Hydroxyapatite Powder Coating: A Technique for Long-Term Visualization of Soft-Tissue Grafts Following Tegmen Repair

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Introduction

Postoperative imaging following tegmen repair may identify persistent bone defects despite adequate repair with non-radiopaque materials. Our institution utilizes a 3-layer repair technique whereby autologous bone is placed between 2 layers of acellular dermis (AD). To enhance postoperative visualization on CT scans, we developed a novel method of coating the AD with hydroxyapatite (HA) powder prior to implantation. The goal of this study was to determine the duration of graft visibility on CT following tegmen repair.

Methods

A single-center, retrospective cohort study was performed on a convenience sample of 100 patients who underwent tegmen repair by the senior author between September 2021 and July 2024. Postoperative temporal bone CT scans were analyzed in the coronal plane with Visage Imaging software. A circular region of interest tool set at 1.5 mm^2 measured radiodensity (in Hounsfield units) at 3 distinct locations on the superior layer of AD (**Figure 1**), as well as on the contralateral, non-operative side. The average density of each side was converted to a relative value by dividing AD density by contralateral density. Linear regression analysis was then used to determine trends in graft density over time.

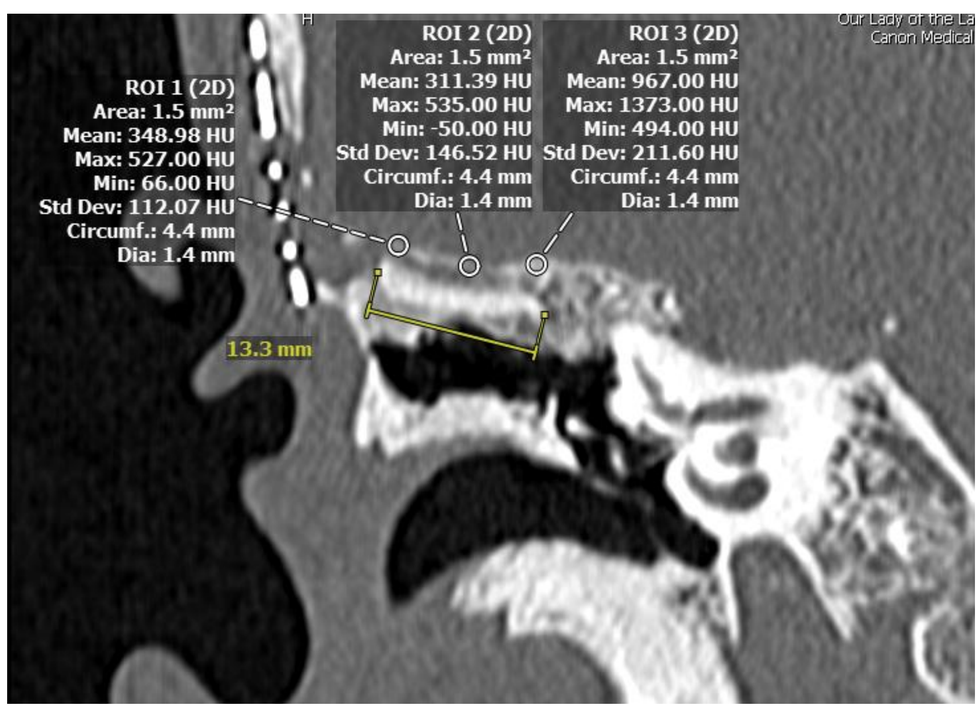

Figure 1: Representative CT temporal bone in coronal plane showing radiodensity measurements at three distinct locations (medial edge, middle, lateral edge) along the superior layer of the graft.

Results

In the 100 cases (85 patients), 65% were female, 57% left-sided, and average age at time of surgery was 57 years. All procedures received a postoperative CT on day 1, with average radiodensity of the HA-coated AD being 285 HU (range 79 HU to 733 HU). Of the 70 cases with contralateral data on day 1, the **average relative density of the graft was 6.38** (range 1.32 to 28.51, where "1" represents no difference from the non-operative side). Subsequent imaging was available in some cases up to 28 months after surgery. Regression analysis showed **no significant difference in relative density over time** (slope = -0.05; 95% CI -0.15 to 0.05; t_{125} = -1.00; p 0.32; y=-0.05x+6.39; r^2 = 0.32, **Figure 2a**). Further analysis also showed no significant difference in relative density change over time (slope = 0.09; 95% CI -0.13 to 0.30; t_{55} = 0.81; p 0.42; y=0.09x-1.47; r^2 = 0.42, **Figure 2b**).

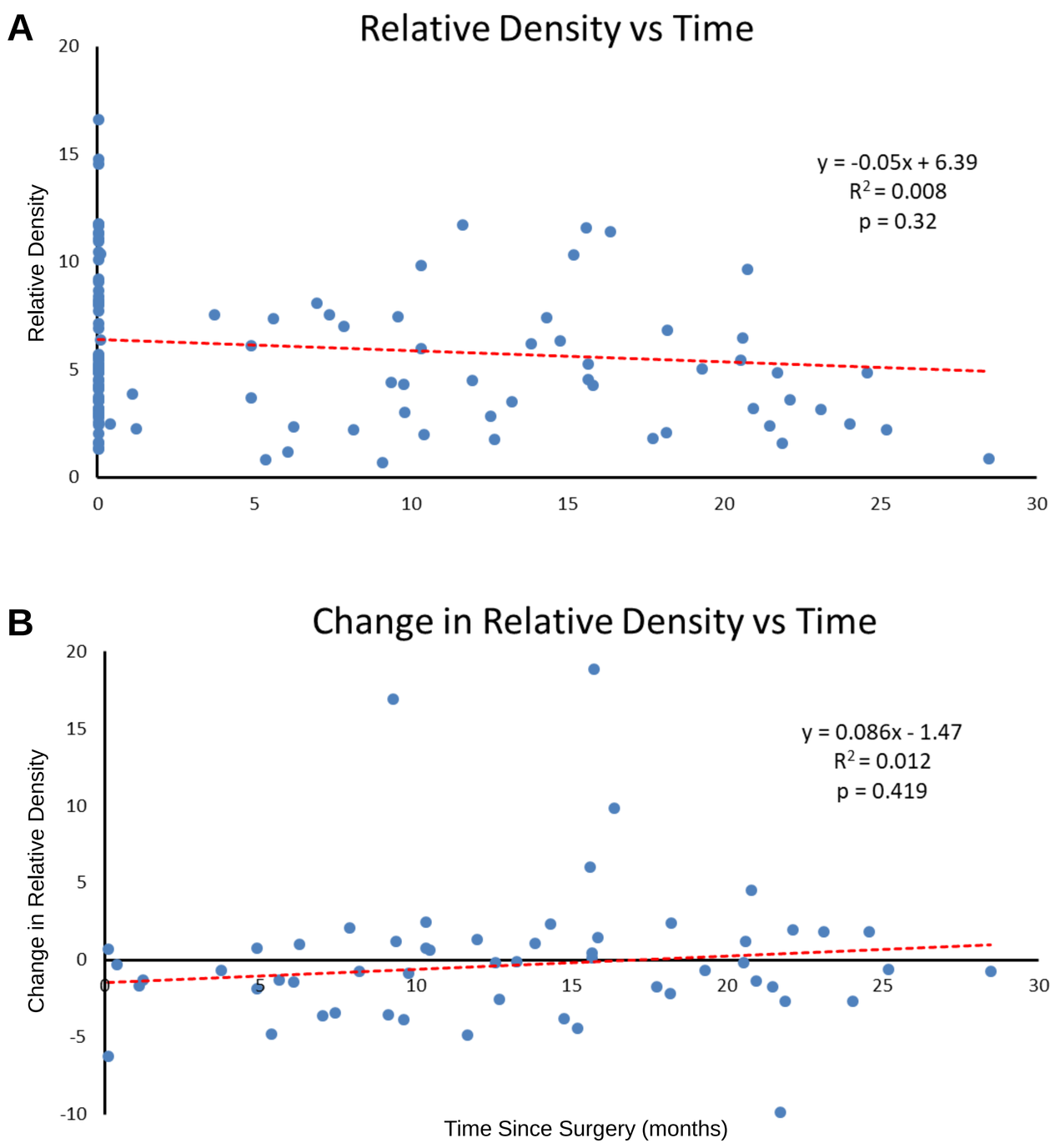

Figure 2: (A) Scatter plot of relative density over time with trend line showing no significant difference. Three outliers (0.03, 28.51; 9.27, 25.26; and 15.73, 26.85) are excluded from the figure. (B) Scatter plot of change in relative density over time with trend line showing no significant difference. A single outlier (9.8, -25.5) is excluded from the figure.

Conclusion

Coating AD with HA powder at the time of surgery leads to adequate visualization on CT for at least 2 years. Such HA-coating strategies can be considered for any dural repair material which would be particularly valuable for properly diagnosing recurrence of encephaloceles in patients previously operated elsewhere.