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Histologic and micro-computed tomography confirmation of cementogenesis over calcium-enriched mixture cement in a human permanent tooth

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Calcium–enriched mixture (CEM) cement is a bioactive calcium-silicate-based material with demonstrated sealing ability, antibacterial properties, and biocompatibility.[1] While multiple animal studies and clinical outcomes suggest its capacity to promote hard tissue formation, such as osteogenesis, dentinogenesis, and cementogenesis with periodontal regeneration, direct histological evidence for cementum formation in human teeth has remained elusive due to ethical and practical limitations in tissue retrieval. Intentional replantation provides a unique opportunity to observe hard tissue responses in a controlled clinical setting.[2,3] This case report documents, for the first time, histologic and micro-computed tomography (micro-CT) confirmation of cementogenesis over CEM cement in a human permanent tooth following 10 years of functional service.

In 2014, a 41-year-old female presented with pain in the left maxillary first molar (tooth 26), which had previously undergone root canal treatment and complex prosthetic rehabilitation including prefabricated metal posts in the mesiobuccal and distobuccal roots, a fiber post in the palatal root, and a PFM crown. Clinical and radiographic examination revealed symptomatic apical periodontitis (Fig. 1A). Considering the restorative complexity and presence of posts, non-surgical endodontic retreatment was not feasible. Intentional replantation was proposed and performed under standard protocol. Root-end resection/preparation and root-end filling with CEM cement (~3 mm) was carried out extraorally within 12 min, followed by atraumatic reinsertion (Fig. 1B). Postoperative healing was uneventful. Periodic follow-ups over the next 10 years demonstrated complete resolution of symptoms, radiographic evidence of complete periapical healing (Fig. 1C), and excellent clinical function.

In 2024, the patient presented with an acute abscess associated with the adjacent second molar. Severe vertical bone loss and tooth resorption were noted around the distobuccal root of the first molar, prompting its extraction (Fig. 1D). The tooth was fixed in 10 % buffered formalin for microscopic and histological evaluation. The extracted tooth was examined under an operating microscope, and a hard, translucent layer was observed over the root-end

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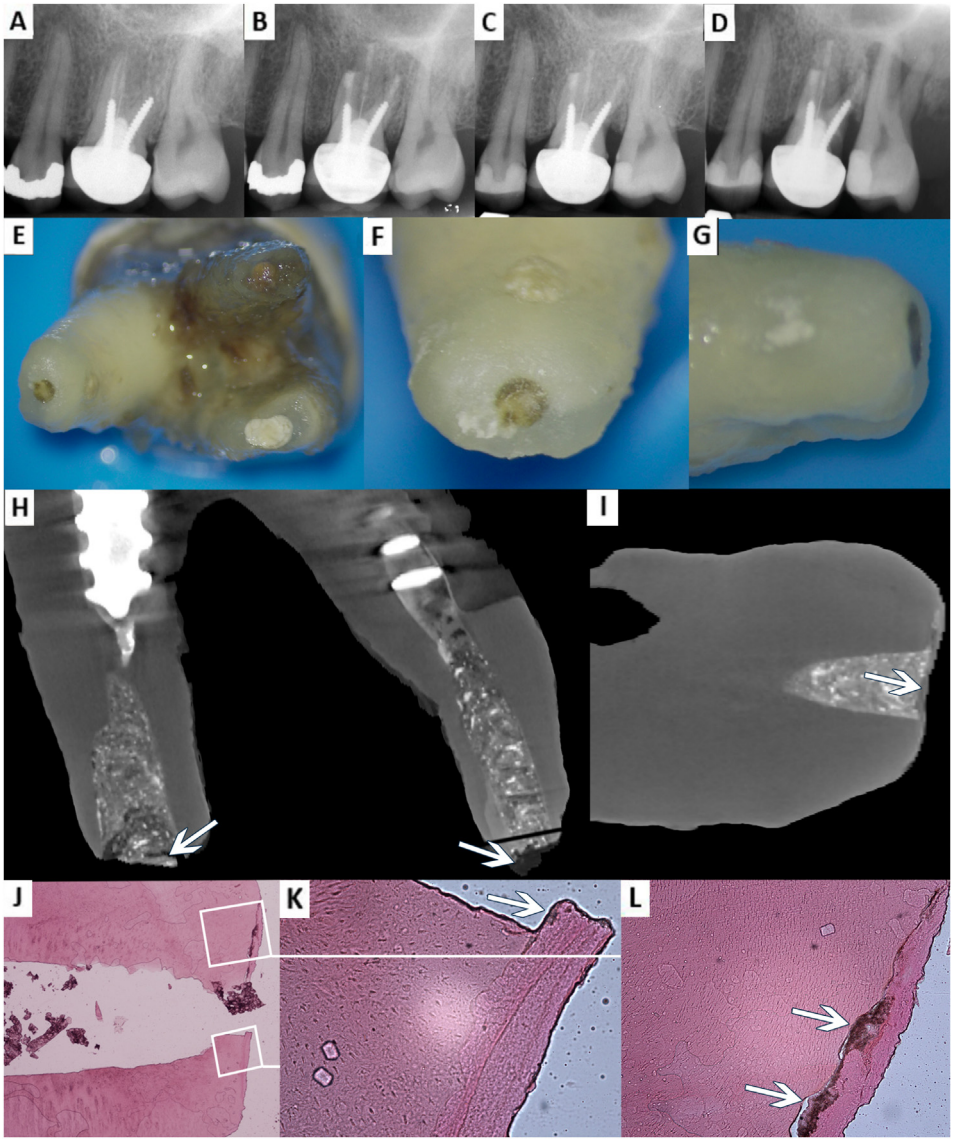

Figure 1 Radiographic, microscopic, micro-CT, and histologic findings of the intentionally replanted maxillary left first molar with CEM root-end filling. (A) Preoperative radiograph showing apical periodontitis in tooth 26 with previous endodontic treatment and prosthetic rehabilitation. (B) Immediate postoperative radiograph following intentional replantation with root-end filling using CEM cement. (C) A five-year follow-up radiograph demonstrating complete periapical healing. (D) Pre-extraction radiograph showing severe vertical bone loss and root resorption around the same tooth. (E) Extracted tooth under surgical microscope, revealing a hard, translucent layer over the root-end filling. (F, G) High magnification views confirm a smooth, mineralized surface on the resected palatal root-end. (H, I) Micro-CT cross-sections showing a mineralized layer with cementum-like density and morphology over the root-end and root-end filling material (white arrow). (J) Histologic section (H&E stain) showing acellular cementum deposited over resected dentin and residual CEM fragments of the palatal root. (K) Cementum formation directly over CEM cement (white arrow). (L) Entrapped CEM particles within the newly formed cementum layer, confirming cementogenesis over both dentin and biomaterial (white arrows).

filling material (Fig. 1E), which was confirmed with further magnification (Fig. 1F and G). Micro-CT analysis confirmed the presence of a mineralized layer with density and morphology consistent with cementum (Fig. 1H and I). Histological sections (H&E stained) demonstrated cementum formation over the resected dentin surface (Fig. 1J and K), cementogenesis directly over the CEM cement (Fig. 1K), and entrapment of small residual CEM fragments between newly deposited cementum layers (Fig. 1J and L). The newly deposited hard tissue exhibited typical features, consistent with acellular cementogenesis.

This evidence confirms that CEM cement as root-end filling can serve as a scaffold for true cementum formation in human permanent teeth. These findings constitute the first direct human histologic evidence of cementogenesis over a calcium-silicate-based cement. While animal studies and in vitro investigations have supported the cemento-inductive potential of CEM (with normal PDL),[1,4,5] this case

offers real-world clinical and histological validation. The presence of cementum bridging over both dentin and CEM surfaces confirms biocompatibility and regenerative integration of this biomaterial within the periapical environment. The long-term clinical success further underscores the relevance of CEM in root-end surgeries and intentional replantation.

Declaration of competing interest

The authors have no conflicts of interest relevant to this report.

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NA.

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