Why Biphasic? Assessment of the Effect on Cell Proliferation and Expression

*Pierre Schembri-Wismayer, MD, PhD,** *and Josette Camilleri, BChD, MPhil, PhD, FICD, FIMMM, FADM†*

Abstract

Introduction: Tricalcium silicate (TCS)–based materials are used in endodontics because they are hydraulic and interact with blood, tissue fluids, and phosphate-based root canal irrigants, resulting in biomineralization. Newer-generation materials are biphasic; calcium phosphate is added to the TCS; thus, the material has 2 cementitious phases. The effect of this addition is not known; thus, the aim of this study was to characterize biphasic cements and assess cellular proliferation and expression. **Methods:** TCS cement mixed with calcium phosphate monobasic or hydroxyapatite in 1:1 proportion was prepared. The powders and the mixed cements soaked in Hank's balanced salt solution for 28 days were characterized by scanning electron microscopy (SEM), energy-dispersive spectroscopy, and X-ray diffraction analysis. Ion leaching was investigated using inductively coupled plasma mass spectroscopy. Cellular interaction with material leachate was investigated by exposing human primary osteoblasts to the leachate from the cements. Cell growth and proliferation were determined using methyltetrazolium assay and SEM. **Results:** The addition of a calcium phosphate phase to tricalcium silicate changed the material hydration with a reduction in pH and calcium ion release in the leachate when calcium phosphate monobasic was added. No crystalline calcium hydroxide was formed for both biphasic materials. The biphasic cements exhibited a reduction in cell growth and proliferation. SEM of the materials showed heavy carbonation of the material surface caused by processing for microscopy. **Conclusions:** The addition of a second cementitious phase results in modification of the hydration characteristics of TCS cement with deterioration of material and biocompatibility properties. *(J Endod 2017;■:1–9)*

Key Words

Cell viability assay, characterization, dental material, leaching, primary osteoblasts

Significance

Endodontic materials that use a combination of calcium phosphate and tricalcium silicate show a modified hydration process. There is a reduction in the formation of crystalline calcium hydroxide and deterioration in the biological properties of the material.

Tricalcium silicate–based materials are used as bone cements and also in endodontics. Their main attraction lies in their hydraulic nature; their interaction with the environment in which they are placed is a function of the calcium hydroxide produced as a by-product of hydration (1, 2). Tricalcium silicate–based materials interact with tissue fluids and phosphate-based solutions, precipitating a calcium phosphate phase on the material surface (3–5). In contact with dentin, the materials cause dentin bridge formation (6, 7) and react with the dentin walls, forming a mineral infiltration zone, which has been verified in both dentin replacement materials (8) and root canal sealers (9).

Some materials based on tricalcium silicate include another cementitious phase such as calcium sulphoaluminate and calcium fluoraluminate cement (10, 11), tricalcium aluminate (12, 13), calcium sulfate (14, 15), and calcium phosphate (16–18). The second cementitious phase is added to enhance the material properties. In fact, improved physical (10, 11, 13) mechanical (10, 11), chemical (19), and biological (14–17) properties have been described. However, some additions may affect the hydration mechanisms of tricalcium silicate, particularly the precipitation of calcium hydroxide (10), thus compromising the biological properties of the material (20).

Biphasic cements using a combination of tricalcium silicate and a calcium phosphate phase (calcium phosphate monobasic) are clinically available for endodontic use as EndoSequence BC materials, which exist in premixed injectable forms as root canal sealer and root-end filling paste and putty. EndoSequence BC (Brasseler, Savannah, GA) materials exhibit high calcium ion release (21, 22), bioactivity (22, 23), and excellent biological properties (24–30). When compared with monophasic materials like mineral trioxide aggregate (MTA), biphasic materials (EndoSequence BC) showed reduced biological compatibility (27, 29) particularly in the early phases (26) and bioactivity in biomimetic solutions (22, 23). Conversely, other studies showed similar (24) or higher bioactivity of EndoSequence BC (28) when compared with MTA. In addition, intracanal placement of MTA compared with EndoSequence BC resulted in a higher pH in simulated root resorption defects that was time and root level dependent (30), thus indicating that the hydration mechanisms may have been altered by the biphasic cement as the pH was reduced.

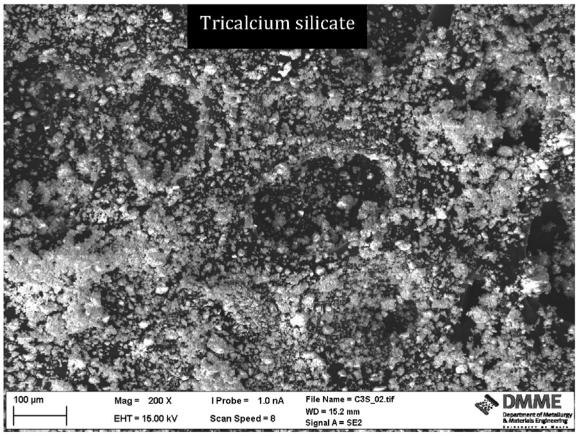
From the literature reviewed, it does not seem clear whether adding a second cementitious phase to tricalcium silicate modifies the hydration and is thus beneficial to the biological properties of the resultant material. The aim of this study was to

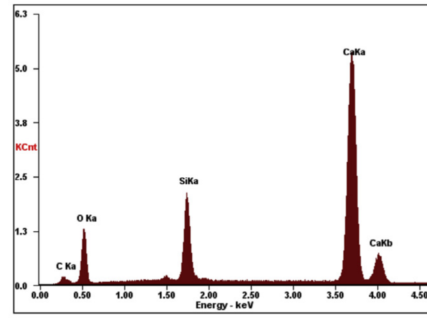
From the *Department of Anatomy, Faculty of Medicine and Surgery and †Department of Restorative Dentistry, Faculty of Dental Surgery, University of Msida, Malta.

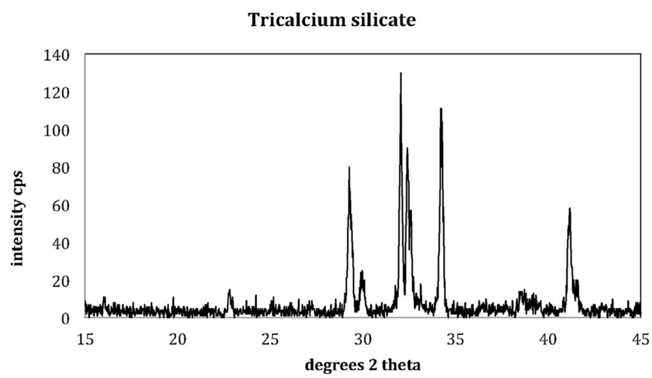
Address requests for reprints to Prof Josette Camilleri, Department of Restorative Dentistry, Faculty of Dental Surgery, University of Malta, Medical School, Mater Dei Hospital, Msida MSD 2090, Malta. E-mail address: josette.camilleri@um.edu.mt

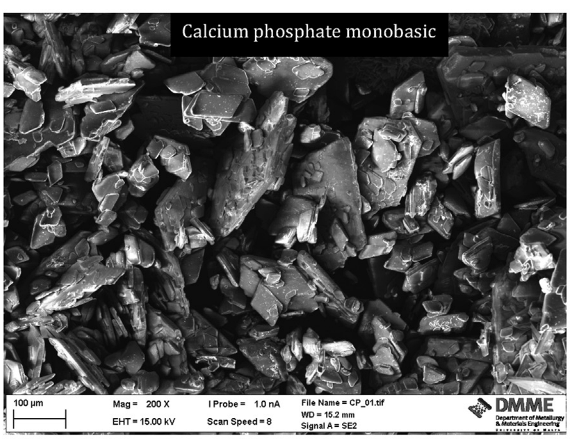
0099-2399/$ - see front matter

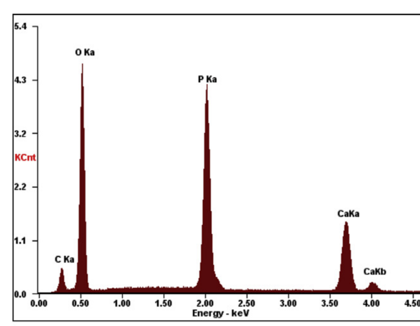
http://dx.doi.org/10.1016/j.joen.2016.12.022











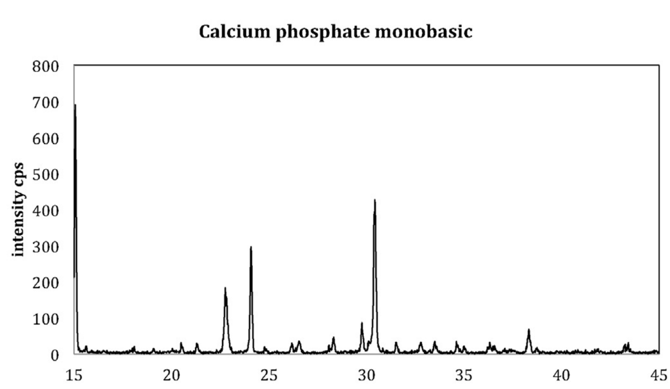


Figure 1. Scanning electron micrographs, energy-dispersive spectroscopic scans, and XRD plots of tricalcium silicate, calcium phosphate monobasic, and hydroxyapatite powders.