

Chin Augmentation Using Minimally Invasive Technique and Bioplastique

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The plethora of problematic techniques for improving minor chin recessions has left the plastic surgeon inevitably uncertain of the most effective remedy. Research we began in 1968 has led us to the development of a new biphasic polymer and minimally invasive implantation techniques aimed at solving the soft-tissue deficiency dilemma. Bioplastique consists of inert, textured particles of critical dimension dispersed within a bioexcretable gel vehicle. Previous experimentation in rabbit ears has shown that the gel component is rapidly phagocytosed, excreted, and replaced by a fibrin matrix within 3 days. The matrix is then replaced by host collagen, gradually forming a stable encasement around each microparticle. Further evaluation has revealed that the implant resists migration and absorption. Based on these encouraging results, a clinical phase was initiated. Thirteen patients lacking chin prominence have subsequently been improved with Bioplastique implants. The infection rate was 0 percent, and other complications were minor. At 26 months, no evidence of migration or absorption has been observed, and the aesthetic results remain. (*Plast. Reconstr. Surg.* 95: 985, 1995.)

Evolution of the hominidae skull is clearly marked by an increase in chin protrusion, and we often unconsciously associate lack of dignity and weak character with a small chin.^{2,3} Deficiencies of the chin, moreover, disrupt facial harmony and serve to accentuate other peccadillos, mainly that of an ill-proportioned nose.^{2,6} Most patients, though, are not cognizant of their receding chin, and advancement genioplasty remains one of the few facial ameliorations that the surgeon is justified in recommending to achieve facial balance.^{3,4,6}

Although no mathematical or tangible rule exists, it is generally agreed that the proper chin extends just to the vertical plane dropped from the nasion and perpendicular to the Frankfurt plane, with a slight retraction being accept-

able.^{2,4,5,7} Recessions from this plane have been categorized by the treatments they require.^{2,5} While major retractions present few alternatives to the surgeon other than major maxillofacial surgery, treatment for lesser degrees of micrognathia usually can be achieved with camouflaging techniques.^{2,6,8} The variety of techniques for improving such minor chin deficiencies, however, has left the plastic surgeon with several choices.

Early attempts at small-scale genioplasty utilized "theoretically ideal" autologous or homologous cartilage and bone grafts and continued for many years despite the increased risk of donor-site morbidity and the significant tendency to warp or be absorbed.^{3,4,9,11} Efforts to increase host toleration of collagen through intensified cross-linking and improved irradiation techniques initially appeared to decrease both specific and nonspecific responses.^{11,12} The unnatural rigidity of such implants, however, makes them temporal under the strong molding forces produced by mandibular action.^{4,8,10,11}

Others have channeled their interests into alloplastic prostheses, prompting the early trial of polyethylene and methyl methacrylate implants.^{5,13} Because of their difficulty to fabricate and shape and reports of allergic potential,^{4,14} these were largely abandoned for inorganic counterparts such as Dacron and Teflon and more recently silicone elastomer implants.⁴ Solid silicone rubber became quite popular owing to its high degree of inertness and appeared to simplify augmentation mentoplasty.^{3,4,6,8} A paucity of overlying subcutaneous tissue and vulnerability to osteolytic activity may require

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The senior author has a vested interest in the product.

caution for these solid implants for chin use. They remain popular despite criticisms of bone resorption, malposition, extrusion, excess augmentation, and possible infection.^{3,4,6,15,16}

Many surgeons thus subscribe to Trauner and Obwegeser's¹⁷ sliding osteotomy for even minor augmentations, it appears, to the exclusion of all implant techniques.^{18,19} While such procedures remain effective for treatment of ancillary problems such as asymmetry and vertical excess, inherent within invasive techniques are risks of higher morbidity, infection prolonged over the increased healing time, bone resorption, and less frequent complications such as hypothesia and anesthesia.^{4,6,11,16,18,20}

Reconstituted bovine collagen became available in 1981 for percutaneous injection and eliminated many concerns of invasive techniques. Various primary responses from skin tests have contraindicated the material for 3.2 to 33 percent of test populations.^{12,21} The absorption of the material, moreover, has resulted in repeated application becoming a common method of administration, compounding cost, complications, and scar tissue.^{1,12,21,22} This raises further questions relating to recent studies showing dose-related systemic antibody responses in those multiply injected with collagen, the ramifications of which remain unanswered.²¹

The advent of suction lipoplasty led to several reports of autologous fat injections to correct the ptotic chin. This requires a viable donor site on the patient, however, and longer follow-ups have shown absorption of tissue injected into the facial area in some patients.²³

Silicone fluid has been injected for a number of years peripherally as a lubricant for hypodermic needles, catheters, and other medical devices without adverse reaction.^{16,22,24} Its acceptance for use in soft-tissue restoration, however, has diminished.^{12,22} Although silicone fluid has been shown to be an inducer of host collagen,^{1,25,26} most practitioners have relied on silicone volume for the desired effect, resulting in relatively large doses that subsequently migrated or were absorbed.^{2,21} Efforts to prevent such impermanence included catalyzing the inflammatory response with mild to toxic adjuvants in hopes of minimizing migration.²¹⁻²⁷ It appears that most, if not all, of the ill effects of injected silicone fluid can be traced back to such unscrupulous administration by unknowing, untrained practitioners.^{16,21}

What, then, is the perfect implant, and how

theoretically close to it can we come? According to Krizek,²⁰ it should neither be susceptible to infection nor promote a healing response that would alter its characteristics; it would emulate the tissue it is augmenting, providing, most importantly, a permanent yet removable result. While no such ideal material may ever be found, we have kept such goals in mind in developing a new implant material designed for permanent soft-tissue augmentation achieved through directed, minimally invasive techniques.

It is well known that fibrotic tissue will encapsulate any foreign material that cannot be extruded or absorbed by the body. Our previous work with breast prostheses has shown that irregular surface texturing with inert microparticles promotes random tissue ingrowth while preventing micromotion at the host-prosthesis interface.^{28,29} Dynamic stability is thus achieved by the net "cancellation" of any contractile motions. Other studies undertaken have shown the maximum particle size in cellular uptake of foreign or dead material to be 60 μ m. We established the critical particle size for resistance to phagocytotic activity at 100 μ m or greater in this study.

MATERIALS AND METHODS

With these conclusions and criteria at hand, an injectable biphasic polymer was fabricated for use in augmentation of soft tissue. This material is the same as that described for initial animal experimentation.^{1,30} It consists of solid microparticles between 100 and 600 μ m in diameter, a size too small to be palpably detected yet greater than the critical dimension established. These inert particles were made of fully polymerized and vulcanized solid methyl methylpolysiloxane and prefabricated with a textured surface. They were then suspended in a biocompatible gel vehicle that has been shown previously to be freely transported in the body and excreted unchanged by the kidneys.³¹ This gel has the trade name Au24k and consists of macromolecules from the pladone family, having the empirical formula $(\text{CHCH}_2)_2\text{N}(\text{CH}_2)_s\text{-CO}$. It was polymerized to have an average molecular weight of 13,600 daltons and a viscosity similar to that of honey. The gel polymer was diluted with deionized water to produce an osmotic gradient dissimilar to that of extracellular fluid and was sterilized and placed in cartridges for injection.

Pocar

A special pencil-tipped pocar was developed to establish a highly arrayed network of tunnels within the subcutaneous tissue into which the microimplants could be placed. This instrument allowed us to infiltrate any dense scar tissue present, very difficult with blunt techniques, while preserving noble structures. This prevents damage to tissue and bleeding, which could interfere with placement of the polymer particles.

Cannula

A new injection/dissection cannula was developed with a blunt, bullet-like tip and offset hole on the tapering end. This allows the leading end to push aside arteries, nerves, and veins. The blunt tip occupies more than 50 percent of the cross-sectional diameter of the cannula, and the edges of the hole are deburred and smooth so that center punching is also prevented. This structure thus allows safe and atraumatic insertion movement and continu-

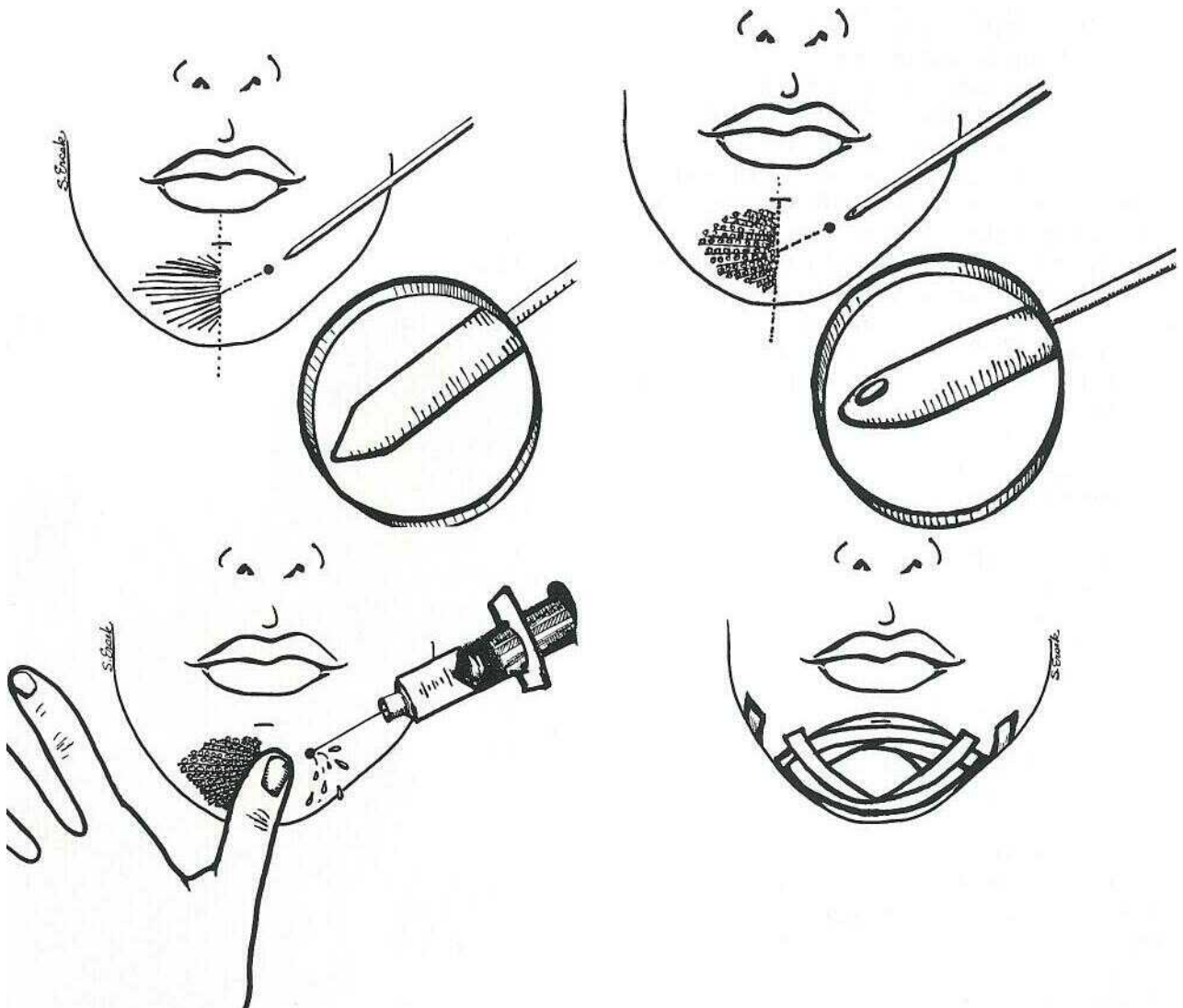


FIG. 1. (Above, left) The initial process of pre-tunneling in a radial fashion from a remote puncture site using the pencil-tipped pocar. By pre-tunneling the half opposite the entrance site, the instrument remains at or just above the level of the periosteum. (Above, right) Precise placement of the particles using the blunt cannula. By mimicking the path and technique of the pocar while in constant motion and with slight trigger pressure only on withdrawal, particles are evenly distributed within the highly arrayed network of tunnels well beneath the dermis. (Below, left) By holding digital pressure over the midline while rinsing the remote puncture site and "no man's land" with local anesthesia, retention of particles within the wound itself is prevented. (Below, right) Immobilization of the area from the sublabial crease to the submandibular ridge allows an even diffusion of particles within the augmentation area.

ous, undisturbed placement of the microparticle-gel mixture upon withdrawal movement.

Injection Gun

A special highly leveraged injection ratchet mechanism with a significant mechanical advantage was constructed to be compatible with both cartridge and cannula. This gun allows increments as small as 0.03 cc to be expressed through the cannula hole.

Procedure

The procedure was systematized for each patient, although amounts of Bioplastique varied as needed. After careful demarcation of the proposed augmentation site, noting the midline, the entire area was injected with Xylocaine 1% with epinephrine 1:100,000, providing the local block needed as well as full hemostasis. This was done as close to the periosteum as possible, since minimal bleeding is required at the intended plane of injection.

A remote puncture was then achieved with a 20-gauge sharp needle on each side of the pogonion, peripheral to the outlined area, so that 1 to 2 cm of "no-man's land" isolates the puncture sites from the area of implantation. Pretunneling was then performed using the pencil-tipped pocar of equal gauge. This was done initially in a radial fashion originating from the puncture site and extending to the periosteum in a manner such that the right half was pretunneled from the left entrance site, and vice versa (Fig. 1, *above, left*). These tunnels were then crisscrossed. Pretunneling was done in various planes, but care was taken to keep these near the periosteum. The best results were obtained by creating a total of 30 to 40 tunnels, concentrating them in the central portion of the chin, and tapering their depth and distance laterally.

The microparticles were then implanted from the same remote puncture site by means of the injection gun. Injection was done only on withdrawal, mimicking the path and technique of the pocar and injecting only to the midline (Fig. 1, *above, right*). The cannula was kept in constant motion, and trigger pressure was gently maintained on withdrawal such that a 0.1-cc volume injection was 30 cm in length. Thus, for the chin illustrated (Fig. 1) with an injection portion of 2 cm in length (midline to periphery), 15 or 20 passes of the cannula would constitute one pull of the trigger.

These methods allow precise and even placement of the microparticles at the intended

plane and prevent deposition near the puncture site, which could impede healing of the dermis and result in palpable elevations. Such techniques also provide a maximum host-prosthesis interface and a minimum of beading or coalescing of these particles (Fig. 2).

After injection, the pressure is released in the gun and the cannula quickly withdrawn. Digital pressure is applied to the midline while the puncture site and "no man's land" are rinsed with local anesthesia to further prevent extrusion (Fig. 1, *below, left*).

The chin is then splinted with suture strips to immobilize the area from the sublabial crease to the submandibular ridge (Fig. 1, *below, right*). Patients are instructed to use digital manipulation to dissociate any palpable irregularities discovered during the first postoperative week.

Removal

Bioplastique can be removed by one of two methods. Because the microimplants induce individual encasements of host connective tissue,

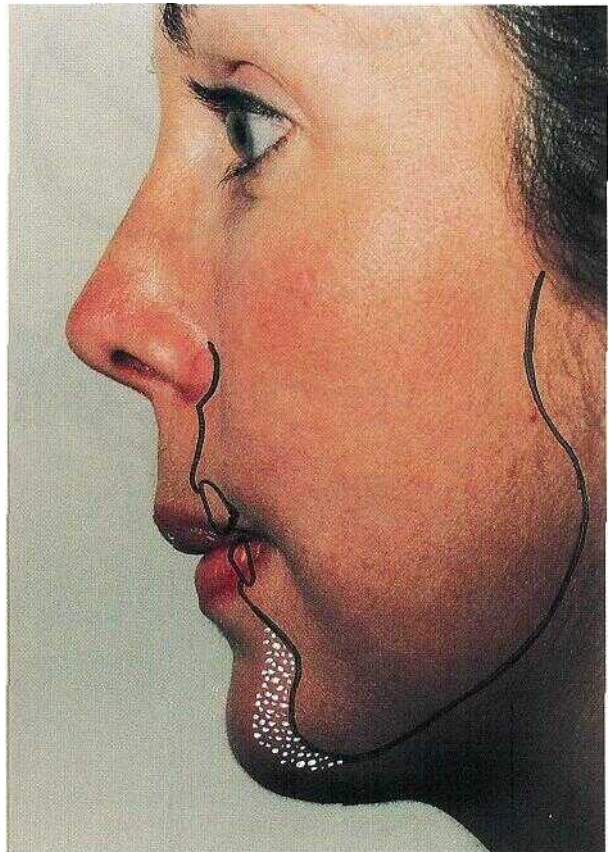


FIG. 2. The techniques employed provide a minimum of beading or coalescing of the particles and a maximum host-prosthesis interface. The resulting increase in tissue mass is a combination of Bioplastique and the patient's own connective tissue.

TABLE I
Procedures and Results

Patient	Supplementary Procedures	AMT:Bp (cc)	Complications	Remedy
1		2		Sharp microsuction
2		1		
3	Bp to lips, chin; SAL to neck; rhinoplasty; lower bleph; brow lift	1.6		
4		1		
5	SAL to neck	2	Asymmetry after 2 cc	Reinjected 0.3 cc
6		1	Asymmetry	Digital manipulation
7		.3		
8	Rhinoplasty		—	—
9		.6		
10	Lower blepharoplasty, septoplasty	2		
11	Rhinoplasty, SAL to neck	2	—	—
12	Brow lift	1		
13	Removal of orbital prosthetic disk	2	—	—

the blunt suction technique is not a reasonable method for removal. However, by using an 18-gauge or larger sharp needle and by rotating the needle while passing through the area of excess augmentation, tissue samples can be removed readily and safely. We have used these techniques in the patients described herein and in about 100 patients for other anatomic defects. Alternatively, Bioplastique can be removed by direct excision of the particles with their surrounding scar capsule or by a needle biopsy method.

Follow-Up

Patients were followed at 1 and 6 weeks, 3 and 6 months, and biannually. All patients in this

study have been registered by the author with the Implant Registry in Torrance, Calif. This registry is a worldwide nonprofit service operated 24 hours a day so that patients or their physicians can obtain their medical history or details specific to implant surgery. The Implant Registry also contacts patients every 6 months so that proper correspondence with our patients in the future is possible.

All our chin augmentation patients are included in this series; they are consecutive.

RESULTS

Thirteen patients have received a total of 18.2 cc of Bioplastique in 14 injections on an exper-



FIG. 3. Patient 3. (Left) This 38-year-old woman had microgenia and thin lips; supplemental procedures were lower blepharoplasty, rhinoplasty, brow lift, and dermabrasion to the chin. (Center) Patient is seen 13 months after application of Bioplastique to the chin and 1 month after application of Bioplastique to the lips. (Right) Here the patient is seen 3 years after Bioplastique application to the chin and 2 years after Bioplastique application to the lips.

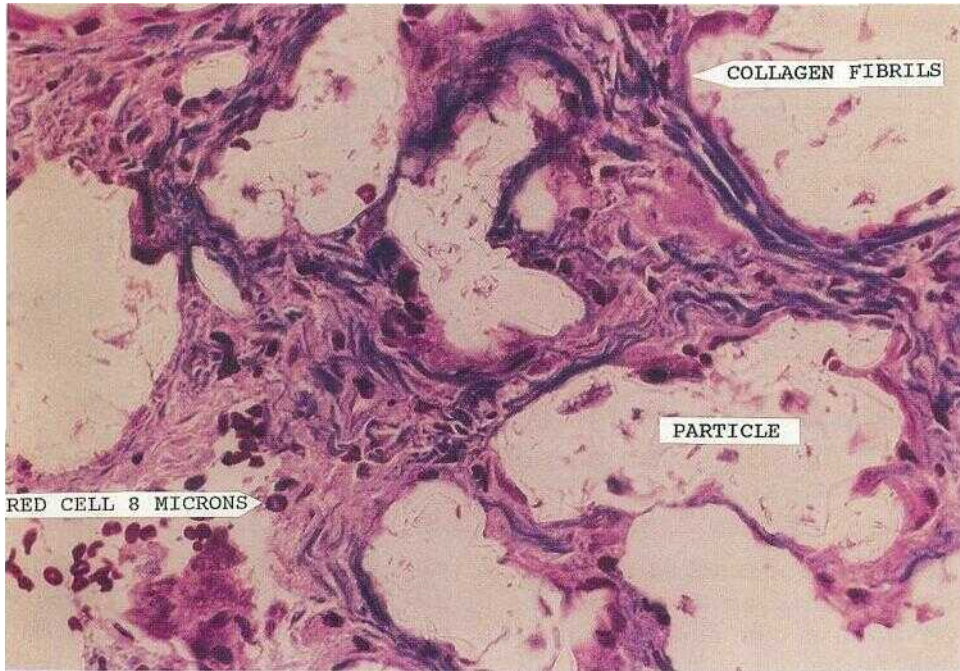


FIG. 4. Bioplastic microparticles seen at $\frac{1}{2}$ years of implantation. Each particle is surrounded by its own host-prostheses interface of host collagen. All particles are contained within the implantation site.

imental basis beginning in April of 1989 (Table I). Several augmentations were performed in conjunction with other facial cosmetic proce-

dures to maximize the enhancement, all on an outpatient basis. The infection rate has been zero to date. A persistent swelling in the chin of

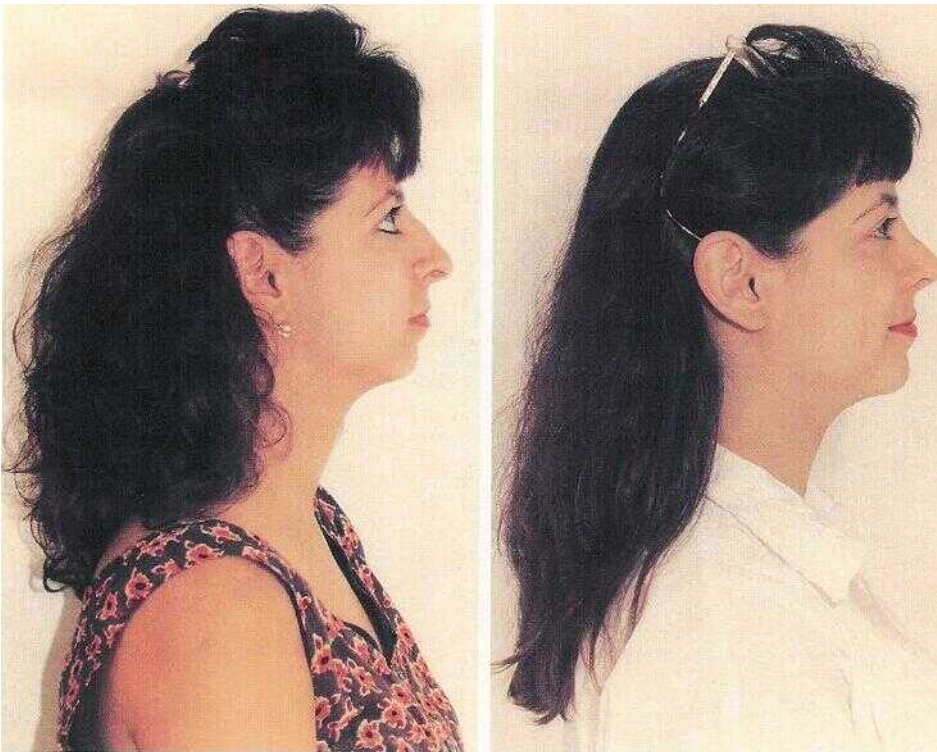


FIG. 5. Patient 8. (Left) This 26-year-old woman had micrognathia and an enlarged nose. (Right) Patient is seen here 6 months after injection of 2 cc of Bioplastic to her chin and supplemental rhinoplasty.



FIG. 6. Patient 10. (Left) This 38-year-old woman is seen preoperatively with microgenia and lower blepharoclasia. She also suffered from a deviated septum with airway obstruction. (Center) Patient is seen here 3 months after injection of 2 cc of Bioplastique to her chin, lower blepharoplasty, and septoplasty. (Right) Patient is seen here at 2 years and 9 months postoperatively.

our first patient warranted culture on several occasions; however, all such cultures were negative. Removal of some of the Bioplastique was indicated a few months thereafter for this patient when the chin appeared to her to be too prominent. After injection of 2 cc into the chin of another patient, the left lateral portion was thought by her to be too defined. Therefore, a small amount (0.3 cc) of Bioplastique was added 1 cm below the nasolabial fold to create a smooth, symmetrical mandibular line. Uneven diffusion was reported by a third patient but was easily resolved with minimal digital pressure within 1 week of implantation.

Aesthetic improvement was thus eventually achieved for all patients, and all such final results have remained permanent and asymptomatic to date, 60 months maximum.

DISCUSSION

The aesthetic improvements seen in our patients (Figs. 3 through 6) clearly are not the direct result of the relatively small amount of solid material implanted. It is based on the principle that any foreign material that cannot be absorbed, dissolved, or extruded by the body (all previous complications) will naturally be isolated and encapsulated by host connective tissue. By fabricating solid macroparticles of a specific size and injecting them beneath the soft tissue of the chin, this macroimplant neither migrates nor is absorbed, dissolved, or extruded. Consequently, the particles are surrounded by a fibrous capsule. It is this encapsulation process that is stimulated in a

predictable manner that enhances the augmentation. By dispersing the particles within the gel and then injecting this in a highly arrayed manner at the augmentation site, the greatest dynamic transition between the carrier gel and host connective tissue is achieved. The gel vehicle is therefore quickly displaced by the patient's own serum, the fibrinogen forming a stable fibrin matrix within 3 days. Fibroblasts attach to each particle, and host collagen begins forming at 1 week. Thus patients have a 1-week window period to mold the implant to desired form. The use of highly inert and textured particles, moreover, allows ingrowth of each thin capsule, resulting in multiple, small, stable encasements. While 60 months is too soon to draw definitive conclusions, it appears that Bioplastique neither is susceptible to infection nor promotes an adverse healing response and provides a permanent yet removable soft-tissue augmentation.

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