmometer is designed to measure, the difference between 2 eyes, and what is clinically and cosmetically apparent to the patient. When these values are contrasted, the decrease in relative exophthalmos ranged from 1.5 to 5.0 mm (mean, 2.88 mm). There was an observed loss of effect in only 1 patient (patient 2) after 62 weeks of follow-up, and this was minimal (0.5 mm).

The grading of preoperative and postoperative photographs revealed an average score improvement of 2.3 for sulcus deformities (Figure 2). All patients tolerated the procedure well. One patient’s injection (patient 3) was complicated by a peribulbar hemorrhage related to retrobulbar anesthesia administration. This patient responded well to a pressure patch over the orbit for a few days. Most patients noted moderate postoperative pain for several days that was controlled with oral analgesic agents.

COMMENT

To our knowledge, this is the first case series that quantitatively demonstrates the efficacy and longevity of injectable calcium hydroxylapatite, a previously undescribed material, to replace orbital volume in patients with PESS. Other injectable substances that have been discussed in the literature include cross-linked collagen, autologous fat, silicone oil, self-inflating hydrogel pellets, and hard tissue replacement polymer. Tanag and colleagues recently described using injectable calcium phosphate cement in an animal model that proved to be a safe and effective material for orbital volume augmentation. The advantages of calcium hydroxylapatite include ease of application, a biocompatible product, a titratable volume of replacement, and the possibility of successive injections. Furthermore, we believe the procedure meets the qualifications for medical reimbursement for anophthalmic enophthalmos correction.

Our experience with injectable calcium hydroxylapatite for cosmetic applications has typically resulted in long-term retention of less than half of the injected volume, ranging up to 2 years. However, we observed a continued effect with minimal loss of volume in the orbit at 1 year or more postoperatively. There are several possible explanations for the lasting results of calcium hydroxylapatite filler in the anophthalmic socket. There is less movement in the anophthalmic socket compared with the continuous dynamic actions that create facial rhythms. While it may be argued that extraocular muscle movement and eye blinking cause motion in the orbit, the con-
### Table. Patient Characteristics

<table>
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<th>Patient No./Sex/Age, y</th>
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<th>Volume Injected, mL</th>
<th>Before Calcium Hydroxylapatite</th>
<th>After Calcium Hydroxylapatite</th>
<th>Difference (Change), mm</th>
<th>Relative to Fellow Eye, mm</th>
<th>Sulcus Grade</th>
<th>Follow-up, wk</th>
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Abbreviations: BPE, blind painful eye; Hx, history; MM, malignant melanoma; MO, microphthalmos.

**Figure 2.** Preoperative and postoperative clinical appearance of an anophthalmic orbit in 4 patients. A, A 51-year-old woman preoperatively demonstrated 7 mm of anophthalmic enophthalmos, blepharoptosis, and superior sulcus deformity in her left eye. B, The same woman received 2 vials (2.6 mL) of injectable calcium hydroxylapatite, with correction of 5 mm of enophthalmos that has persisted at 71 weeks. C, A 45-year-old woman presented with 4 mm of anophthalmic enophthalmos in her right eye. D, The same woman received 1 vial (1.3 mL) of calcium hydroxylapatite filler, resulting in improvement of superior sulcus deformity and 2.0 mm of enophthalmos correction, with only 0.5 mm of loss noted at 62 weeks. E, A 28-year-old woman had 3 mm of preoperative anophthalmic enophthalmos in her left eye. F, In the same woman, complete correction of enophthalmos, medial filling of the superior sulcus deformity, and improvement of blepharoptosis was achieved with 1 vial of calcium hydroxylapatite filler, with sustained effect seen at 45 weeks. G, A 20-year-old man had 2 mm of anophthalmic enophthalmos in his right eye. H, In the same man, 1 vial of injectable calcium hydroxylapatite was placed, resulting in full resolution of the enophthalmos, lasting through 50 weeks.
fined space of the bony socket provides a different milieu than that of the soft tissues of the face. Moreover, the socket has been further altered by enucleation or evisceration, where blood supply and movement are decreased. The filler is placed in the extraconal space along the periosteum of the orbital walls in orbital fat, where there is little motion effect. Furthermore, the orbit provides a privileged space that lacks lymphatic architecture, thus limiting the removal of filler. In addition, a more robust reaction of collagen formation could hypothetically be occurring in the orbit than elsewhere. Presumably, collagen ingrowth around the microspheres replaces the gel vehicle in the subcutaneous tissues to some degree and occurs in a similar manner in the orbit. 10

Initially, we expected a reduction of approximately 1 mm of enophthalmos per 1 mL of injected calcium hydroxyapatite. The amount of improvement observed, however, surprisingly has yielded up to 2 mm of correction for a 1.3 mL injection. Since this original pilot study, a larger cohort of patients has been treated with similar results, but with less than a year of follow-up. Two of these patients developed edema of the lower eyelid and cheek for several weeks, which spontaneously resolved. An additional patient was noted to have anterior migration of the filler that was palpable in the lower eyelid postoperatively at 4 weeks. This has improved during the last few months and was likely related to suboptimal placement of the injectable calcium hydroxyapatite. We encourage deep placement of the filler along the orbital floor mainly posterior to the implant so that such a complication can be avoided.

An important implication of this study is for the use of filler on other facial sites. Our findings would suggest that injectable calcium hydroxyapatite lasts longer in areas with less movement, blood supply, and lymphatic drainage. This is consistent with our experience using this filler for cosmetic applications in the face. Placing calcium hydroxyapatite filler deep along the periosteum or in fat in facial areas with more movement seems to produce greater longevity than immediately under the skin. For this reason, injectable calcium hydroxyapatite has become our deep filler of choice.

Our pilot study suggests the efficacy, simplicity, and safety of this procedure. When one compares the costs and risks of general anesthesia, deep orbital dissection, and placement of a rigid implant to correct enophthalmos, injectable calcium hydroxyapatite should be the procedure of choice for anophthalmic patients requiring orbital augmentation. This study only reflects our long-term experience with anophthalmic orbits. We anticipate broader clinical uses of the filler and, in fact, most recently performed the procedure successfully in a blind enophthalmic eye. A larger study is under way, with more patients with anophthalmic enophthalmos and with blind enophthalmic eyes, before possibly using the procedure in sighted patients.

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Author Contributions: Study concept and design: White, McCann, and Anderson. Acquisition of data: Vageli, McMullan, Burroughs, and Anderson. Analysis and interpretation of data: Vageli, McMullan, McCann, and Anderson. Drafting of the manuscript: Vageli, McMullan, and White. Critical revision of the manuscript for important intellectual content: Vageli, McMullan, Burroughs, McCann, and Anderson. Statistical analysis: Vageli and McMullan. Administrative, technical, and material support: Burroughs, White, McCann, and Anderson. Study supervision: McCann and Anderson.

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REFERENCES