

Use of Mineral Trioxide Aggregate (MTA) by Post-graduates in Restorative Dentistry in the UK

J.I. Foley *

Abstract - All postgraduate trainees in Restorative Dentistry within the United Kingdom were contacted by e-mail and invited to participate in a structured on-line questionnaire regarding MTA usage. Responses were received from 46/65 (70.8%) postgraduate trainees. MTA was used by 15/46 (32.6%) trainees in the primary dentition and 46/46 (100%) in the permanent dentition. Barriers to the use of MTA in the permanent dentition related to material cost and in the primary dentition, the lack of an evidence base. Overall, 32/46 (69.6%) had received tuition during their postgraduate programme and 21/46 (45.7%) indicated an interest in further educational opportunities in material use.

KEY WORDS: MTA Cement, Graduate Dental Education

INTRODUCTION

Mineral trioxide aggregate (MTA) is a relatively recent dental material which has numerous clinical applications¹. For vital teeth, it has been advocated for pulp capping²⁻⁴ and pulpotomy techniques⁵⁻⁷ in both the primary and permanent dentitions, whilst for non-vital permanent teeth its uses have included apical barrier formation in both immature teeth^{8,9} and within the coronal fragment of fractured roots¹⁰. In addition, it has been proposed as a repair material for radicular perforation¹¹, a retrograde root filling material following apicectomy¹² and finally, as an endodontic sealer¹³.

Within the United Kingdom (UK), to be eligible to practice as a Specialist in Restorative Dentistry and to be listed on the UK General Dental Council's (GDC) Specialist List in the discipline, postgraduates must undertake a five year training programme and subsequently, present for and be successful in a specialist dental surgery examination administered by one of the four Royal College of Surgeons (RCS) in the UK. Postgraduate programmes can be undertaken either within the NHS Hospital Dental Service or within a University Setting. A Specialist in Restorative Dentistry is eligible for appointment as either a substantive- or honorary Consultant within the UK National Health Service (NHS).

Whilst the dental literature surrounding MTA continues to evolve, there appears to be a limited number of well-designed clinical trial on the material's usage¹. As such, dentists may be reluctant to adopt such a material in to their clinical practice. The aim of this study was to assess the current use and opinions of MTA amongst postgraduates in Restorative Dentistry in the UK.

MATERIALS AND METHODS

The Secretary of the Postgraduate Group in Restorative Dentistry within the UK was contacted by e-mail in July

2009 to outline a proposed on-line structured questionnaire designed to investigate the usage of- and opinions of postgraduate trainees in Restorative Dentistry in relation to MTA cement. Permission was sought to acquire the e-mail distribution list of all postgraduate trainees in the discipline. Following consent from the Postgraduate Group, an e-mail was sent to all postgraduates (n = 65) during August 2009 inviting questionnaire participation with a web link provided to access the survey. A second reminder e-mail was sent four weeks later to all potential participants to encourage non-responders to access and complete the survey. The survey was closed in December 2009.

The questionnaire was designed using www.surveymonkey.com with the initial part of the questionnaire seeking personal details as follows:

- Gender
- Age range
- Stage of postgraduate trainee, i.e. Year One to Five
- Setting of postgraduate education, i.e. NHS Hospital Dental Service or University
- Full- or part-time postgraduate programme

The second part of the survey investigated the use- and opinions of MTA in both the primary- and permanent dentitions as follows:

- Current use of MTA
- Types of clinical procedure undertaken with MTA
- Type of MTA material currently used
- Rationale for the choice of MTA cement in current use
- Barriers to the use of MTA

Finally, the questionnaire sought information regarding the following:

- Education in the use of MTA
- Further educational requirements

* BDS, FDS (Paed Dent), MDSc, PhD

RESULTS

Responses were received from 46 postgraduates (70.8%) (F: 17; M: 29) and of these, the proportion of trainees in each year of their programme were as follows: Year One: 10/46 (21.7%), Year Two: 8/46 (17.4%) Year Three: 7/46 (15.2%); Year Four: 6/46 (13.0%) and Year Five: 15/46 (32.6%). Regarding age range, 10/46 (21.7%), 20/46 (43.5%) and 16/46 (34.8%) were aged between 25-29 years, 30-34 years and 35 years and over, respectively. In relation to geographical location, 32/46 (69.6%) of postgraduates were based in England, 7/46 (15.2%) in Scotland, 6/46 (13.0%) in Ireland and 1/46 (2.2%) in Wales. Concerning the location of their postgraduate programme, 32/46 (69.6%) were based within the NHS Hospital Dental Service and 14/46 (30.4%) were in a University setting and of these, 38/46 (82.6%) were full-time and 8/46 (17.4%) were part-time postgraduates.

In relation to the use of MTA, 15/46 (32.6%) of postgraduates used the cement in the primary dentition and of these, seven used the cement as a pulp capping agent and eight for pulpotomy techniques. Concerning the permanent dentition, all postgraduates reported MTA use with 18/46 (39.1%) and 14/46 (30.4%) reporting cement use in pulp capping and pulpotomy techniques, respectively. The clinical procedures for which MTA cement was used in non-vital permanent teeth are given in Figure 1.

Regarding materials, ProRoot MTA was used by 21/46 (45.7%) of respondents, White ProRoot MTA by 17/46 (37.0%), MTA-Angelus by 5/46 (10.9%) and 3/46 (6.5%) were unsure of the material which was used. The reasons given for the choice of material are given in Figure 2 with 7/46 (15.2%) noting that this was their Consultant's choice and 6/46 (13.0%) observing that the cement was chosen for ease of use and also, cheaper cost (Figure 2). Reported barriers to the use of MTA in the primary dentition related to lack of training in the use of the material which was cited by 13/46 (28.3%) postgraduate trainees and in relation to the permanent dentition, 13/46 (28.3%) postgraduates noted that material cost was a barrier to MTA usage (Figure 3).

Regarding previous education in the use of MTA, 32/46 (69.6%) reported training during their postgraduate programme and 25/46 (54.3%) having attended a postgraduate course. In addition, 6/46 (13.0%) indicated that they were "self-taught". Concerning further educational opportunities in the use of MTA, 18/21 (85.7%) postgraduates indicated an interest and when given a range of choices and being allowed to select more than one option, 5/21 (23.8%), 17/21 (81.0%) and 12/21 (57.1%) indicated an interest in didactic teaching, clinical skills courses and supervised clinical sessions.

DISCUSSION

The present study was designed to capture the usage and opinions of MTA amongst postgraduate trainees in Restorative Dentistry within the UK. In addition, the questionnaire investigated previous- and potential educational needs of this group of dentists. All postgraduates in the discipline were contacted *via* e-mail to invite study participation in an attempt to maximise replies and to minimise study costs. All potential responders were contacted twice by e-mail and a possible response time of four months was given and as such, it was slightly disappointing that there was not a higher response rate. Nonetheless, this was greater than previous e-mail and on-line questionnaire surveys^{14,15}. The study author acknowledges that the opinions of those who chose not to respond may have altered study findings. To date, the majority of such dental surveys have been postal questionnaires^{16,17}. Despite the fact that previous web-based surveys have demonstrated a lesser response rate amongst potential study participants, the decision to approach potential study participants using e-mail assumed that it would potentially yield a higher response rate^{14,15}. In fact, the response rate in the current study was similar to previous postal questionnaires^{16,18}. Nonetheless, the range of opinions collated demonstrates the differing use and opinions of postgraduate trainees in the discipline.

Regarding the use of MTA, approximately one-third of postgraduate trainees had used the cement in the primary

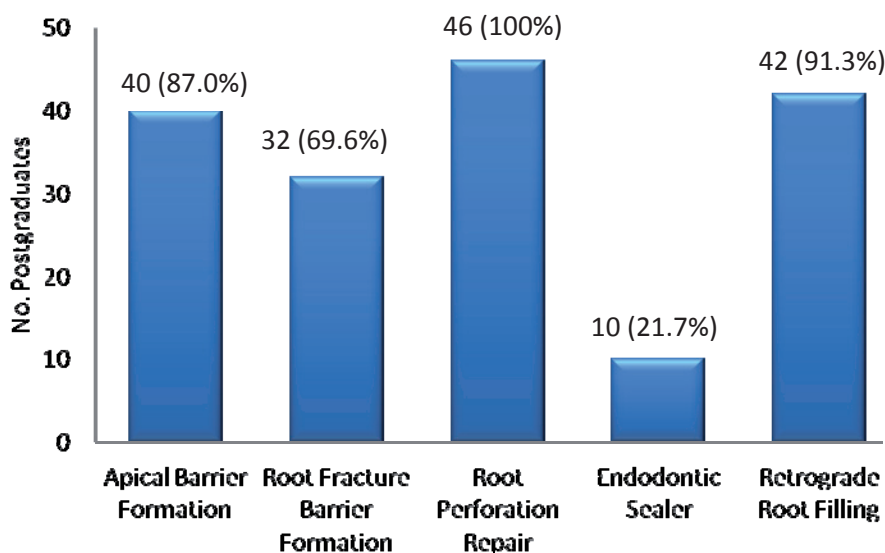


Figure 1. Clinical procedures undertaken with MTA for non-vital permanent teeth.

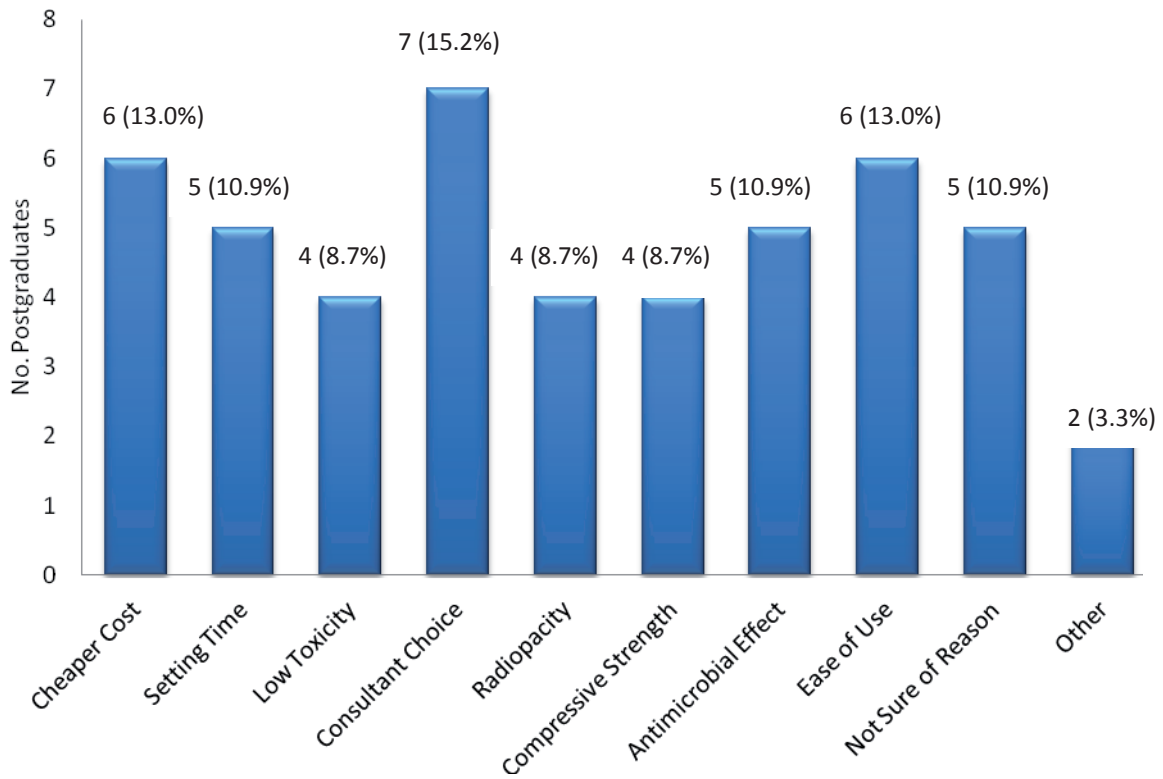


Figure 2. Reasons selected for the use of a material type of MTA amongst postgraduate trainees. Note that respondents were allowed to select only one response.

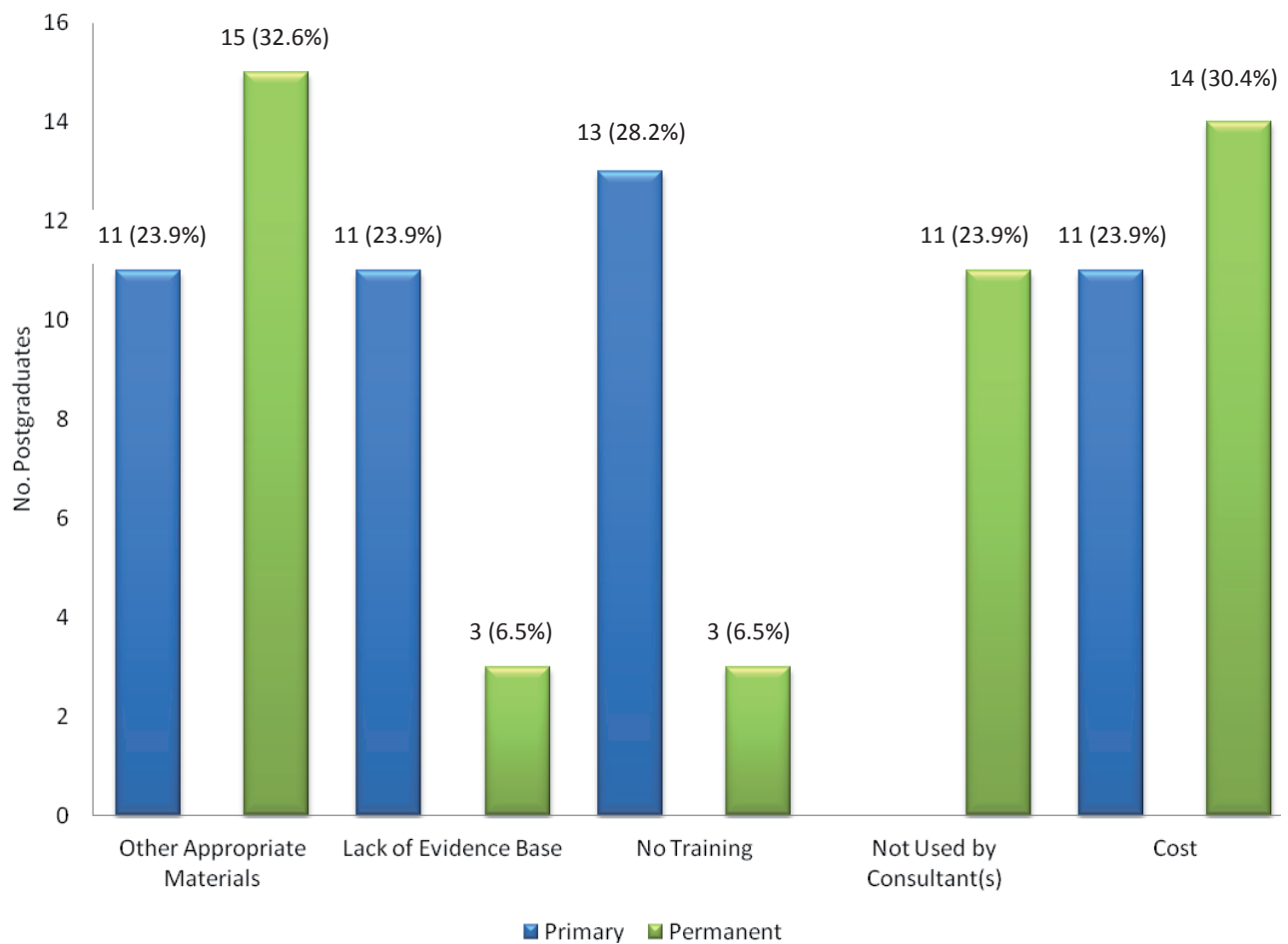


Figure 3. Barriers to the use of MTA in the primary- and permanent dentitions amongst postgraduates. Note that respondents were allowed to select multiple responses.

dentition with the material used for a pulpotomy technique. This would appear to be a similar finding to one other study which investigated the use of MTA amongst postgraduate trainees in Paediatric Dentistry whereby 9/35 (25.7%) used the material for a pulpotomy technique (unpubl. data). A number of effective alternatives have been mooted as pulpotomy medicaments, including ferric sulphate and calcium hydroxide. This is not surprising given current concerns regarding the use of formocresol which has traditionally been used as a pulpotomy agent^{19, 20}. Recent studies have also reported good success rates with the use of MTA in pulpotomised primary molar teeth^{21, 22}.

In non-vital teeth, all postgraduates reported MTA usage in apical barrier formation. One previous questionnaire survey undertaken amongst Consultants in Paediatric Dentistry reported that 68.2% had either used or arranged for the use of MTA in this clinical situation²³. In addition, one more recent study determined that MTA was used for apical barrier formation amongst postgraduates in Paediatric Dentists by 31/35 (88.6%) of trainees (unpubl. data). Perhaps surprisingly, however, in the similar clinical scenario of root fracture, postgraduates reported lesser usage. Otherwise, MTA appeared to be used for the repair of root perforations and also, as a retrograde filling material. One recent randomised controlled clinical trial confirmed the superior healing properties of MTA when used following root resection of teeth with periapical infection²⁴. The use of MTA as an endodontic sealer, however, appeared to be less popular. This latter finding may result from a paucity of studies looking at the potential for MTA to be used as a root canal sealer. To date, the dental literature relates either to case reports or *in vitro* studies²⁵.

The most commonly used materials appeared to be ProRoot MTA and White ProRoot MTA, with the former appearing to be more popular. Interestingly, a number of other postgraduates were unaware of the type of MTA used in their clinical practice. This was reflected in the response to the reasons for choosing a particular MTA type whereby a number of postgraduates were unsure of the basis for the choice of material and a further proportion reported that the rationale related to the cement choice of their Consultant(s). Interestingly, MTA-Angelus appeared to be in limited use. The cost of ProRoot MTA, both grey and white, retails at approximately £275 for a 5 dose pack which is considerably more than MTA-Angelus, both grey and white, which is marketed at £45 for a 1G Pack 7 Applications. Of note, is that postgraduates reported the cost of MTA as being a barrier to its use despite noting that their choice of MTA would more frequently be White ProRoot MTA rather than MTA-Angelus. Presumably at this level, trainees have limited or no exposure to budgetary costs of materials and equipment. Otherwise, the postgraduates noted the lack of evidence base surrounding the use of MTA cement and also, the appropriateness of other materials. One recent review acknowledged that whilst laboratory-based studies and animal investigations have supported the favourable clinical impression of MTA, there is still insufficient available evidence surrounding the material and the expense of the material may be preclusive²⁶.

Exploring previous education in the use of MTA, the majority reported this during their postgraduate programme and in addition just over half had also attended a separate postgraduate course. A small number of trainees also in-

dicated that they were "self-taught". Just less than one-half of all postgraduates indicated that they would like further educational opportunities specifically as either clinical skills courses or supervised clinical sessions.

Indeed, nearly all postgraduate trainees requested clinical skills courses in MTA usage whilst just over one-half suggested that further supervised clinical sessions would be useful. An electronic literature search of scientific papers using PubMed searching for the key words Mineral Trioxide Aggregate, MTA cement, Gray MTA, Grey MTA, White MTA, GMTA, WMTA and mineral AND trioxide AND aggregate produces just over 800 results. This gives an indication of the relatively limited evidence base surrounding the material and perhaps accounts for the novelty of the technique in the clinical situation. As such, Specialists in Restorative Dentistry and hence, those who are involved in teaching the use of MTA to postgraduates may themselves have limited experience in the use of the material.

CONCLUSION

MTA is in frequent use amongst trainees in Restorative Dentistry particularly in the permanent dentition. Barriers to the use of MTA in the permanent dentition related to material cost and in the primary dentition, the lack of an evidence base. The majority of postgraduate trainees had received training in the use of MTA during their programme, although nearly one-half of trainees expressed an interest in relation to further educational opportunities in MTA cement usage.

ADDRESS FOR CORRESPONDENCE:

Dr J.I. Foley. The University of Aberdeen Dental School and Hospital, Foresterhill, Aberdeen, AB25 2ZR. Tel: 01224 555155 Fax: 01224 552794. E-mail: j.foley@abdn.ac.uk

REFERENCES

1. Parirokh, M., Torabinejad, M. Mineral trioxide aggregate: a comprehensive literature review--Part III: Clinical applications, drawbacks, and mechanism of action. *J Endod*; **36**(3): 400-13.
2. Accorinte Mde, L., Holland, R., Reis, A., et al. Evaluation of mineral trioxide aggregate and calcium hydroxide cement as pulp-capping agents in human teeth. *J Endod* 2008; **34**(1): 1-6.
3. Nair, P.N., Duncan, H.F., Pitt Ford, T.R., Luder, H.U. Histological, ultrastructural and quantitative investigations on the response of healthy human pulps to experimental capping with Mineral Trioxide Aggregate: a randomized controlled trial. 2008. *Int Endod J* 2009; **42**(5): 422-44.
4. Tuna, D., Olmez, A. Clinical long-term evaluation of MTA as a direct pulp capping material in primary teeth. *Int Endod J* 2008; **41**(4): 273-8.
5. El-Meligy, O.A., Avery, D.R. Comparison of mineral trioxide aggregate and calcium hydroxide as pulpotomy agents in young permanent teeth (apexogenesis). *Pediatr Dent* 2006; **28**(5): 399-404.
6. Moretti, A.B., Sakai, V.T., Oliveira, T.M., et al. The effectiveness of mineral trioxide aggregate, calcium hydroxide and formocresol for pulpotomies in primary teeth. *Int Endod J* 2008; **41**(7): 547-55.
7. Percinoto, C., de Castro, A.M., Pinto, L.M. Clinical and radiographic evaluation of pulpotomies employing calcium hydroxide and trioxide mineral aggregate. *Gen Dent* 2006; **54**(4): 258-61.
8. Sarris, S., Tahmassebi, J.F., Duggal, M.S., Cross, I.A. A clinical evaluation of mineral trioxide aggregate for root-end closure of non-vital immature permanent incisors in children-a pilot study. *Dent Traumatol* 2008; **24**(1): 79-85.

9. Simon, S., Rilliard, F., Berdal, A., Machtou, P. The use of mineral trioxide aggregate in one-visit apexification treatment: a prospective study. *Int Endod J* 2007; **40**(3): 186-97.
10. Cvek, M., Mejare, I., Andreasen, J.O. Conservative endodontic treatment of teeth fractured in the middle or apical part of the root. *Dent Traumatol* 2004; **20**(5): 261-9.
11. Mente, J., Hage, N., Pfefferle, T., et al. Treatment outcome of mineral trioxide aggregate: repair of root perforations. *J Endod* 2010; **36**(2): 208-13.
12. Tawil, P.Z., Trope, M., Curran, A.E., et al. Periapical microsurgery: an in vivo evaluation of endodontic root-end filling materials. *J Endod* 2009; **35**(3): 357-62.
13. Ding, S.J., Kao, C.T., Shie, M.Y., Hung, C., Jr., Huang, T.H. The physical and cytological properties of white MTA mixed with Na₂HPO₄ as an accelerant. *J Endod* 2008; **34**(6): 748-51.
14. Creasy, J.E., Mines, P., Sweet, M. Surgical trends among endodontists: the results of a web-based survey. *J Endod* 2009; **35**(1): 30-4.
15. Lee, M., Winkler, J., Hartwell, G., Stewart, J., Caine, R. Current trends in endodontic practice: emergency treatments and technological armamentarium. *J Endod* 2009; **35**(1): 35-9.
16. Woolley, S.M., Hingston, E.J., Shah, J., Chadwick, B.L. Paediatric conscious sedation: views and experience of specialists in paediatric dentistry. *Br Dent J* 2009; **207**(6): E11; discussion 280-1.
17. Wilson, P.H., Boyle, C.A., Smith, B.J. Conscious sedation training received by specialist registrars in restorative dentistry in the UK: a survey. *Br Dent J* 2006; **201**(6): 373-7.
18. Soldani, F., Foley, J. An assessment of rubber dam usage amongst specialists in paediatric dentistry practising within the UK. *Int J Paediatr Dent* 2007; **17**(1): 50-6.
19. IARC. International Agency for Research on Cancer. IARC classifies formaldehyde as carcinogenic to humans. Press release no. 153. <http://www.iarc.fr/pageroot/PRELEASES/pr153a.html>. 2004.
20. Rodd, H.D., Waterhouse, P.J., Fuks, A.B., Fayle, S.A., Moffat, M.A. Pulp therapy for primary molars. *Int J Paediatr Dent* 2006; **16**: 15-23.
21. Agamy, H.A., Bakry, N.S., Mounir, M.M., Avery, D.R. Comparison of mineral trioxide aggregate and formocresol as pulp-capping agents in pulpotomized primary teeth. *Pediatr Dent* 2004; **26**(4): 302-9.
22. Holan, G., Eidelman, E., Fuks, A.B. Long-term evaluation of pulpotomy in primary molars using mineral trioxide aggregate or formocresol. *Pediatr Dent* 2005; **27**(2): 129-36.
23. Mooney, G.C., North, S. The current opinions and use of MTA for apical barrier formation of non-vital immature permanent incisors by consultants in paediatric dentistry in the UK. *Dent Traumatol* 2008; **24**(1): 65-9.
24. Christiansen, R., Kirkevang, L.L., Horsted-Bindslev, P., Wenzel, A. Randomized clinical trial of root-end resection followed by root-end filling with mineral trioxide aggregate or smoothing of the orthograde gutta-percha root filling--1-year follow-up. *Int Endod J* 2009; **42**(2): 105-14.
25. Bernardes, R.A., de Amorim Campelo, A., Junior, D.S., et al. Evaluation of the flow rate of 3 endodontic sealers: Sealer 26, AH Plus, and MTA Obtura. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2010; **109**(1): e47-9.
26. Srinivasan, V., Waterhouse, P., Whitworth, J. Mineral trioxide aggregate in paediatric dentistry. *Int J Paediatr Dent* 2009; **19**(1): 34-47.