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Integration of Mandibular Osteogenesis with Percutaneous Radiofrequency to Contour Lower Face and Neck

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Abstract

Surgical techniques for temporary implantation of the electrical field-generating chin implant and percutaneous radiofrequency-induced tissue tightening have previously been described. The purpose of this study was to determine if a combination of the technologies to first, induce sustainable intramembranous bone remodeling, and second, treat neighboring tissue with liposuction and radiofrequency treatment is feasible, effective and safe. Six patients with mandibular hypoplasia, microgenia, submental and submandibular fat deposits, and excessive laxity of skin underwent surgical implantation of the battery-operated "chin-implant," which generates negative polarity electrical pulses. After 12 months, satisfactory change of chin contours was induced and implants were removed. Cephalometric controls taken 3 to 6 months later showed an average increase of mandibular length 5.26 mm. Once sustainable bone remodeling was demonstrated, patients were subjected to the second stage of lower face contouring: Super wet syringe assisted liposuction and percutaneous radiofrequency treatment with generator inserted through existing liposuction stab-incision. Subcutaneous tissue in the vicinity of the previous electrical field was liposuctioned in the same fashion as tissue not subjected to electrical field. No complications occurred in any of six patients. There were no cases of skin burns or seroma formation. Correction of the flaccid skin was striking in all cases with progressive tissue contraction and tightening that plateaued in two months. This study provides an encouraging option in contouring the lower face and neck, as it offers strengthening of bone lines, increased projection, change of soft tissue tone, and contour refinement with improved aesthetic line definition.

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Introduction

The safety and efficacy of induction of appositional mandibular bone growth by electrical field and liposuction, combined with application of percutaneous energy to produce tissue tightening has been demonstrated in animal studies and clinical trials and reaffirmed by clinical practice [1,2]. Such methods allow for refinement of the jawline and cervico-mental angle, and enhancement of chin projection. Because electric and thermal fields may affect physical characteristics of surrounding tissue, it is prudent to assess if fascial, subcutaneous fat, and skin will respond in the same manner to liposuction and radiofrequencies as "intact" tissue, not previous affected by electrical signals, would [3,4]. This study was undertaken to determine if both technologies and techniques can be safely integrated and if radiofrequencies can be effective following bone remodeling and soft tissue exposure to electrical field [5].

Material and Methods

Six female patients with a mean age of 20 years (range 15 to 25 years) were included in the study. Inclusion criteria were mandibular hypoplasia and microgenia with normal occlusion, submental fat deposit, and poor lower jaw line definition. The procedures performed in this study were in accordance with the ethical standards of the Investigational Review Board of Jalisco Institute for Reconstructive Plastic Surgery and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed Consent Informed consent was obtained from all patients before being enrolled in the study.

In the first stage of lower face contouring, the modulator was implanted. The technique was similar to the technique for the insertion of an alloplastic permanent chin implant *via* submental incision [1]. The active plate delivered negative polarity pulses with the following characteristics: Frequency 4 Hz, pulse amplitude -1000 mV, pulse width 1.5 milliseconds (Figure 1). The hermetically

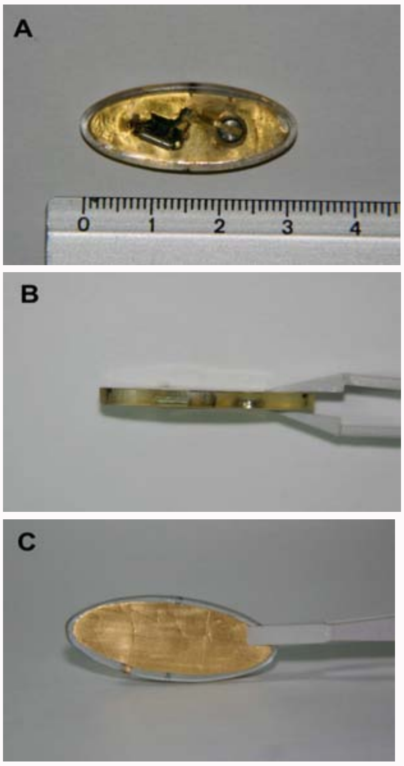

Figure 1: The osteogenesis modulator: a) exposed battery and high-performance circuitry overlying 0.1 mm thick medical gold plate connected to the circuitry, b) side view with visible circuitry, c) top view.

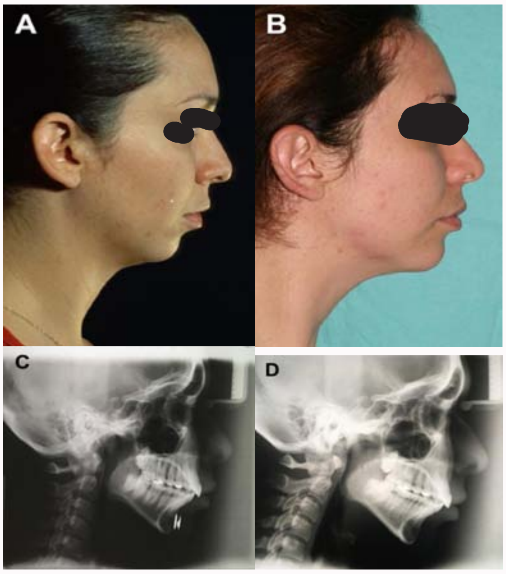

Figure 2: Twenty-five-year-old female underwent chin bone modulation and rhinoplasty: A) Preoperative profile view. B) Postoperative profile view, 18 months after modulator removal. C) Preoperative cephalographic image. D) Postoperative cephalographic image, 18 months after modulator removal. In this case, the modulator was in place for 12 months.

sealed "chin implant" could operate continuously for up to 18 months. Temporary implantation of the electrical field-generating implant produced sustainable growth of intramembranous bone. It was removed when chin projection was increased to the level of patients' preference, typically 6 to 12 months after implantation (Figure 2). Then implant was removed allowing submental

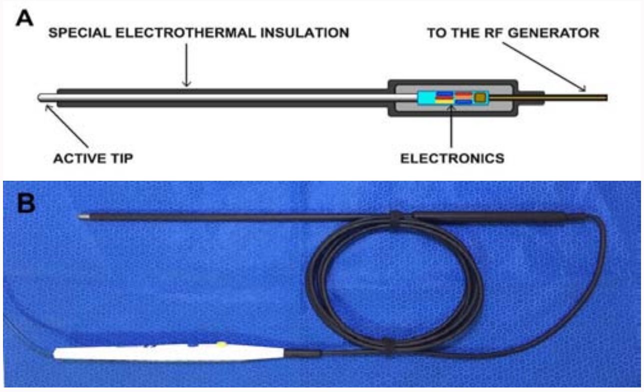

Figure 3: The percutaneous radiofrequency device. A) Schematic diagram of the device. B) Intraoperative photo of Acewand Face electrosurgical unit.

liposuction and submental and/or submandibular triangle treatment with radiofrequencies (Figure 3, 4). Two consecutive steps were undertaken after bone modulator removal. First, a super-wet syringe-assisted liposuction of the treatment area was performed, followed by percutaneous radiofrequency application with 150 kHz to 1 MHz frequency range. The radiofrequency emitting device rod was passed along marked tracks (6 mm to 8 mm apart), then the Acewand Face (San Diego, CA, USA, Guadalajara, Jalisco, Mexico) (electrosurgical unit set at 15 watts output, coagulation mode, was activated and the rod was withdrawn at a sustained speed of 1 cm/second [2,6].

Results

When the modulator was removed the average increase in mandibular length (cephalometrically assessed distance between the articulare and pogonion landmarks) was 5.26 mm (range from 2.83 mm to 7.6 mm) [7,8]. The average increase in soft tissue chin "envelope" projection was approximately 90% of the thickness of added bone length by appositional growth (average 4.7 mm, range 2.5 mm to 6.8 mm) (Figure 2). Liposuction was performed without technical problems and radiofrequency application with strict

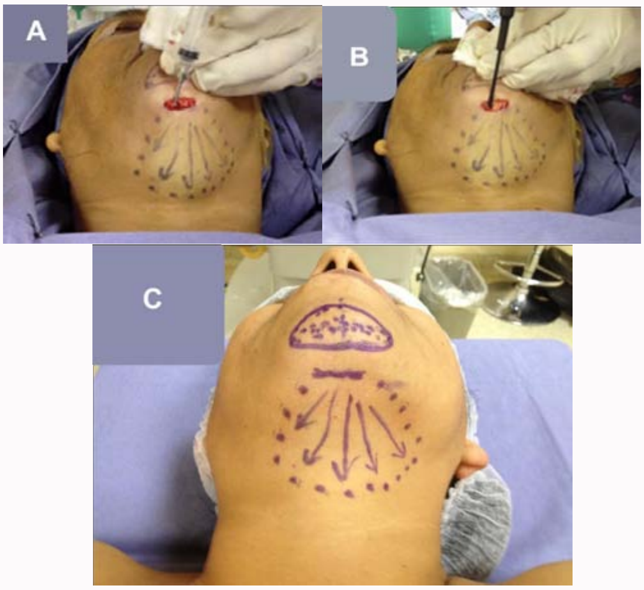

Figure 4: Patient admitted for removal of the modulator and A) submental area liposuction, followed by B) radiofrequency treatment. C) The immediate outcome.

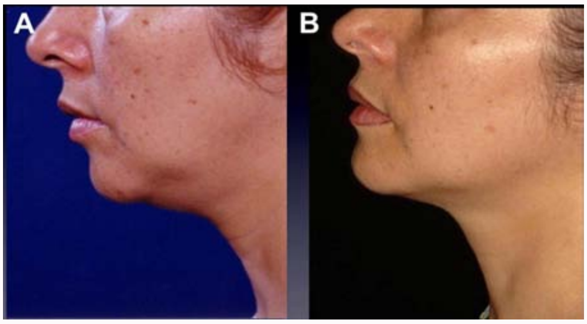

Figure 5: Twenty-year old female with poor chin projection, poorly defined jaw lines and stable body weight. A) Prior to implantation of osteogenesis modulator. B) Postoperative view after 18 months after modulator removal and radiofrequency treatment of the area of submandibular triangles. In this case, the modulator was placed for 12 months.

Figure 6: 19-year-old female patient with chin hypoplasia and relatively poorly defined jaw line. A, C) Pre-operative appearance. B, D) 18 months after removal of the osteogenesis modulator and radiofrequency treatment of both submental and mandibular triangle areas. In this case, the modulator was placed for 6 months.

adherence to the principle of maintaining sustained speed of rod passage resulted in uniform skin and subcutaneous contraction and tightening. Improved contour of jaw lines and cervicomental angle was notable within days after the procedure in each case. After approximately three years follow up, early clinical results were maintained, without evidence of bone resorption, changes in occlusion, area innervation, external skin surface characteristics or any other adverse effects (Figure 5, 6).

Discussion

Poor jaw line definition is a relatively common problem affecting not only aging individuals, with lower face soft tissue shifting down and obfuscating the jaw line, but also young individuals or even children born with small lower jaw. Deficiency in volume and projection of the chin only enhances the aesthetic problem of poor jaw line definition [8]. Skeletal osteotomies and rearrangements often trade one visual deficiency for another, perhaps increasing projection but leaving gaps and bony surface irregularities at osteotomy sites. For this reason, "substance" addition to the chin or mandibular angle is intuitively chosen as a solution, but not free of problems related to implants [8,9].

Alternatively, soft tissue sculpting by lifting procedures or use of tissue fillers and soft tissue tightening alone to improve lower facial contours produce limited, inconsistent, frequently non-sustainable results, often with adverse effects [10].

Such limitations made the concept of integrating "programmable" and sustainable autologous bone osteogenesis and soft tissue sculpting by liposuction and tissue tightening appealing for lower facial and neck contouring.

Traditionally, electrical field generating devices were researched and applied to stimulate long bones healing [11]. It was even stipulated that strategies developed for stimulation of long bones, which develop and heal by endochondral ossification, may not be suitable or directly applicable for intramembranous bones [12]. Investigations into the effects of electrical field induced stimulation of osteogenesis by intramembranous type of bone were limited to models with osteotomized or surgically disrupted bone (e.g., for implants placement) [12-14]. Thus, the use of the same intervention for aesthetic purposes was attractive, given the ability to generate new facial bone *de novo* and add to the existing surface of intact bone, without simultaneous resorption, by apposition [1,15]. Our studies and clinical observations prove it that this is possible [1]. Although osteogenesis and chin remodeling by means of the electrical field takes time, the final outcome can be determined by shared decision making with the patients, and ultimately the implant is removed, leaving only native bone as the end result. Obviously, this novel application of the electrical field to "programmable" build-up of intramembranous bone does not have to be limited to the chin. Potential applications of and indications for programmable remodeling of facial skeleton with osteogenesis may include facial masculinization, malar enhancement, balancing of facial or cranial contours after orthodontic treatment, or craniofacial surgery [15,16].

In this study, for practical purposes, only candidates for chin enhancement and subsequent area soft tissue modifications were selected to allow for investigation of the safety and efficacy of integration of combined techniques (osteogenesis and soft tissue contouring). Results indicate that liposuction and radiofrequency therapy can be effective after bone remodeling and soft tissue exposure to electrical field. Programs integrating bone remodeling with refinements provided by soft tissue treatments open new horizons not only for aesthetic, but also reconstructive surgery.

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