Endodontics in the era of hydraulic materials

A number of materials with a range of chemistries are used in dentistry. These materials are inert and disintegrate when wet, and thus need a dry operating field. These characteristics have shaped our clinical procedures, leading to the use of rubber dam, three-in-one syringes and high vacuum suction devices, drying with ethanol and other efficient barriers to moisture contamination. The need to have a material that does not disintegrate when placed in wet conditions was first addressed in the mid-1990s by Mahmoud Torabinejad from Loma Linda University in the USA with the introduction of Portland cement for use as a dental filling material[1,2]. A personal communication with the late Prof Tom Pitt Ford (King's College London), who was both my and Torabinejad's PhD supervisor, revealed that the invention of such a material was related to the ability of Portland cement in concrete to withstand wet environments (Pitt Ford T, personal communication, 2002). Torabinejad investigated the use of Portland cement as a root-end filling material and to repair root perforations[3,4], as both environments are naturally wet. A radiopacifier, bismuth oxide, was added because the cement could not be detected on radiographs[5], which made postoperative assessment difficult. The mixture of Portland cement and bismuth oxide was named mineral trioxide aggregate (MTA), bearing the inventor's initials. It is worth noting that the use of Portland cement in dentistry dates back to the 19th century, with German clinicians Witte and Schlenker[6,7] reporting its use mixed with other additives for endodontic procedures.

I was introduced to research on MTA in 2003, when I started my PhD and received a commonwealth scholarship to spend a year in the United Kingdom. My PhD work involved the development of a fast-setting cement to be used as a core build-up material for vital teeth. It was while working on this project that I realised that in addition to having the ability to be used in wet environments, Portland cement also produces calcium hydroxide when it hydrates[8]. Endodontists have now changed their practice, using hydraulic materials that hydrate and interact with the environment in which they are placed. Now, rather than inert and dry, we have started embracing wet and interactive. The microbiological properties of materials are more appreciated, and endodontists' primary interest is moving away from leakage and sealing ability towards a biological approach. Vital pulp therapy and management of immature teeth with regenerative endodontic procedures has become increasingly popular. Together with other advances like the use of magnification, ultrasonics and nickel-titanium, hydraulic cements have caused our clinical practices to evolve significantly.

It is a pleasure to be the guest editor for this special issue on hydraulic cements. I have chosen authors who have made a great contribution to the literature on the use of hydraulic cements in endodontics. The papers provide an overview of the different clinical procedures and how the development and introduction of hydraulic cements has impacted endodontic practice. The aim of these articles is to guide clinicians and make best practice recommendations for the use of these materials, linking the science to clinical practice. In the first article, Stéphane Simon, who has been instrumental in researching vital pulp therapy, offers an overview of pulp capping, pulp chamber pulpotomy and pulp vitality preservation[9]. The use of hydraulic cements has also led to problems with tooth discolouration, and this clinically relevant topic is discussed by Noushin Shokouhinejad, focusing on regenerative endodontic treatment[10]. The third article, contributed by the German team of David Donnermeyer, Till Dammaschke and Edgar Schäfer[11], addresses the current debate about the methods used in root canal obturation and whether it is time to adopt an easier obturation method requiring less armamentarium, such as single-cone obturation with hydraulic calcium silicate–based sealers, raising the question of whether such sealers are a game changer in root canal obturation.

To return to my favourite subject, I teamed up with Carlos Aznar Portoles to write an article on the challenges involved in using hydraulic cements for root-end filling[12]. For more complex cases, the Italian group (some of whom are now based in the UK) of Federico Foschi, Massimo Giovarruscio, Angelo Zavattini and Riccardo Tonini provide an overview of how to use hydraulic cements for reparative procedures[13]. The area in which these cements have changed clinical practice significantly is paediatric endodontics, with the old techniques using toxic chemicals having been replaced with more biologically based practices. This is discussed in the final article by Saeed Asgary, Ghassem Ansari, Sara Tavassoli-Hojjati, Alireza Sarraf Shirazi and Ardavan Parhizkar[14], who have been at the forefront of material development and testing in the last two decades.

I have invited the best clinicians and researchers from all over the world to contribute to this special issue. Understanding hydraulic cements and the best way to use them is essential to achieve high clinical success rates, and we can hope to see a paradigm shift in endodontic practice in the near future.

Josette Camilleri, BChD, MPhil, PhD
Guest Editor
Reader in Applied Endodontic Materials,
School of Dentistry, University of Birmingham,
Birmingham, United Kingdom

References

1. Torabinejad M, White JD [inventors]. Loma Linda University, assignee. Tooth filling material and method of use. US patent 5,415,547. 23 April 1993.
2. Torabinejad M, White JD [inventors]. Loma Linda University, assignee. Tooth filling material and method of use. US patent 5,769,638. 16 May 1995.
3. Lee SJ, Monsef M, Torabinejad M. Sealing ability of a mineral trioxide aggregate for repair of lateral root perforations. J Endod 1993;19:541–544.
4. Torabinejad M, Watson TF, Pitt Ford TR. Sealing ability of a mineral trioxide aggregate when used as a root end filling material. J Endod 1993;19:591–595.
5. Shah PM, Chong BS, Sidhu SK, Ford TR. Radiopacity of potential root-end filling materials. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1996;81:476–479.
6. Witte. The filling of a root canal with Portland cement. German Q Dent; J Central Assoc German Dent 1878;18: 153–154.
7. Schlenker M. Das füellen der wurzelkanäle mit Portland-Cement nach Dr Witte. Deutsche Vrtljschr F Zahnh 1880;20:277–283.
8. Camilleri J, Montesin FE, Brady K, Sweeney R, Curtis RV, Pitt Ford TR. The constitution of mineral trioxide aggregate. Dent Mater 2005;21:297–303.
9. Simon S. Pulp capping, pulp chamber pulpotomy and pulp vitality preservation. ENDO EPT 2020;14:175–185.
10. Shokouhinejad N. Endodontics in the era of hydraulic calcium silicate cements: special focus on tooth discolouration following regenerative endodontic treatment. ENDO EPT 2020;14:187–195.
11. Donnermeyer D, Dammaschke T, Schäfer E. Hydraulic calcium silicate–based sealers: a game changer in root canal obturation? ENDO EPT 2020;14:197–203.
12. Camilleri J, Aznar Portoles C. Clinical perspective on hydraulic materials developed for root-end surgery. ENDO EPT 2020;3:205–216.
13. Giovarruscio M, Tonini R, Zavattini A, Foschi F. Reparative procedures for endodontic perforations: towards a standardised approach. ENDO EPT 2020;14:217–228.
14. Asgary S, Ansari G, Tavassoli-Hojjati S, Sarraf Shirazi A, Parhizkar A. Clinical applications of hydraulic calcium silicate–based biomaterials in paediatric endodontics. ENDO EPT 2020;14:229–241.