analysis, $P < 0.05$). A total of 764 genes were up-regulated and 574 down-regulated in ES compared with LS odontoblasts. Amongst these genes, several known markers of odontoblasts (including Coll I, DMP1, Amelogenin, Osteoclacin) were found to be differentially expressed, as weel as several other genes not previously studied in odontoblasts. Several of these are components of intracellular signalling, including pathways involved in MAPKinase, apoptosis, TGF-Beta, or FGF transduction. Ontological analysis revealed that 28.33% of the bovine genes identified by microarray analysis were assignable to biological processes, 26.79% as cellular components and 32.26% in molecular processes. RT-PCR analysis confirmed the differential expression of some of the cited genes. For example, Amelogenin was only detected in ES, whereas osteocalcin was detected only in LS odontoblasts. Collagen-I expression was not, however, differentially expressed, although Adrenomedullin and DMP1 were, up- and down-regulated in LS, respectively. These results agreed with the microarray findings.

Conclusion The differential changes in gene expression in primary and secondary dentinogenesis indicate modifications in transcriptional control of the cells and highlight the need to identify the nature of these control mechanisms both to characterize cell phenotype and to better understand how cell secretory behaviour can be controlled during tertiary dentinogenesis.

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A survey on the experience of UK endodontists and general dental practitioners in the management of intra-canal fractured endodontic files

Aim To investigate the attitudes of general dental practitioners (GDPs) and endodontists in the UK towards management of fractured endodontic file (SEF).

Methodology A questionnaire was sent to 330 systemically selected GDPs and all endodontic specialists working in the UK (170). It was accompanied by a covering letter explaining the aims of the study and indicating that all information given would remain confidential. Those who did not respond to the first mailing were sent another two mailings comprising a differently worded covering letter and another copy of the questionnaire. Data were analysed using chi-squared test at the 0.05 level of significance.

Results The overall response rate was 75% (82.82% for endodontists and 70.92% for GDPs). 18.5% of respondents reported they would retrieve files located in the apical third of root canals with a significantly higher proportion of endodontists (25.9%) compared with that of GDPs (14%) doing so. A significantly higher proportion of endodontists (98.5%) used ultrasonics for removal of SEF compared with GDPs (75.8%). The most common complication of SEF retrieval was excessive removal of dentine (67%). The majority of respondents (88.5%) reported that they would leave the un-removed file *in situ* and obturate the root canal.

Conclusion This study showed that both endodontists and GDPs are aware of the limitations of root canal anatomy when removal of separated instruments is considered. Excessive removal of dentine, which was the most common complication associated with the removal process, suggests the need for more conservative techniques. Both endodontists and GDPs demonstrated a conservative approach towards unsuccessful management of SEF. Further studies regarding attitudes of GDPs and endodontists towards some specific aspects of management of SEF are required.

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Serum contamination affects the surface hardness of Portland-type cements

Aim To compare the surface hardness of cured mineral trioxide aggregates (MTAs), Portland cements (PC) and a dental gypsum product (die stone) after mixing with the recommended solution alone or incorporating serum.

Methodology Samples ($n = 3$) of white MTAs (ProRoot and Angelus), white PCs (Lafarge) and dental die stone (BPB) were mixed to standard consistency with recommended solution or 50 : 50 (v/v) recommended solution : defibrinated horse serum, packed into 15 mm × 2mm Perspex moulds and stored at 37 °C/100% humidity. Vickers hardness (3/specimen: 200 g at 0.05 mm mm^{-1}) was determined at 1 or 4 h (depending on setting time), 1, 2, 3, 7, 14, 28 and 56 days. Differences in surface hardness between materials and mixing solutions and changes over time were compared with ANOVA and paired sample *t*-tests ($P < 0.05$).

Results Die stone attained full hardness within 1 day and remained constant thereafter. White PC and MTAs became significantly harder with time. Serum contamination greatly reduced the 1-day hardness of white PC and ProRoot MTA, significantly increased the 56-day hardness of PC and all MTAs.

Conclusions The Vickers hardness of white PC and MTAs increased for extended periods after initial hardening. Portland-type cements appeared to cure in a dissimilar manner to a gypsum-based dental stone. The hardness of white PC was greater than that of white MTAs at all times after initial hardening. Significant serum contamination may retard the early hardening of some Portland-type cements, but uniformly produced a significantly harder material at 56 days. The mechanisms of this action are incompletely understood. Clinically, assessing the set of MTAs at 24 h may not be warranted.

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The influence of bisphosphonates on bone generation using a chick femur model

Aim To determine the effect of a bisphosphonate (pamidronate) delivered using one of two carriers on bone generation, using a chick femur model supported by the chorio-allantoic membrane of a chick egg.

Methodology Twenty chick femurs freshly harvested from fertilized eggs were randomly allocated into two groups: (i) Affi-Gel blue bead carrier ($n = 10$); and (ii) hydroxyapatite bead carrier ($n = 10$). The femurs in each group were further randomly divided into control ($n = 4$) and experimental ($n = 6$) subgroups. Carriers charged with PBS solution and 0.1 mol L^{-1} pamidronate were delivered into the bone marrow of each femur at its mid portion via a needle puncture. Each femur was then implanted onto the chorio-allantoic membrane of a chick egg and incubated for 7 days. From each control subgroup femur, four consecutive histological sections were obtained after processing at the mid-portion of the puncture site to act as the inter-bone control. From each experimental subgroup femur, two consecutive histological sections were obtained after processing at a distance of 400–450 μm from both ends of the puncture site to act as the intra-bone control; and four

consecutive histological sections were obtained from the mid portion of the puncture site to act as the tests. Bone generation was quantified and the ratio of cross-sectional area of bone marrow to circumference of bone (outcome ratio) was determined amongst different groups using a software package, Image-Pro®Plus. The data were analysed using Mann–Whitney tests and Wilcoxon signed rank tests.

Results The outcome ratio in the test group was significantly ($P < 0.001$) smaller than the inter-bone and intra-bone control groups. There was evidence of bone formation directly over the carriers charged with pamidronate.

Conclusions The successfully developed test model was able to establish that local deposition of pamidronate had a positive effect on bone generation within a period of 7 days, regardless of the carrier used.

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An audit of the technical quality of primary orthograde root canal treatment performed by undergraduate dental students

Aim To investigate the technical quality of primary orthograde root canal treatment performed by undergraduate dental students.

Methodology A retrospective radiographic analysis of the technical standard of root canal treatment performed over 1 year of the undergraduate course was undertaken. All primary root canal treatments performed by late 4th and final year students between 1 April 2006 and 31 March 2007 were evaluated. All students had completed an introductory laboratory course using stainless steel hand instruments and Gates Glidden drills and a subsequent course using Nickel titanium instruments. Additionally, some students completed a voluntary one-term special study module (Endodontics) for 12 sessions. All radiographs of completed root canal treatments were assessed as to the technical quality of the root filling. Two calibrated observers assessed the radiographs under standard conditions using a lightbox and SDI radiograph viewer. The root fillings in each canal were assessed by length, satisfactory being within 0–2 mm of the radiographic apex, quality of obturation (absence of voids) classified as satisfactory, and taper, with the radiographic appearance of a uniform taper classed as satisfactory. The type of clinic, either a general restorative or endodontic was also recorded.

Results A total of 266 root canals were evaluated in 149 teeth. The final radiograph was unsuitable in four teeth and one tooth was extracted shortly after canal preparation. The remaining sample size was 253 canals in 144 teeth (61 anterior, 37 premolar, 46 molar). No endodontic instruments were fractured during the study. Overall, 163 individual root canals (64.4%) and 87 teeth (60.4%) were classed as satisfactory. Fifty-five canals and 21 teeth (one lower anterior, five premolars, 15 molars) were treated on the endodontic clinic, 46 canals (83.6%) and 15 teeth (71.4%) of these were satisfactory. A total of 198 canals in 123 teeth (60 anterior, 32 premolar, 31 molar) were treated on the restorative clinic with 117 canals (59.1.6%) and 72 teeth (58.5%) being satisfactory.

Conclusions Overall, 60.4% of teeth met the criteria of root filling within 2 mm of the radiographic apex, no voids and uniform taper. A higher percentage of compliance was noted on the endodontic special study module.

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Ion release characteristics, precipitate formation and sealing ability of a potential new root canal filling material

Aim To test a new polycaprolactone (PCL)/bioactive glass (BAG) composite as a root filling material capable of producing a seal under moist conditions by precipitation.

Methodology Formulations of PCL/BAG composites were made using the solvent casting method and then modified into a form physically deliverable into root canals. Root canals of single-rooted extracted human teeth were modified by de-coronation and removal of the apical 2 mm of the root. Canal instrumentation was performed with gates glidden drills (1% NaOCl and 17% EDTA irrigation) to achieve a degree of standardization of shape. The canals were filled with the composites using warm vertical compaction (the composites are thermoplastic and behave like gutta-percha) but without root canal sealer. A group of obturated teeth ($n = 6$ per composite formulation) was monitored for ion release (Na^+, Ca^{2+}, PO_4^{3-}, $P_2O_7^{4-}$, $P_3O_9^{3-}$ and $P_5O_{10}^{5-}$) into solution from the apical portion using ion chromatography. Three composite formulations were used to fill 10 roots each and half ($n = 5$) exposed to saline, whilst others were sectioned immediately; both were examined by light and scanning electron microscopy to evaluate adaptation, precipitate and film formation. A further group of 30 roots was obturated to evaluate seal formation by dye penetration; a control group ($n = 10$) consisted of conventional gutta-percha and Roth's sealer delivered in like manner to the test material; two test groups ($n = 10$ each) were obturated with a composite formulation producing the optimal precipitate, the apices of teeth in one group were immersed in saline for 7 days and the other not.

Results All samples released various amounts of ions which followed inversely to the concentration of iron oxide within the bioactive glass. Adaptation of the experimental material was better than the gutta-percha control groups. The formation of precipitate was evident in some specimens; in others film formation and dentine tubule entry by the material was observed. The dye penetration test showed that composite root filling specimens immersed apically in saline for 7 days had significantly less leakage (almost none) than those not immersed in saline at all ($P < 0.001$) or the gutta-percha control ($P < 0.001$).

Conclusions Polycaprolactone–bioactive glass composites may have potential as 'sealer-free' root filling material because of their ion release, precipitate formation and short-term seal.