The Status of Mineral Trioxide Aggregate in Endodontics Education in Dental Schools in Turkey


Abstract: The aim of this study was to assess the current status of mineral trioxide aggregate (MTA) as an educational material in dental schools in Turkey. A survey was sent to senior members of the endodontic departments of seventeen dental schools; fourteen responded. All respondents reported that they used MTA in their clinical practice, with apexification, perforations, retrograde fillings, and root resorptions being the most frequently occurring treatment procedures. All reported that information was given to students regarding MTA mainly as part of the curriculum. The third and fourth years were the periods when MTA was introduced to students in most of the schools. Twelve schools reported that students had the opportunity to observe procedures in which MTA was used, but students had the chance to use the material in a very minor proportion of the schools, mainly under the supervision of clinical instructors. Ten schools agreed that MTA should be included in the regular endodontic curriculum. Financial constraints seemed to be the predominant reason for those who answered this question negatively, followed by difficult handling properties and low radiopacity of the material. Within the limitations of this study, it can be concluded that ways should be sought to prevent financial difficulties from depriving dental students of the opportunity to receive information about contemporary methodologies such as MTA utilization.

Dr. Tanalp is Associate Professor, Department of Endodontics, Faculty of Dentistry, Yeditepe University, Turkey; Dr. Karapinar-Kazandag is Assistant Professor, Department of Endodontics, Faculty of Dentistry, Yeditepe University, Turkey; Dr. Ersev is Associate Professor, Department of Endodontics, Faculty of Dentistry, Istanbul University, Turkey; and Dr. Bayirli is Professor, Department of Endodontics, Faculty of Dentistry, Yeditepe University, Turkey. Direct correspondence and requests for reprints to Dr. Jale Tanalp, Faculty of Dentistry, Yeditepe University, Bagdat Caddesi 238, Güztepe-Istanbul, Turkey 34728; 902163636044/6439 phone; 902163636211 fax; jale.tanalp@yeditepe.edu.tr.

Keywords: clinical education, dental education, endodontics, mineral trioxide aggregate, Turkey

Submitted for publication 5/1/11; accepted 10/3/11

Since its first introduction in 1993, research on the use of mineral trioxide aggregate (MTA) has been extensive. The main reason for this significant interest is related to its multiple advantageous properties, such as low shrinkage and good sealing ability,1,3 biocompatibility,1,3,4 insensitivity to moisture and blood, radiopacity, promotion of biological repair and hard tissue formation, and regeneration of periodontal ligament.5 Based on a detailed literature review, Parirokh and Torabinejad6 concluded that MTA is the material of choice for some clinical applications. Pulp capping, pulpotomy, apexification procedures, formation of an apical barrier, root resorptions, and retrograde fillings are among the areas of usage of MTA.7 MTA-based sealers have also been evaluated in terms of their sealing capacity and release of calcium, and it has been concluded that MTA sealers release calcium ions in solution that encouraged the deposition of calcium phosphate crystals.8

MTA is mainly derived from Portland cement. The composition of the material shows that the main components are calcium and silica and bismuth oxide.7 Nowadays, there are two forms of MTA on the market: the gray and white forms. The primary differences between gray and white MTA from Portland cement have been indicated as the absence of potassium and the presence of bismuth oxide.7,9,10 However, all three materials have similar constituents, reported as tricalcium silicate, tricalcium aluminate, calcium silicate, and tetracalciumaluminoferrite.10,11 Although many aspects of mineral trioxide aggregate have been investigated in a considerable number of investigations so far and a literature search in PubMed resulted in over 700 references concerning this material, its use in dental education has not yet been explored. Research by Pitt Ford et al.12 investigated the use of mineral trioxide aggregate in dental schools in the United Kingdom. Given the positive reports on the favorable characteristics of MTA, it can be expected that dental schools educate their students about this material in their classroom-based instruction and use it in their practice as indicated depending on the case.
With increasing demand among university candidates to be enrolled in a dental faculty and increasing popularity of the profession, there is a growing trend in Turkey to open new dental schools. Meanwhile, there is recent interest in updating dental education curricula to be compatible with European standards and to meet the requirements of the Bologna process. This necessitates continuous revision of educational programs and implementation of new concepts. The purpose of our investigation was to assess the current status of MTA in didactic education and clinical use in endodontics in dental schools in Turkey. Additional questions were concerned with how the information was provided to the students and in which years of education the students were instructed about MTA. In order to assess the general attitudes of academicians towards MTA, faculty members were also surveyed about their opinions concerning the inclusion of instruction about this material in the dental school curriculum. In addition, questions concerning materials used for different procedures as well as those used during permanent obturation of root canals were included.

Methods

This study was approved by the faculty review board for research involving human subjects. Data were collected with a survey that was sent to the chiefs of endodontic departments in dental schools in Turkey (the survey is available from the corresponding author). Of thirty-eight dental schools, seventeen were included. The remaining twenty-one dental schools that did not offer dental education for more than five years were excluded in order to survey only schools with dental education in all grades of the five-year dental education and to ensure that the overall educational system was relatively established. The schools excluded from the survey were those that were in the process of implementing their curriculum where changes and modifications are quite likely. There were also some schools among these that had just completed their foundation but not yet initiated the dental education process. Thus, it was presumed that inclusion of these schools would not reflect a true picture of an established dental curriculum.

The study performed by Pitt Ford et al. was taken as the basis for the development of the survey with some additional items. The first part of the survey focused on the clinical use of MTA and the procedures in which this material was selected to be used. Questions were asked about the usage of MTA in various dental applications (pulp capping, partial pulpotomy, root canal treatment, apexification procedures, retrograde filling in surgical procedures, perforation repair, and root resorptions) by both clinical faculty members and students. Questions concerning the inclusion of MTA in preclinical studies were included as well. In addition to the questions by Pitt Ford et al., information was collected concerning how instruction about the use of MTA was provided to the students, such as in lectures or in seminars, and in which years of their dental education this information was included in the curriculum. In addition, the respondents were asked to name the materials used for different dental applications including permanent obturation of root canals and whether they agreed that MTA must be included in routine predoctoral endodontic education. Respondents who answered this last question negatively were asked to provide the reasons for their answers. Confidentiality of each school was ensured in the survey.

Results

Fourteen of the seventeen contacted schools (response rate of 82.4 percent) responded. No response was received from the remaining three schools, even though notices were sent. Among the respondents, ten schools indicated the presence of a clinic dedicated to only endodontic practice. MTA was used in the clinical practice by all the faculty members of the responding schools. MTA was used most frequently for apexification, retrograde fillings, perforations, and resorptions. Endodontic faculty members of six schools used MTA as a pulp capping agent, and faculty members of only one school used it for root canal treatment. Partial pulpotomy was not reported to be a procedure where MTA was used by any endodontic faculty member.

All the respondents reported that information was given to the students regarding MTA and its clinical applications. All these schools responded that information about MTA was given as a course during endodontic education. In addition, six schools indicated that, apart from the regular curriculum, seminars were also used as a means to give information about MTA to their students. The third and fourth years of dental education were the periods when MTA was introduced to students in most of the schools. One school indicated that MTA started to be taught in the second year and continued in the third and
fourth years. Two schools reported that MTA was a topic of the endodontic curriculum only in the fifth year of dental education.

MTA was not used in preclinical lab studies in any of the dental schools that responded, the chief reason being reported as financial constraints. Five schools further indicated that there was no available time allocated for this purpose during the preclinical course program.

The question concerning students’ observation of the use of MTA resulted in different answers. Only two schools responded that students did not have the opportunity to watch the use of MTA during their educational period. The use of MTA for the use of obturation of perforations was a procedure observed by the students of the remaining twelve schools. Six schools additionally reported that students were able to observe MTA usage in root resorptions, five in apexification procedures, seven in retrograde fillings during surgical endodontics, and two in direct pulp capping.

The majority (ten) of the dental schools that responded reported that their students did not have the opportunity to perform MTA application during their endodontic practice. One school responded that students were allowed to use MTA during pulp capping depending on the specific case. Three schools indicated that MTA was used for the repair of root perforations during endodontic practice. One of these schools further added that the students used MTA for the closure of perforations they accidentally made during endodontic practice, under the supervision of their clinical instructors.

Another question in the survey was about which material was used by students during specific dental procedures. For direct pulp capping, calcium hydroxide seemed to be the material of choice in all dental schools, with one school reporting the usage of MTA depending on the case. Only six schools responded to the question about partial pulpotomy, and calcium hydroxide was the preferred material. The remaining schools reported that partial pulpotomy was not a procedure applied in their endodontic clinics. For root canal treatment, gutta-percha in conjunction with AH Plus root canal sealer was said to be the filling methodology used by the majority (eleven) of the dental schools. One school reported Sealapex as the sealer of choice, whereas another school reported a resin-based sealer without indicating a brand name. Another school reported that Endomethasone N in conjunction with gutta-percha was the preferred methodology in the student clinic for the permanent obturation of root canals. In case apexification was to be performed by students, calcium hydroxide in multiple appointments was the treatment modality for all the respondents. Surgical retrograde filling was not a procedure performed by undergraduates in any of the responding schools. On the other hand, two schools reported that students could participate in these interventions as observers. Seven schools indicated that MTA was used for the repair of root perforations and the procedure was performed by the faculty member or assistant in charge of the clinic. The remaining schools indicated that amalgam, glass ionomers, and composites were used for this purpose. Root resorptions were mainly treated using calcium hydroxide. Four schools further indicated that MTA was sometimes used for this purpose by the faculty member in charge of the clinic.

Ten of the fourteen dental schools agreed with the opinion that MTA should be included in the regular predoctoral endodontic curriculum. The main concerns of the respondents who gave negative answers to this question were the material’s high cost, difficult handling properties, and relatively low radiopacity. One respondent commented that the teaching of MTA should be restricted to postgraduate education since its usage required special training.

Finally, the respondents were asked to note any additional comments and suggestions they had on the topic. Among those who responded, the chief concern involved the financial constraints of the material and difficult handling characteristics although there was a consensus about the material’s beneficial properties. Seven of the respondents made additional comments in the final part of the survey, and all of them focused on financial difficulties restricting the implementation of the material in clinical use and routine student education. It is clear that only a certain portion of school budgets can be used for student training and clinics. Even though this factor was not included in one of the survey questions, it can be speculated that universities experience difficulties even in the implementation of materials they believe to be beneficial and evidence-based. This is a serious issue that needs to be discussed in detail to develop supportive strategies. One respondent expressed anticipation of domestic products being launched in the market that might lead to lower prices for the material. This respondent further commented that even research assistants in endodontics preferred to restrict usage of MTA to scientific investigations and very challenging cases that may otherwise be unpredictable to handle with cheaper materials. One respondent
seemed to be the preferred period for the delivery of information regarding MTA, which might be considered reasonable because these are the years when clinical studies of students are initiated and clinical skills are being implemented. The second year of dental education might be considered early for the introduction of MTA, especially if it is not to be used in preclinical studies. However, in case it is included in the second-year curriculum, it might be recommended to revisit this material in a later year for the purpose of better implementation and not leaving the topic as theoretical knowledge only.

In view of the results regarding the mode of delivery of information on MTA, it seems that the regular endodontic curriculum is the general means of introducing the material to students. Six schools also reported seminars as a method of teaching MTA use. In Turkey, there is a trend for dental supply agencies to visit dental schools regularly to give seminars and training on their products. Sometimes, national and international visitors are also invited to give lectures on specific topics. The schools that indicated seminars as a means of education on MTA may have been referring to these activities. Nevertheless, the organization of seminars and conferences may be encouraged to broaden the scope of students’ education about new products, to enhance self-development, and to draw attention to innovations for which adequate time cannot be spared during the curriculum due to the crowded timetable.

The comments of one respondent concerning the questionable results of pulp capping with MTA is worth commenting on. The utilization of MTA in pulp capping is a new methodology whose long-term success has not been investigated well with longitudinal clinical studies. On the other hand, more homogeneous dentine bridge formation with fewer tunnel defects compared to calcium hydroxide has been found in a number of histological evaluations. A recent retrospective study attempted to determine the long-term clinical success of direct pulp capping, undertaken under comparable conditions, by using MTA and a non-setting calcium hydroxide paste. The results showed that MTA appears to be more effective than calcium hydroxide for maintaining long-term pulp vitality after direct pulp capping and immediate restoration of the pulp-capped tooth should be aimed for in these procedures. On the other hand, it is clear that further clinical investigations on the topic are warranted for the implementation of the material in clinical practice. The results of our study, which found that calcium hydroxide was the material of choice for direct pulp capping procedures during...
dental education, confirm that calcium hydroxide for pulp capping is still being taught as the gold standard to new generations of dental practitioners in Turkey.

A concern was expressed by one respondent over the inadequacy of radiopacity of MTA below a certain thickness. Although different results are available in the literature depending upon variations in investigation methodologies and the type of MTA tested (gray or white), the average radiopacity value of the material has been reported as 7.17 mm of an equivalent thickness of aluminum.1 The respondent did not report the specific procedure in which MTA showed unfavorable radiopacity below a certain thickness; however, in case retrograde fillings are concerned, a 4 mm apical barrier has been reported as more appropriate in terms of prevention of displacement.1 Thus, the respondent may not have selected the appropriate thickness and drawn an unwarranted conclusion. Nevertheless, future studies are required to make more definite comments regarding the ideal thickness of MTA to be used in specific interventions and the influence of thickness on the radiopacity of the material.

When the overall results of our study were evaluated, treatment of perforations, resorptions, and apexification were the most common procedures performed by academicians and observed by students. This is an expected result since the majority of these procedures are mainly within the scope of endodontics. Apexification, though it may be more common in pedodontic practice, is a treatment type endodontists also encounter in the clinic. Although prolonged calcium hydroxide application until the formation of an apical barrier has been the traditional treatment modality in these cases previously, there is recent significant interest in performing this type of treatment using MTA, allowing the procedure to be completed in a shorter period. The primary cause of taking such an approach is mainly due to some drawbacks of calcium hydroxide application.16,17 Successful results reported in single appointment apexification procedures using MTA have led this methodology to be more popular among clinicians.18-20 Since academicians play an important role in the assessment and adoption of new materials and methodologies, it can be anticipated that faculty members of endodontics may act as pioneers for the dissemination of this treatment approach among dental practitioners.

The respondents in our survey were also asked about the material and method used for the permanent obturation of root canals. The majority indicated this material as AH Plus sealer in conjunction with gutta-percha. This sealer is generally taken as a standard and benchmark due to its well-proven reliability when research is done on obturation of root canals. This answer of the respondents may imply that while the schools in general are willing to include up-to-date methodologies in their teaching, other factors may affect decisions regarding MTA.

It is an undeniable fact that it takes a long-term accumulation of evidence-based information for new materials, techniques, and systems to be incorporated permanently into a predoctoral dental education program. Studies directed towards the implementation of different disciplines can be given as examples to clarify this issue such as the review performed by Kroeplin and Strub.21 These authors determined that the level of clinical experience in implant practice differed greatly between surveyed universities. They, however, concluded that because oral implant dentistry has become a standard treatment alternative, the predoctoral dental curriculum should include it. Another study that investigated the current teaching of posterior composite restorations found that there were minor variations philosophically in teaching the use and placement of resin composite restorations.22 When the context of endodontology is concerned, whilst rubber dam is accepted as a universally indispensable element of endodontic care and a mandatory constituent of predoctoral education, negative perceptions regarding its use have been noted amongst final-year dental students.23

With all these discrepancies as well as common ideas in hand, it is difficult to make a prediction regarding the future status of innovations or concepts in dental education. Mineral trioxide aggregate was specifically chosen in our study since it is believed to establish its role and position in the field of endodontology as an evidence-based material, given the vast number of studies, case reports, and reviews regarding its properties and usage. It is understandable that faculty members may show some reluctance in the inclusion of certain materials because of financial concerns. However, this does not deny the fact that they should be encouraged to update themselves by following the contemporary literature so as to be able to facilitate students’ knowledge and experience in acknowledged methodologies. When the educator acquires the foundation and skills to differentiate between commercialization and scientific bases, it will be much easier to evaluate the level of evidence of what he or she reads.

It is noteworthy to remember that the present study was limited to endodontics and did not con-
sider pedodontics, which is another important area of MTA use. Pitt Ford et al.\textsuperscript{12} in their study included the results of pedodontic departments as well. They commented that despite three randomized control trials all in favor of the use of MTA, pedodontists seemed to be more cautious about using the material in their clinical practice, indicating lack of evidence as the main reason. Our study attempted to investigate the role of MTA only in the endodontics context, while acknowledging that future studies on pedodontic departments would definitely be useful. Furthermore, the present study focused on the curriculum structure of predoctoral programs, not postgraduate programs. Though the investigation did not cover that level of endodontics education, to our knowledge the schools included in the study all have postgraduate programs. On the other hand, we believe that the delivery of information regarding a well-regarded material such as MTA should not be postponed until after graduation. Postgraduate programs may perhaps include more intensive use of the material, and procedures that are not allowed to undergraduates or those in which students participate as observers only may be performed by postgraduate students to enhance their level of expertise.

It is also noteworthy to mention that this study was limited to established dental schools in one country and highlights the general attitude of academicians towards the material within Turkey. Studies performed in different countries will be supportive in making a more generalized statement regarding the current position of this popular material in dental education worldwide.

Pitt Ford et al.\textsuperscript{12} concluded that some way should be sought to overcome disadvantages so that students are offered the best possible education in modern thinking and practice of endodontics that is not confined to root canal treatment only. The results of the present survey support their opinion. Financial difficulties should not impinge upon contemporary educational methods and prevent the selection of correct and up-to-date methodologies that will have a positive impact on patient care. Studies directed towards this topic performed in different countries shall definitely contribute to highlighting this issue.

**Conclusion**

Strategies should be developed so that beneficial innovations such as the various applications of MTA would be better integrated into endodontic education in dental schools in Turkey and elsewhere. Financial concerns and restrictions should not be the determining factor in what is taught.

**Acknowledgments**

The authors would like to thank all faculty members who participated in this study for their kind support and contribution.

**REFERENCES**