

A survey of dental practitioners in Wales to evaluate the management of deep carious lesions with vital pulp therapy in permanent teeth

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In brief

Provides an overview of the current provision of vital pulp therapy for the management of cariously exposed permanent teeth by general dental practitioners, community and hospital-based dental clinicians in Wales.

Highlights the differences in protocol and methodology between the dental settings in the provision of vital pulp therapy for cariously exposed permanent teeth.

Stresses the requirement for high quality postgraduate training in vital pulp therapy.

Objective To evaluate the management of deep carious lesions with vital pulp therapy in permanent teeth by dental practitioners within Wales. **Design** Postal questionnaire. **Setting** General practitioners (GDS), community (CDS) and hospital-based dentists (HDS) in Wales. **Methods** Community and hospital dental services with a remit for provision of restorative dentistry (CDS = 71; HDS = 46) and general dental practitioners (N = 510) were approached regarding their management of deep carious lesions with vital pulp therapy in permanent teeth. The postal questionnaire took the form of an anonymous survey. Questions covered usage parameters, training issues and reasons for material choice. **Results** The response rate was 29%. The majority of HDS (89%) used MTA or Biodentine for vital pulp therapy in contrast to GDS (41%) and CDS (32%). The main reasons cited for avoiding the use of MTA or Biodentine included cost, lack of training and difficulty in material handling. **Conclusion** Usage of MTA or Biodentine for vital pulp therapies is low in the general dental and community dental settings. Cost and lack of training are the main barriers for the uptake of these materials. Postgraduate training may be useful in addressing these barriers. Increasing their adoption would be advantageous as they have been shown to produce a more predictable outcome compared to traditional materials (for example, calcium hydroxide).

Introduction

There is a high prevalence of dental caries in Wales where 63% of 15-year-old children and 47% of dentate adults have obvious caries in their permanent dentition.¹ Late stage consequence of deep caries is the loss of tooth vitality resulting in apical periodontitis, the complications of which include pain and sepsis.

Apical periodontitis is a common dental disease and studies conducted in Europe and Scandinavia show that 33% of 20-

30-year-olds have at least one periapical lesion and this rises to over 62% for those over 60.² Where tooth retention is desired, management of this disease requires resource-heavy and time-consuming treatment, namely root canal therapy (and often extracoronary restoration). Data for 2014/2015 from the Welsh Government National Health Service (NHS) Dental Services Centre show that 24,500 and 1,700 endodontic treatments, in adults and children respectively, were performed by general dental practitioners (GDP) in Wales which constitutes 4.4% and 1.2% of all treatments, respectively.³ The estimated cost to the NHS was £1.5 million (based on approximate 'Band 2' fee of £60).

Over the past few decades minimally invasive techniques aimed at pulpal preservation, such as direct pulp capping and partial pulpotomy, have received wider acceptance and preference over pulpectomy before root canal filling.^{4,5} In

addition to the benefits of reduced cost and treatment time and simpler treatment, vital teeth also have a higher survival rate than root treated teeth.⁶ The lower survival rate of root treated teeth are often attributed to decreased and weakened tooth structure and reduced proprioceptive function leading to increased fracture risk.⁶

The objective of vital pulp treatment is to maintain pulpal vitality (American Academy of Paediatric Dentistry 'AAPD' 2014).⁷ In a situation where there is a carious pulp exposure and the pulp is viable (that is, normal pulp or reversible pulpitis), it is recommended that either direct pulp capping or partial pulpotomy is undertaken, depending on the size of exposure. Direct pulp capping is the placement of a medicament directly over a small exposure of the pulp whereas partial pulpotomy involves partial removal of inflamed pulp tissue beneath the exposure

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before placement of medicament.^{7,8} Both techniques can have success rates as high as 98-100% over a period of two to nine years when performed on cariously exposed young and mature teeth.^{4,9} The traditional belief that vital pulp treatment should be restricted to young permanent teeth has been challenged as studies have shown that cariously exposed mature teeth are also capable of pulpal regeneration.^{9,10} A study conducted by Matsuo *et al.*¹⁰ found no significant difference in success rates of direct pulp capping between patients over and under 40 years.

Traditionally, calcium hydroxide has been the material of choice for vital pulp treatment.¹¹ Despite its long-term documented success, contemporary studies have demonstrated its disadvantages when compared to mineral trioxide aggregate (MTA) (a thoroughly investigated biosilicate material initially introduced by Torabinejad in the mid-1990s for application as a root end filling material).¹² In 1996, Pitt-Ford *et al.*¹³ found that MTA, when used as a pulp-capping material in monkeys, produced less inflammation and better dentine bridge formation relative to calcium hydroxide. Aeinehchi *et al.*¹⁴ in 2002 subsequently supported these findings by demonstrating the same results in human teeth.

Unlike MTA, calcium hydroxide degrades over time due to its high solubility, does not promote consistent odontoblast differentiation, is cytotoxic in cell culture, and creates tunnel defects in the reparative dentine. Ingress of microbes via these tunnel defects are hypothesised to induce pulpal irritation, dystrophic calcification and potential degenerative changes in the pulp.¹⁵ MTA induces pulpal cell proliferation, cytokine and calcium

ion release, which contribute to reparative dentine formation. It also exhibits an excellent sealing ability, is non-absorbable due to its low solubility and has a high compressive strength.⁹ The AAPD guidelines and several authors have suggested MTA to be more favourable than calcium hydroxide for use in direct pulp capping and partial pulpotomy.^{7,16}

Since the introduction of MTA, biomaterials with claimed improved physical properties such as Biodentine (Septodont, France) have become popular in the market. Biodentine has been shown to produce similar results to MTA but, unlike MTA, is easier to handle, has a shorter setting time (12 minutes versus 2 hours and 45 minutes) and is less expensive.^{12,17} A study by De Rossi *et al.*¹⁷ in 2014 found that Biodentine demonstrated tissue compatibility and allowed for dentine bridge formation of similar morphology and integrity to that of MTA for direct pulp capping and pulpotomy in dogs' teeth. Though not specifically recommended in the guidelines, the current evidence supports the use of this material for pulpal repair.¹⁷

In view of the developments in pulpal medicaments and worldwide changes in clinical practice,¹⁸ there exists little UK data on how dental practitioners currently perform vital pulp therapies for cariously exposed pulps in permanent teeth. This study aims to evaluate the management of deep carious lesions with vital pulp therapy (that is, direct pulp capping and partial pulpotomy) in permanent teeth by dental practitioners in Wales. In greater detail to: i) determine how frequently vital pulp therapies are performed; ii) investigate the materials used for vital pulp therapies among the national cohort of dental practitioners in the general dental services (GDS), community

dental settings (CDS) and hospital based restorative dental services (HDS); and iii) determine the factors associated with uptake or avoidance of such materials.

Methods

A postal questionnaire was designed and piloted through staff members at Cardiff Dental Hospital. This was subsequently amended, reviewed and approved by the Cardiff Dental School Research Ethics Committee [Reference No: 1450].

To increase compliance, the questionnaire was restricted to four A4 pages, comprising a covering letter and fourteen questions. Within the covering letter, participants were provided an explanation as to the purpose of the questionnaire with particular emphasis on anonymity.

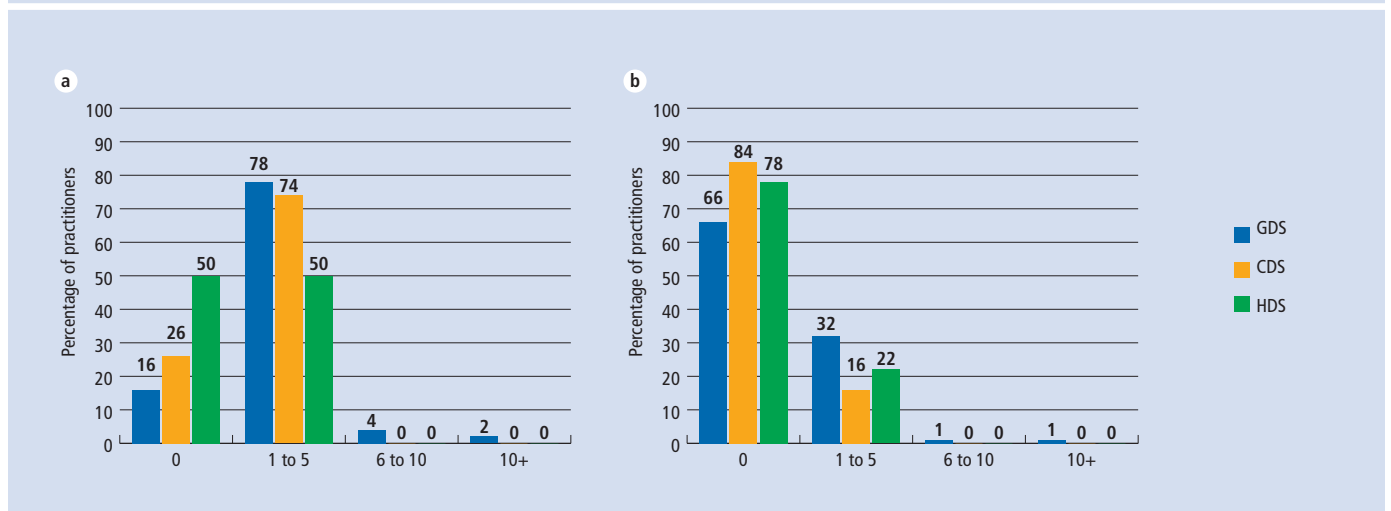
The first section of the questionnaire gave participants the option to opt out of answering the questionnaire. The second and third questions screened for those dentists that did not undertake vital pulp therapy.

The second section of the questionnaire comprised ten questions concerned with the practice setting, frequency of performing vital pulp therapies, the materials used and procedural training undertaken by the practitioner. The third and final section consisted of demographics.

In January 2015, the definitive postal questionnaire was delivered to CDS (N = 71), HDS (N = 46) and GDS (N = 510) in Wales using an address database held by the Welsh Dental Postgraduate Department. A reply-paid envelope was also included. Due to anonymity, a repeat sending of the questionnaire was not possible.

After a three month reply period data was collated and examined.

Fig. 1 Monthly performance of a) direct pulp capping and b) partial pulpotomies in three different care settings



Results

The results are given as absolute frequencies as well as percentages. One reply was found to be from a practice solely dedicated to orthodontics and seventeen practices (13 GDS and 4 CDS) were no longer at the address. These were excluded from the study. Twelve general practices (2%) chose to opt out of answering the questionnaire. Three questionnaires from general practices (1%) were inadequately completed. This left 131 (26%), 20 (28%) and 18 (39%) appropriately answered questionnaires from the GDS, CDS and HDS respectively for use in the data analysis.

Questions 1 and 2

Practitioners were asked whether they considered vital pulp treatment in permanent teeth to be in the remit of their service. This is relevant for those dentists where specific job planning may preclude the provision of such treatment. Eighteen responses from the GDS (4%) and one from the CDS (1%) were to the negative.

Question 3

In order to identify the practice setting, practitioners were asked whether treatments were performed in the GDS, CDS or HDS.

Questions 4 and 5

The questions aimed to establish the approximate number of direct pulp caps and partial pulpotomies carried out by the practitioner on a monthly basis. Categories comprised '0', '1-5', '6-10' or '10+' (Fig. 1a and 1b).

Very similar numbers of direct pulp caps were performed within the GDS (78%) and CDS (74%), all performing between one and

five treatments on a monthly basis. Sixteen percent GDS and 26% CDS practitioners did not perform direct pulp caps. In the HDS, the numbers were split, with 50% of practitioners performing none and 50% performing between one and five treatments per month. Only two general dental practitioners (2%) performed in excess of ten direct pulp caps per month.

For partial pulpotomies, the majority of practitioners in the GDS (66%), CDS (84%) and HDS (78%) did not perform this treatment at all. A low number of GDS (32%), CDS (16%) and HDS (22%) were performing between one to five treatments on a monthly basis. One general practitioner (1%) performed in excess of ten partial pulpotomies per month. This practitioner was one of the two practitioners that also performed in excess of ten direct pulp caps per month.

Questions 6 and 7

To investigate the types of materials used for vital pulp therapy, practitioners were asked which materials they had ever used for direct pulp capping and partial pulpotomy. Multiple answers were allowed.

In all three settings, CDS (51%), HDS (47%) and GDS (44%), setting calcium hydroxide was the most commonly cited material for direct pulp capping. Other materials included non-setting calcium hydroxide, MTA, Biodentine, glass-ionomer cement and Kalzinol (Fig. 2a).

For partial pulpotomy, very similar numbers were reported in the GDS (33%) and CDS (42%) with practitioners most commonly citing setting calcium hydroxide. This is in contrast to HDS, where Biodentine (39%) was most commonly cited (Fig. 2b).

Question 8

The numbers of dentists that routinely use MTA or Biodentine for either direct pulp capping or partial pulpotomy was examined. A significant majority of practitioners in the HDS (89%, N = 16) did use MTA or Biodentine, in comparison to a much lower proportion of practitioners in the GDS (41%, N = 46) and CDS (32%, N = 6).

Question 9

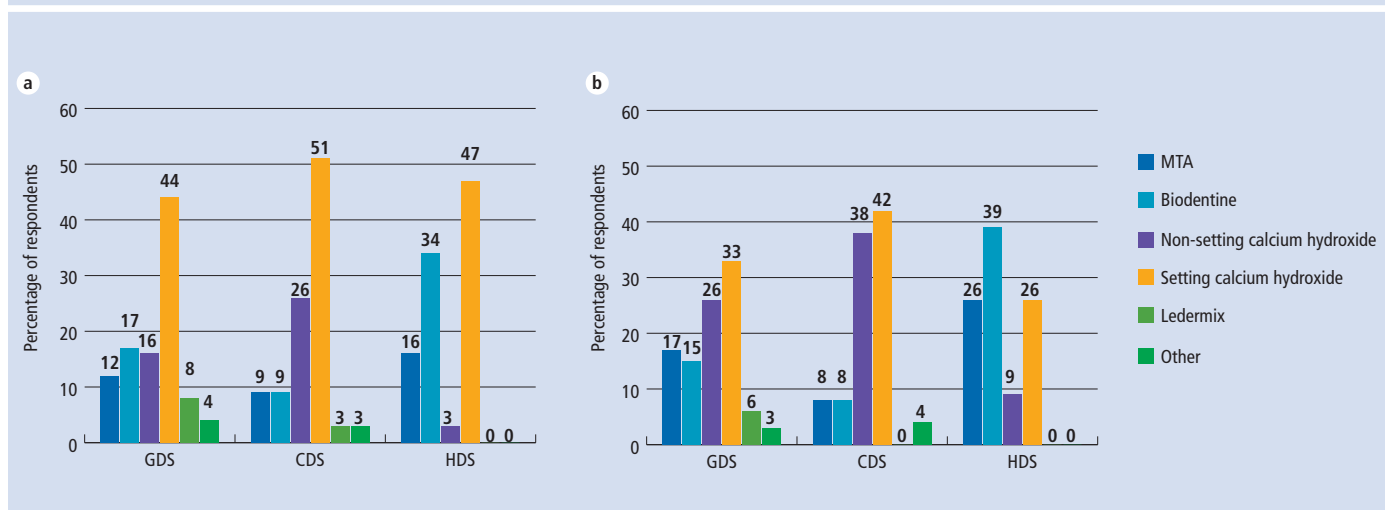
Practitioners that did not routinely use MTA or Biodentine were asked the reasons for avoiding their use. Predefined scenarios with check boxes were provided with the option to comment further if applicable. Multiple answers were allowed.

In the GDS, 40% of the 113 respondents stated that cost was the main inhibitory factor, 25% lack of training and 14% had never encountered MTA or Biodentine. This is in contrast to the CDS where of the 19 respondents 42% stated that lack of training was the main inhibitory factor, 26% cost and 11% time and difficulty in handling the material. In the HDS, only one respondent cited time as the inhibitory factor (Fig. 3).

Questions 10 and 11

Returning to the cohort of practitioners that were utilising Biodentine or MTA, questions 10 and 11 enquired as to how many years these materials had been in use. Check boxes were included for 'less than 1 year', '1-3 years', '4-6 years', '7-10 years' and '10+ years'. The majority of practitioners had been using these materials for between 1-3 years (68%, N = 49 for direct pulp caps; 65%, N = 60 for partial pulpotomy).

Fig. 2 Materials used for a) direct pulp capping and b) partial pulpotomies in three different care settings



Question 12

When asked whether postgraduate training in the use of MTA or Biodentine for vital pulp therapies would be beneficial to the practitioners of Wales, an overwhelming 85% (N = 96) agreed that this would be and 12% (N = 14) being unsure.

Question 13

The remaining two questions were related to demographics. Question 13 determined the year of qualification. The majority (35%, N = 53) of practitioners qualified between 1980-1989, followed by 27% (N = 40) between 2000-2009 and 20% (N = 30) between 1990-1999.

Question 14

This question enquired as to the country of qualification. The majority (95% N = 143) were of 'UK and Ireland' origin with few from mainland Europe, America, Asia and Africa.

Discussion

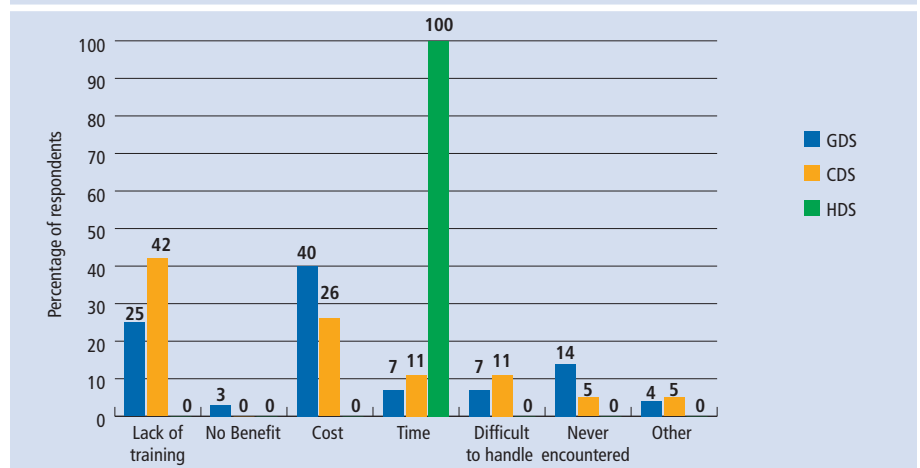
This study sought to collect data from all general dental practices, dentists working within restorative dentistry departments of hospitals or community dental clinics in Wales. A postal survey provided a simple means of data collection and in this survey the response rate of 29% (N = 184 returns of 627 questionnaires) was much lower in comparison to other dental questionnaires.¹⁹ Despite utilising sound techniques,¹⁹ it is possible that the topic being addressed is complex and consequently not a priority to many participants. It is therefore accepted that interpretation of survey data must take into account the low number of respondents and the risk of participation bias. However, data from 131 general dental practitioners does provide useful information on the treatment trends of this group of clinicians.

Wales has a unique position in the UK as it is served by one dental teaching hospital and school located at its capital, Cardiff. It is fortunate that data on practices and practitioners is held centrally within the Postgraduate Department of Medical and Dental Education. This has allowed the authors an opportunity to investigate, as a whole, the practicing methods of vital pulp treatment among the nation's dentists.

Frequency

Responses from the survey showed that direct pulp capping was performed infrequently and pulpotomies performed rarely. A study by Bjorndal *et al.*²⁰ showed similar results,

Fig. 3 Factors inhibiting the uptake of MTA or Biodentine in those practitioners reporting not using these materials



reporting a low frequency of vital pulp treatments undertaken in Danish adults in 2003, with less than ten pulp capping and less than three pulpotomy procedures recorded per 1000 patients. It may be that practitioners have a stronger preference toward other treatment modalities, however, this is difficult to ascertain in the absence of data. Within the current literature, studies have shown a variation in treatment strategies among dentists.^{6,21} Oen *et al.*²² in 2006 surveyed a group of practitioners engaged in applied research and learning and discovered that in a scenario where a pulp exposure was anticipated during caries removal, 59% selected direct pulp capping, 26% 'immediate endodontics' (that is, pulpotomy) and 14% pulpectomy.

The basis of vital pulp therapy arises from the current histological understanding of the caries process and its effect on the pulp. Caries, initiated by oral bacteria, can progress to result in pulpal exposure, and if this occurs chronic inflammatory exudate and liquefaction necrosis results beneath the exposure site.^{23,24} For treatment to be successful, it is therefore necessary to remove the infected, necrotic and disintegrated pulpal tissue. Histologically, treatment can be considered successful when there is evidence of reparative dentine bridge formation, preservation of pulpal vitality and odontoblast layer integrity, preserved periodontal ligament and absence of bone or root resorption and microorganisms.¹⁷

One of the concerns regarding direct pulp capping in the management of cariously exposed permanent teeth is the failure to remove the infected dentine remnants introduced into the pulp during caries excavation. This may be the reason for the poor success

rates demonstrated.²⁵ Bjorndal *et al.*²⁰ found a 32.8% overall pulp survival rate with direct pulp capping at one year review. Similar results were found by Al-Hiyasat *et al.*²⁶ reporting only 33% success after three years. Partial pulpotomy studies in contrast have shown high success rates. Over a three year follow-up period, Quidemat *et al.*²¹ reported 93% success rate for partial pulpotomy in permanent molars with carious exposures using MTA. It is proposed that controlled removal of the infected coronal pulp serves to increase the healing potential.²⁷ Having said this, it is interesting to note that a greater proportion of the practitioners sampled in the current study perform direct pulp caps over partial pulpotomies (50-82% versus 16-34%) despite evidence in favour of the latter procedure.^{6,20,28,22}

Dental material selection

There is a clear difference in material selection for vital pulp treatment in the HDS versus GDS and CDS. A majority of HDS practitioners reported the use of MTA or Biodentine compared to less than half of CDS and GDS practitioners. It is unsurprising that the majority of HDS practitioners routinely use MTA or Biodentine for vital pulp treatment given that most staff would adhere to the taught standards at their teaching institution (refer to later section 'Education and training'). Certainly, there is a discrepancy in clinical protocol between the HDS versus the GDS and CDS and it is likely that cost, training and other factors are responsible for the low uptake.

Although this study did not directly investigate the predominant material used for vital pulp treatment, calcium hydroxide was the most commonly cited within the CDS

and GDS and presumably this is the material principally adopted within these settings. This may be centred on what dentists were taught as undergraduates and the familiarity of the material.

The most effective material for vital pulp treatment remains a highly debated topic in dentistry. Studies have largely supported either the use of MTA and calcium hydroxide for vital pulp treatment.^{21,29} Despite the longer track record of calcium hydroxide,¹¹ MTA and Biodentine have demonstrated several advantages. These include excellent sealing ability, non-absorbability, high compressive strength, reduced pulpal inflammation and more complete dentine bridging.^{9,13,14} Although improved clinical outcomes with MTA and Biodentine is still not a universally conclusive finding within the literature, it is the authors' opinion that these materials are more favourable for use in direct pulp capping and partial pulpotomy than calcium hydroxide.

Barriers to uptake

Cost was the most cited reason as the inhibitory factor for the use of MTA or Biodentine in vital pulp treatment in the GDS (40%) and CDS (26%). There is a clear difference when comparing the budget allocation between HDS and GDS/CDS. NHS hospital environments are fortunate to have allocated funds for clinical treatments and materials, thus cost of material is perhaps not of 'direct' concern to the individual clinician; a scenario that the authors suggest is not mirrored in the CDS or GDS. The financial barriers to MTA and Biodentine uptake can be appreciated when evaluating material cost. In comparison to setting calcium hydroxide, the market price of Biodentine and MTA is approximately six and sixty-five fold respectively.³⁰ Undeniably, these costs are considerably higher than calcium hydroxide and while it is accepted that financial constraints have an impact on material choice, practitioners should strive to use the best material available that provides the most predictable outcome for their clinical treatments. Certainly, what would be useful to know is the long-term cost benefit and cost effectiveness of materials used for vital pulp treatments, research of which is currently lacking.²⁸ Over the long-term, effective pulp therapy using the most biologically acceptable material may maintain tooth vitality. This may be cost effective as it reduces the need for resource demanding and complex root canal therapy.

The present study found that 25% of GDS and 42% of CDS staff reported 'lack of training' as the prohibitive factor. In addition, 14% of GDS practitioners had 'never encountered MTA or Biodentine' and 11% of CDS practitioners found it 'difficult to handle the material'. It would seem apparent that the level of postgraduate training and operator experience with MTA and Biodentine is low in both these cohorts. This may offer solutions for improving usage by targeting these groups via provision of high quality postgraduate education.

Of note, 11% of CDS staff cited 'time' as the inhibitory factor. It can only be assumed that this relates to either the prolonged setting time or difficulty in mixing and handling MTA and Biodentine. These possible factors could be resolved with the appropriate exposure and training.

Education and training

Currently, undergraduate dental students at Cardiff University School of Dentistry are taught standards for direct pulp capping and partial pulpotomy as summarised below and based on the AAPD guidelines 2014.⁷

A thorough assessment of the tooth is first performed to ensure suitability for vital pulp treatment.⁷ Local anaesthetic is administered and rubber dam is applied. For direct pulp capping, pulpal haemorrhage is controlled using a cotton pellet soaked in sterile saline. A cotton pellet moistened with 1% sodium hypochlorite is subsequently used to wipe the wound ensuring an aseptic field and to remove the superficial blood clot for the application of the pulp capping material.

In pulpotomy cases, the inflamed pulp tissue beneath an exposure is removed to a depth of one to three millimetres or deeper to reach healthy pulp tissue using a high-speed turbine with constant water spray. Haemorrhage control is critical¹⁰ and this is performed as described for direct pulp capping followed by wiping the wound with a cotton pellet moistened with 1% sodium hypochlorite. The site is subsequently covered with either mineral trioxide aggregate (MTA) or Biodentine.

For MTA, the material is mixed into a creamy paste (cement to water ratio 3:1) and placed (at least 1.5mm thick) onto the wound and surrounding dentine floor. The MTA is padded using a moist cotton pellet with minimal pressure. A moist cotton pellet is placed over the MTA and the tooth is restored with a temporary restorative material. A minimum of a week later, the tooth is reassessed to confirm

viability of the pulp with appropriate symptom history and pulp testing. The temporary material and cotton pellet is removed and a final restoration is placed over the set MTA.

For Biodentine, the material is mixed according to the manufacturer's instructions and used to fill the entire cavity preparation with minimal pressure on the pulp wound. Biodentine sets relatively quickly and initial hardening is usually complete within 20 minutes. The material is subsequently prepared after a minimum of 48 hours for enamel restoration using a definitive material, such as composite resin.³¹

The aforementioned biosilicate materials are a relatively new technology in dentistry and many dental practitioners may not have been taught their use during undergraduate training. In this survey, at least 43% of dental practitioners within Wales had qualified before the introduction of such materials. This represents a large proportion of clinicians that would be unfamiliar with its use if postgraduate training had not been sought after qualification.

Even with the implementation of biosilicate materials training in the UK dental undergraduate curriculum, it is questionable whether sufficient training is received. Pitt Ford *et al.*³² in 2007 found that undergraduate dental students in thirteen UK dental schools were taught about the clinical use of MTA. Despite this, there was little opportunity for students to use the material clinically. Only students in seven schools had the opportunity to carry out pulp capping with MTA and in five schools to carry out pulpotomy in permanent teeth with MTA. Financial constraints and a crowded timetable were cited as the main reasons for this limited clinical exposure.

Supervised and focused continuing education improves clinical skills and knowledge and helps delay declining clinical competence. It is encouraging to report that an overwhelming number of dentists felt that postgraduate training in the use of MTA or Biodentine for vital pulp treatment would be beneficial.

Conclusion

The use of MTA and Biodentine for vital pulp therapies in deep carious lesions is low within the cohort of GDS and CDS staff of Wales when compared to HDS staff, where there is an encouragingly high level of uptake.

It appears that the high material cost and the NHS remuneration system within the GDS and

CDS may have a negative influence on the rate of adoption of MTA and Biodentine.

Although increased success rates with the use of MTA and Biodentine is not a universally conclusive finding within the endodontic literature, there is evidence to suggest that these materials provide advantages over traditional medicaments, in particular reducing pulpal inflammation and better dentine bridging. Providing high quality hands-on courses may be useful in allowing dentists in all settings introductory experience, thereby easing the transfer to newer technologies. A dissemination of the practicing regimes of HDS to their CDS and GDS colleagues may ease the transition to biosilicate material technology.

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Appendix 1 Participant information sheet (cont. on page 338)

Dear Colleague

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

Title of project

A survey to evaluate the management of deep carious lesions with vital pulp therapy in permanent teeth by dental practitioners within Wales.

Purpose of the study?

This postal questionnaire aims to evaluate the management of deep carious lesions with vital pulp therapy (including pulp capping and partial pulpotomy) in permanent teeth by dental practitioners within Wales. The duration of the study will last three months.

Our study aims to:

- (i) Investigate the materials used for vital pulp therapies among the national cohort of dental practitioners in the general dental services, community dental settings and hospital-based restorative dental services within Wales.
- (ii) Determine the factors associated with uptake or avoidance of such materials.

Why have I been chosen?

Participants have been selected if they are general dental practitioners or dental clinicians within the community dental settings and hospital-based restorative dental services in Wales. 515 dental practices, 75 community dental services and 36 hospital dental services have been included in this study. Details were obtained from the database held by the Dental Postgraduate Section of the Wales Deanery.

Do I have to take part?

It is up to you to decide whether or not to take part. Should you decide to take part, please note that you will be unable to withdraw once the questionnaire has been returned.

What will happen to me if I take part?

Once you have returned the questionnaire, the data will be collected over a period of three months and the results subsequently reviewed.

What about confidentiality?

All returned questionnaires are anonymous and no repeat mailings will be undertaken.

What do I have to do?

If you decide to participate in the study, this postal questionnaire should take no more than five minutes to complete. The survey consists of 14 questions designed so that, in the main, you need only tick boxes. For those questions with multiple answer choices please circle the most appropriate answer. Please return questionnaires using the pre-paid envelope included.

Are there any risks?

No. The information you provide is anonymous and therefore confidentiality is protected. The data collected will be stored electronically on a secure database and discarded in line with Cardiff University Records Retention Schedule and Guidance for Managing Research Data and Records.

What will happen to the results of the research study?

The trends of the survey will be published in a peer-reviewed journal, likely in 2015. You will not be identified in any report/publication, as the questionnaire is anonymous.

Who is organising and funding the research?

This study is funded by the University of Cardiff.

Contact for further information

If there are any queries or if you require further information relating to the study please do not hesitate to contact us.

Kind regard

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If you would like to opt out of answering this questionnaire please tick here but we would be grateful if you would return the unanswered form for our data collection. Thank you.

1. If direct pulp capping (that is, placement of a medicament directly in contact with an exposed pulp) in permanent teeth is not within the remit of your services tick here .

2. If partial pulpotomy (that is, removal of approximately 1-3mm of inflamed pulp tissue before placement of a medicament) in permanent teeth is not within the remit of your services tick here .

If you have ticked both 1 & 2 please return the unanswered form for our data collection. Otherwise please continue to question 3. Thank you.

3. When performing either direct pulp capping or partial pulpotomy, do you provide this under: (please tick all that apply)

- NHS contract
- Private contract
- Community setting
- Hospital setting

4. Approximately how many direct pulp capping procedures do you perform each month?

- 0
- 1-5
- 6-10
- >10

Appendix 1 Participant information sheet (cont. from page 337)

5. Approximately how many partial pulpotomies do you perform each month?

- 0
- 1-5
- 6-10
- >10

6. Which materials have you ever used for direct pulp capping?

- MTA
- BiodentineTM
- Non-setting calcium hydroxide
- Setting calcium hydroxide
- Other

7. Which materials have you ever used for partial pulpotomy?

- MTA
- BiodentineTM
- Non-setting calcium hydroxide
- Setting calcium hydroxide
- Other

8. Do you use MTA or BiodentineTM for either direct pulp capping or partial pulpotomy?

- No (Please go to question 9)
- Yes (Please go to question 10)

9. Please indicate if any of the options below are why you choose not to use MTA or BiodentineTM for vital pulp therapy. Please elaborate if necessary.

- Lack of training
- No perceived benefit
- Cost
- Time consuming
- Difficult to handle material
- Never encountered BiodentineTM or MTA Other (Please go to question 12)

10. For how many years have you used MTA or BiodentineTM for direct pulp capping?

- <1 year
- 1-3 years
- 4-6 years
- 7-10 years
- 10+ years

11. For how many years have you used MTA or BiodentineTM for partial pulpotomy?

- <1 year
- 1-3 years
- 4-6 years
- 7-10 years
- 10+ years

12. Do you feel postgraduate training in the use of MTA or BiodentineTM for vital pulp therapy would be beneficial to the practitioners of Wales?

- Yes
- No
- Unsure/no opinion

13. In what year did you qualify?

- 1960-1969
- 1970-1979
- 1980-1989
- 1990-1999
- 2000-2009
- 2010-2014

14. Country of qualification?

- UK and Ireland
- Mainland Europe
- Americas
- Australasia
- Asia
- Africa

Thank you for your participation in the study
Please return questionnaires using the pre-paid envelope provided