

Revolutionizing Bone Regeneration: A Comparative Study of TOM Formulations vs. Traditional Grafting Materials

Sean Mojaver DDS¹; Yu Cheng Chang DMD, MSoB¹; Michael Brown PhD²; George Kay DMD, MMSc²; Hector Sarmiento DMD, MSc^{1,3}; Joseph Fiorellini, DMD, DMSc¹

¹ Department of Periodontics, School of Dental Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, USA,

² RevBio, Lowell, MA

³ Private Practice, New York, New York, USA



Revolutionizing Bone Regeneration: A Comparative Study of TOM Formulations vs. Traditional Grafting Materials



Sean Mojaver DDS¹; Yu-Cheng Chang DMD, MSOB¹; Michael Brown PhD²; George Kay DMD, MMSc²; Hector Sarmiento DMD, MSc^{1,4}; Joseph Fiorellini, DMD, DMSc¹

Background

Despite advancements in dental technologies, existing materials face limitations and potential complications. Tetracalcium phosphate combined with O-phospho-L-serine, known as Tetranite (TN), has emerged as a promising material due to its unique properties. As a cohesive and adhesive compound, TN can stick to itself and to bone, making it highly versatile. Studies have been conducted in medical settings for cranial flap fixation, in veterinary practices for socket preservation to prevent mandibular fractures, and in dentistry for implant stabilization and bone grafting.

Aim

To compare the effectiveness of four different formulations of TOM against conventional grafting materials in healing critical-sized defects in rat mandibles. The study seeks to evaluate the bone formation capabilities, maintenance of position, form, and volume, and the rate of material resorption of TOM-based grafts with different porosities compared to standard materials.

Treatment Group	% Porosity
TOM250	0-5%
TOM250G	23%
TOM250GP	27%
TOM300	25%
BG (Bioglass)	N/A
DCBBM	N/A

Table 1 – Treatment Groups and Porosities

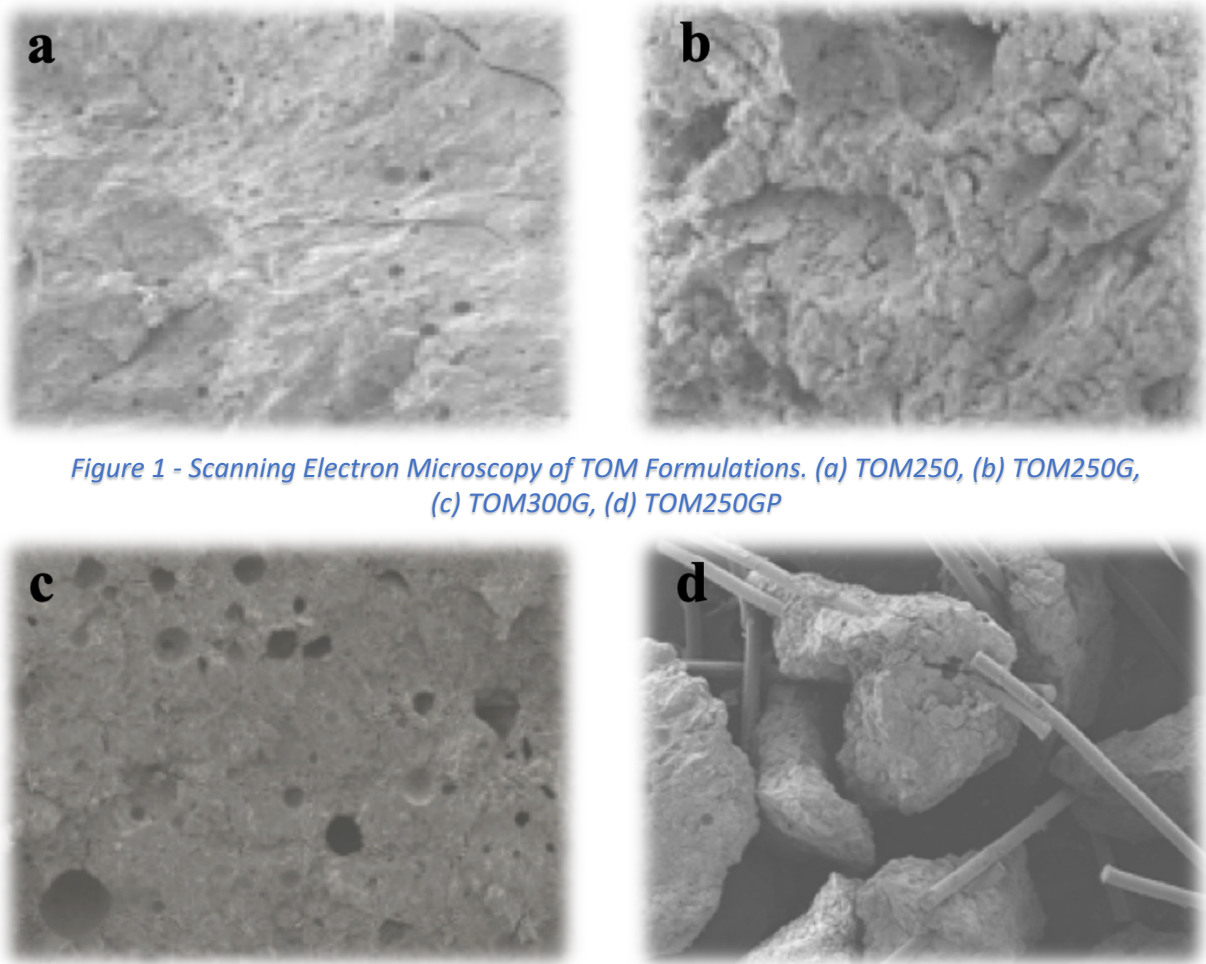


Figure 1 - Scanning Electron Microscopy of TOM Formulations. (a) TOM250, (b) TOM250G, (c) TOM300G, (d) TOM250GP



Revolutionizing Bone Regeneration: A Comparative Study of TOM Formulations vs. Traditional Grafting Materials



Sean Mojaver DDS¹; Yu-Cheng Chang DMD, MSOB¹; Michael Brown PhD²; George Kay DMD, MMSc²; Hector Sarmiento DMD, MSc^{1,4}; Joseph Fiorellini, DMD, DMSc¹

Materials & Methods

Adult male Sprague-Dawley rats were assigned to six cohorts, including four TOM formulations (TOM250, TOM250G, TOM250GP, TOM300G) and two conventional materials (Bioglass, BG; deproteinized bovine bone, DCBBM). Under anesthesia, a standardized 5mm defect was created in the rat mandibles, filled with the formulations, and closed. Postoperative care included analgesics for three days. At 4 and 12 weeks, animals were euthanized for micro-CT and histologic analyses. Micro-CT assessed bone fill, cortical presence, and graft containment, while Image-J software evaluated biomaterial integration within the defect sites. Statistical significance was determined using Student's t-tests and ANOVA, with $p < 0.05$ indicating significance.

Results

Statistical analysis revealed significant differences in bone formation among the groups. At 4 weeks, TOM-based grafts demonstrated superior performance with mean radiographic bone formation scores: TOM250 (2.3), TOM250G (2.0), TOM250GP (2.7), and TOM300 (2.3) compared to BG (1.5) and DCBBM (0.5), with P values less than 0.05 indicating statistical significance. By 12 weeks, histomorphometric analysis showed significant variation in new bone formation: TOM250 ($37.5\% \pm 6.5\%$), TOM250G ($33.2\% \pm 18.5\%$), TOM250GP ($17.6\% \pm 8.3\%$), TOM300 ($28.7\% \pm 8.6\%$), BG ($36.8\% \pm 21.7\%$), and DCBBM ($40.7\% \pm 9.8\%$). The data highlighted a significantly higher performance in bone regeneration and graft resorption for TOM250 and TOM250G, while TOM250GP and TOM300 showed less effectiveness.

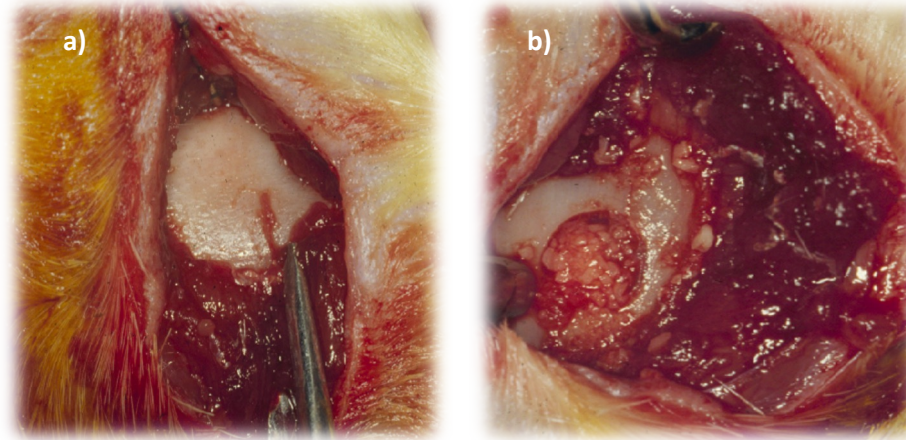


Figure 2 - Rat Mandible

a) = defect creation
b) = graft insertion

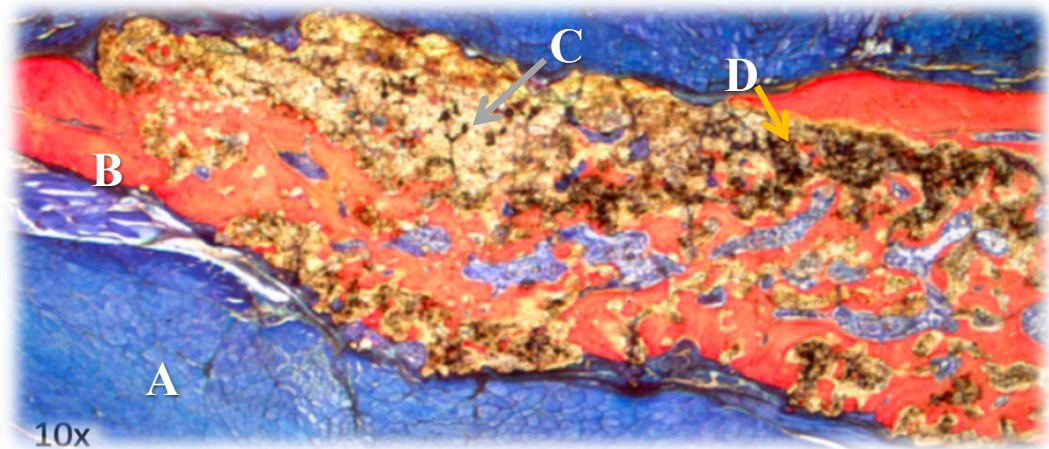


Figure 3 - TOM250 at 12 weeks (A = original bone, B = regenerated bone, C/D = Tetranite)



Revolutionizing Bone Regeneration: A Comparative Study of TOM Formulations vs. Traditional Grafting Materials

Sean Mojaver DDS¹; Yu-Cheng Chang DMD, MSOB¹; Michael Brown PhD²; George Kay DMD, MMSc²; Hector Sarmiento DMD, MSc^{1,4}; Joseph Fiorellini, DMD, DMSc¹

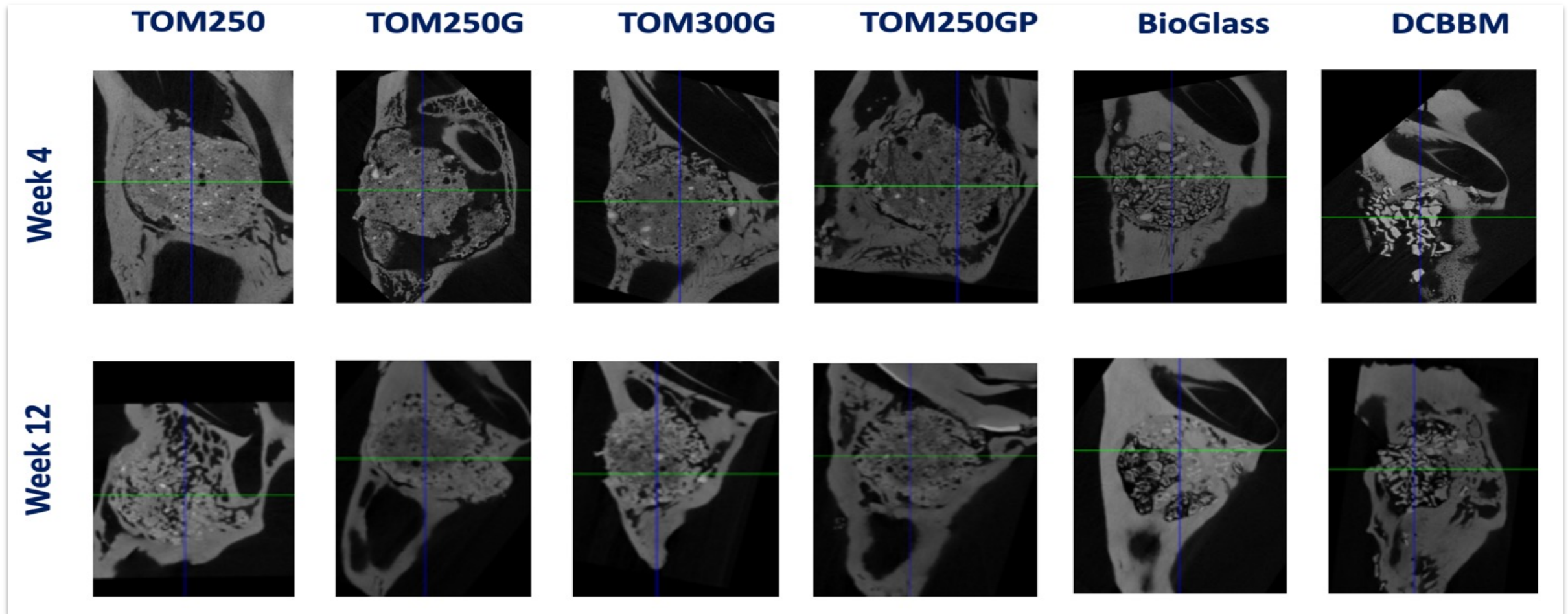


Figure 4 – MicroCT analysis of different formulations at 4 and 12 weeks



Revolutionizing Bone Regeneration: A Comparative Study of TOM Formulations vs. Traditional Grafting Materials

Sean Mojaver DDS¹; Yu-Cheng Chang DMD, MSOB¹; Michael Brown PhD²; George Kay DMD, MMSc²; Hector Sarmiento DMD, MSc^{1,4}; Joseph Fiorellini, DMD, DMSc¹

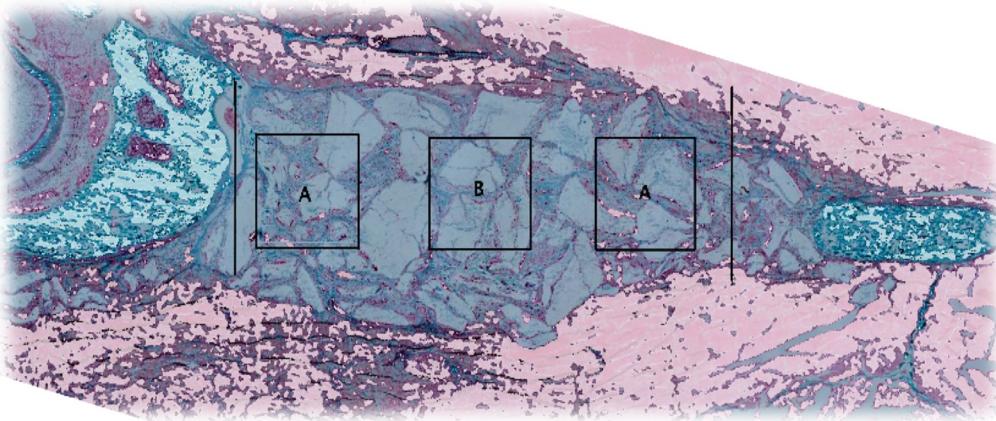


Figure 3 - Regions of interest (ROI) for histomorphometric evaluation - BioGlass Histomorphometry at 12 weeks with color threshold set for the biomaterial (A = Periphery ROI, B = Center ROI)

Conclusion

The findings of this study highlight the enhanced bone regenerative potential of TOM formulations compared to traditional grafting materials, demonstrating significant improvements in bone fill and structural integrity. These results suggest that TOM could revolutionize the approach to dental bone grafting, offering a more effective and reliable solution for complex bone regeneration needs.

Histologic Bone Formation within Surgical Defect (12 weeks)

ROI	TOM250	TOM250G	TOM250GP	TOM300	BG	DCCM
Center	18.2 ± 6.1	29.7 ± 6.9	5.6 ± 3.7	19.9 ± 4.1	25.8 ± 20.1	43.4 ± 24.2
Periphery	48.3 ± 28.9	52.2 ± 25.3	35.8 ± 28.0	35.6 ± 20.3	46.8 ± 23.4	31.2 ± 25.1
Total	37.5 ± 6.5	33.2 ± 18.5	17.6 ± 8.3	28.7 ± 8.6	36.8 ± 21.7	40.7 ± 9.8

Remnant Graft Material within Surgical Defect (12 weeks)

ROI	TOM250	TOM250G	TOM250GP	TOM300	BG	DCCM
Center	59.7 ± 18.2	42.1 ± 25.4	93.9 ± 29.4	73.4 ± 30.1	42.1 ± 28.3	57.8 ± 16.2
Periphery	43.3 ± 18.5	44.3 ± 12.0	84.6 ± 32.2	67.3 ± 20.4	44.4 ± 13.9	55.2 ± 19.0
Total	34.4 ± 20.1	28.8 ± 13.6	60.2 ± 34.3	47.1 ± 21.7	32.3 ± 14.9	37.5 ± 20.2

Table 2 - Image-J Analysis of pixel density for each study formulation

References:

1. Norton, M.R., et al., Bone glue - The final frontier for fracture repair and implantable device stabilization. International Journal of Adhesion and Adhesives, 2020. 102: p. 102647.
2. Xia, P. and Y. Luo, Vascularization in tissue engineering: The architecture cues of pores in scaffolds. J Biomed Mater Res B Appl Biomater, 2022. 110(5): p. 1206-1214.
3. Kesseli, Fioleda P., Caroline S. Lauer, Ian Baker, Katherine A. Mirica, and Douglas W. Van Citters. "Identification of a calcium

phosphoserine coordination network in an adhesive organo-apatitic bone cement system." Acta biomaterialia 105 (2020): 280-289.

4. Cochran, David L., Archie A. Jones, Ryushiro Sugita, Michael C. Brown, Hari Prasad, and George W. Kay. "Twelve-month evaluation of a novel mineral-organic adhesive material used to stabilize dental implants placed in oversized osteotomies in vivo in an animal model." Clinical oral implants research 33, no. 4 (2022): 391-404.