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A Preliminary Report of Percutaneous Craniofacial Osteoplasty in a Rat Calvarium

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ABSTRACT

Objectives: To evaluate the potential for injectable, permanent bone augmentation by assessing the biocompatibility and bioactivity of subperiosteal hydroxylapatite (Radiesse) deposition in a rat model.

Methods: Fourteen adult Sprague Dawley rats were injected in the parietal skull with 0.1 ml of HA (n=10) or a carrier gel control (n=4), using a subperiosteal injection technique on the right and a subcutaneous injection technique on the left. At 1, 3, and 6 months, 3 rats (1 negative control, 2 variables) were sacrificed. At 12 months, the remaining 5 rats were sacrificed. After each harvest, the calvaria were examined under both light and polarized microscopy.

Results: The inflammatory response was limited in all specimens. Injectables were still present 12 months after the injection. New bone formation was only seen when the injection was located deep to a disrupted peristeme. The odd of new bone formation was 48.949 times higher in the parietal skull with 0.2 ml of HA (n=10) vs a carrier gel control (n=4). Under high power, new bone was seen above the HA spherules in this 1

INTRODUCTION

Presently, calcium phosphate cements (CPC), such as hydroxylapatite (HA), are commonly used for the repair of bone defects. Favorable characteristics of CPC include customizability, isoelectric setting, biocompatibility, and bioactivity (resorption is coupled with bone formation). Hydroxylapatite, which is the chemical properties pertaining to setting, open exposure is required to remove the injectable. Therefore the application of CPC is reserved for large defects, such as those that result from tumor extirpation or extensive trauma. However, injectable cements are often faced with smaller craniofacial defects that are of aesthetic concern to the patient but do not warrant the morbidity of open craniofacial reconstruction. Because injectable cements are often faced with craniofacial defects that are of aesthetic concern to the patient but do not warrant the morbidity of open craniofacial reconstruction.

RESULTS

Histologic data are summarized in Table 1. While multineucleated giant cells were often present (Figure 2), only minimal histitis was noted in the specimens. Seven (2 carrier, 5 HA) out of 13 subperiosteal injections were found to be deep to a disrupted peristeme, while the remaining 6 rats were not to be subperiosteal, though they were considered “subperiosteal” (n=4) for the purposes of statistical analysis. Furthermore, any specimen without an identifiable injectable (subperiosteal injection site in specimen 12 and both sites in specimen 13) were excluded.

A multinucleated giant cell is depicted in this high power micrograph. A multinucleated giant cell is often present (Figure 2), and are typically found to be subperiosteal.Histologic data are summarized in Table 1. Table 1. Summary of binary data. The presence of pericranial disruption and new bone formation is indicated with a (+). HA = hydroxylapatite (Radiesse)

Table 1. Summary of binary data. The presence of pericranial disruption and new bone formation is indicated with a (+). HA = hydroxylapatite (Radiesse)

Table 2. Summary of binary data for rate of new bone formation, grouped by all combinations of injection plane and injectable. SC=subcutaneous, SP=subperiosteal, HA=hydroxylapatite (Radiesse)

DISCUSSION

The odd of new bone formation in the subperiosteal HA injection group was 48.949 times higher than the other 3 combinations in aggregate (95% CI (2.637, 735.961), p = 0.002). The marginal effect of subperiosteal injection was also significant. In 1 of 2 rats with successful subperiosteal carrier injections, reactive bone was present at the time of harvest. This rat, specimen 7, was sacrificed at 6 months (Figure 3). Reactive bone was not seen in the absence of HA. Reactive bone was not seen in the absence of HA.

Refinements in the technique for subperiosteal injection are desired. In our study, a larger scale is warranted to better elucidate the stimulus for the osteoactivity we observed histologically.

REFERENCES


 Minor deformities of the craniofacial skeleton can be quite bothersome aesthetically to patients. Radiesse provides an ideal option for reconstruction. To our knowledge, no one to date has examined the histologic effects of Radiesse injection at the bone level. We have now shown that Radiesse is biocompatible and long-lasting subperiosteally. In designing the study, we did consider the fact that the trauma of pericranial disruption could trigger osteoactivity and therefore confound results. We attempted to control for this with the carrier only injections; hypothesizing that new bone formation would be either absent or less pronounced without HA.

Furthermore, our technique for pericranial disruption was only successful 54% of the time. Consequently, the numbers for truly subperiosteal HA and carrier injections were simply too low to demonstrate a statistically significant difference in the rate of new bone formation between the two. Notably, though, the odd of new bone formation in the subperiosteal HA injection group was significantly higher than the aggregate of all other combinations of injection plane and injectable.

We also attempted to show that the plane of injection seems to be critical in any effort to induce osteoactivity as none of the subcutaneous injections could trigger osteoactivity and therefore confound results. We attempted to control for this with the carrier only injections; hypothesizing that new bone formation would be either absent or less pronounced without HA.

Radiesse is a biocompatible and long-lasting subperiosteal injectable. Unfortunately, our technique for pericranial disruption was only successful 54% of the time. Consequently, the numbers for truly subperiosteal HA and carrier injections were simply too low to demonstrate a statistically significant difference in the rate of new bone formation between the two. Notably, though, the odd of new bone formation in the subperiosteal HA injection group was significantly higher than the aggregate of all other combinations of injection plane and injectable.