

What's new for the clinician – summaries of recently published papers

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1. NeoMTA versus conventional white mineral trioxide (MTA) aggregate in revascularisation of non-vital immature permanent anterior teeth (a randomised controlled trial)

Damage to newly erupted anterior permanent teeth whose roots are still developing can be disastrous for young children and the aesthetic consequences thereof can have lasting effects on the wellbeing of the growing child. Also, there is the risk of fracture, discoloration due to pulp necrosis and a loss of the anterior permanent tooth at a young age which is costly to repair/replace.

Several techniques have been used for the management of non-vital immature permanent teeth including calcium hydroxide apexification and apical plug technique. Although these techniques were successful in achieving apical closure and healing of the periapical pathosis, they do not contribute to any quantitative or qualitative increase in root dimensions since a hard tissue barrier formation only occurs apically without further root development¹.

Revascularisation is a regenerative endodontic procedure (REP) that stimulates the continuation of root development. It is considered a valuable treatment as it strengthens the root walls by stimulating the deposition of hard tissues and promoting the development of normal apical morphology¹. Mineral trioxide aggregate (MTA) has been widely used in revascularisation procedures for coronal sealing because of its biocompatibility, good sealing properties and marginal adaptation. However, its poor handling characteristics and potential coronal discoloration effects are the major disadvantages of using white mineral trioxide aggregate (WMTA)¹.

The NeoMTA (NuSmile) is pure MTA that is marketed as a cost-effective MTA intended to be used for paediatric pulp therapy as it has a fast setting time, easy handling and its most important modification is its non-staining formulation. Tantalum oxide (Ta₂O₅) has been added to NeoMTA as a radiopacifying agent instead of bismuth oxide (Bi₂O₃) which has been linked mainly to the cause of discoloration in conventional MTA which is a significant aesthetic concern¹. Tawfeek and colleagues from Egypt (2023)¹ reported on a trial that sought to evaluate clinically and radiographically the effect of using two types of coronal plug materials in the revascularisation of non-vital immature permanent anterior teeth with special reference to assessment and evaluation of discoloration potential over a period of one year.

MATERIALS AND METHODS

This was a parallel, double-blinded, randomised controlled trial with a 1:1 allocation ratio with two groups of 15 teeth which was the unit of interest.

A total of 30 non-vital immature permanent anterior teeth in 25 children were enrolled in this study with the following inclusion criteria: children were 8-15 years old; free from any systemic diseases; upper traumatised permanent anterior teeth with non-vital pulp and immature root apex; with pulp space not needed for post and core. Children with poor oral hygiene or those with teeth with root resorption, luxation injuries and root fracture, and severe discoloration/unacceptable colour difference between affected tooth and contralateral tooth were excluded.

Pre-operatively, personal, medical, dental, trauma history and clinical examination were attained based on the checklist of the European Society of Endodontology for revitalisation's pre-operative diagnostic procedures¹. Conventional pre-operative periapical radiographs were also taken. Preparation for digital radiographic procedures and construction of a radiographic stent was done to perform an individualised Extension Cone Paralleling (XCP) index for each patient. A radio-opaque object of known dimension (5mm stainless steel wire) was embedded in the acrylic stent before setting.

The 30 permanent immature teeth were randomly assigned by a simple randomisation procedure into two equal groups: Experimental Group (N) – 15 teeth treated with NeoMTA (NuSmile Neo MTA) and Control Group (W) – 15 teeth treated with Conventional WMTA (White Angelus MTA) using shuffled closed white opaque envelopes picked by a patient at the second appointment just before placement of the coronal plug step.

The participants and legal guardians were blinded. Additionally, the radiographic assessor, one of the clinical assessors for the colour change to avoid detection bias, and the statistician were blinded to avoid reporting bias. Treatment of the selected teeth was performed according to AAE [12] clinical considerations for a regenerative procedure and the same procedures were applied to all teeth in the study. The only difference was the coronal plug material used.

At the first appointment, each tooth was locally anaesthetised using topical anaesthesia gel benzocaine 20% followed by labial infiltration using Articaine HCL 4% with 1:100,000 epinephrine, then isolated with a rubber dam. A conventional access cavity was done, then the working length was determined radiographically. Passive pressure irrigation using 1.5% sodium hypochlorite (NaOCl) (20ml/canal, 5min) with a side vent needle placed 1-2mm from the apex, then sterile physiological saline (5ml), followed by 17% Ethylenediaminetetraacetic acid (EDTA) (20ml/canal, 5min). Canal dryness was performed using suitable size paper points then placement of intracanal medication (double antibiotic paste) prepared from equal amounts of

Ciprofloxacin 500mg and Metronidazole 500mg with a ratio of 1:1. The mix was delivered into the canal using a disposable plastic syringe having plastic tips adjusted to be 2mm shorter than the working length. The excess paste was removed, and the access cavity was sealed with dry cotton and 3-4mm of light-cured resin-modified glass ionomer (RMGI), then the patient was dismissed for 4 weeks.

After 4 weeks, the response to the initial treatment done at the first appointment was assessed. Complete resolution of signs and symptoms which include pain, swelling, sinus or fistula was considered success of the first appointment. Tooth colour baseline T_0 was recorded for the affected tooth at the beginning of the second appointment using VITA Easyshade V digital spectrophotometer – three measurements were recorded then the mean colour was calculated. Intraoral photographs were captured for documentation using fixed settings of the camera with no flash.

At the second appointment, each tooth was locally anaesthetised using topical gel and labial infiltration using 3% mepivacaine without vasoconstrictor. The temporary dressing was removed after isolation by rubber dam then irrigation with 17% (EDTA) (20ml/canal, 5 min) followed by canal dryness. Bleeding was obtained by overinstrumenting and rotating a pre-curved K-file at 2mm past the canal to have the entire canal filled with blood. A tight cotton pellet slightly wetted with sterile saline was inserted and left for 10-15min to allow the formation of a clot, then cleaning of any blood remnants on the walls of the cavity was done using a bond brush. A resorbable collagen matrix Colla-plug™ was placed over the clot followed by placement of the coronal plug material according to the tooth allocated in which group – either NeoMTA (NuSmile Neo MTA) or conventional WMTA (White Angelus MTA) – forming about 3mm thickness just underneath the cemento-enamel junction (CEJ). Excess material on the cavity wall was removed, then a conventional periapical radiograph was taken to double-check the proper position of the coronal plug in relation to CEJ. Once the material became firm within 10-15min, RMGI followed by composite filling (3M, Filtek, Z350) was placed. Immediate postoperative (baseline) digital radiograph was taken at the end of the second appointment with a digital X-ray machine using a standardised paralleling technique by the (XCP) alignment system with the radiographic stent and the large 3x4cm phosphor storage plates (PSPs) imaging plate (Soredex DIGORA®). The DIGORA Optime scanner scanned imaging plates.

All patients were planned to be recalled for clinical follow-up after 1 week, 1 month, 3 months, 6 months and 12 months while radiographic follow-up was planned to be at 6 months and 12 months but, due to the Covid-19 lockdown, a modified follow-up was done as all patients were not able to attend the 6 months recall visit. Consequently, the following measures were done to assure the patients and their parents. Through a phone call, parents were asked about pain and change in colour if present. Parents were taught how to examine visually the vestibule. Moreover, parents were requested to send an intra-oral photo if possible. All the data that were collected during this period were just to check on patients but were not used for statistical analysis. In the follow-up visit the treated teeth were evaluated for clinical parameters: Pain on biting: reported by asking the patient about the presence of pain while biting (yes/no);

Pain on percussion: detected by tapping the tooth with the back of an autoclavable mirror; Presence of swelling, sinus or fistula: checked by visual examination and palpation of the labial vestibule and the palatal area related to every affected tooth. Mobility was examined using the back of 2 autoclavable mirrors. The unit of measuring these parameters was binary (present/absent). For discoloration, parents reported discoloration (presence/absence of change in tooth colour) or there was visual assessment of discoloration by two assessors reported as the presence/absence of tooth colour change.

There was also a more objective quantitative assessment of colour change. The spectrophotometer measured the colour of teeth based on the Commission Internationale de l'Eclairage's CIELAB colour space system. The $L^* a^* b^*$ system allows colour specification within a three-dimensional space where the L^* axis represents the degree of lightness within a tooth and ranges from 0 (black) to 100 (white); the a^* plane represents the degree of green-red within a tooth, a^* values range from red (+80 a^*) to green (-80 a^*); and the b^* plane represents the degree of blue-yellow within the tooth and b^* values range from yellow (+80 b^*) to blue (-80 b^*). Three measurements were recorded for each follow-up then the mean colour was calculated. The change in tooth colour was calculated by monitoring changes in ΔL , Δa , Δb by subtracting the baseline measurements from the follow-up measurements. Delta E (ΔE) is the total colour difference or the distance between two colours, (ΔE) was calculated. The proposed limit for colour difference adopted in this study was set at 3.7 ΔE units (perceptibility threshold) which means how much colour change is considered perceptible; differences beyond this limit were considered clinically perceptible.

Radiographic parameters assessed were presence of external or internal root resorption; assessment of periapical area – presence or absence of radiographic signs of infection; and root lengthening, which was measured on the Digora software.

RESULTS

During the follow-up period, four cases (26.7%) dropped out from each group and were excluded from the data analysis. Twenty children with 22 teeth completed the 12-month study period.

For clinical outcomes, all teeth showed normal clinical findings – there was a complete absence of signs and symptoms such as pain on biting, pain on percussion, swelling, sinus/fistula and mobility in both groups during all follow-ups so both groups were (100%) clinically successful with no statistically significant difference between groups. In terms of discoloration, none of the parents reported discoloration at the 1-week follow-up, at 1 month only one parent in Group (N) reported the presence of discoloration in one tooth (9.1%) and two parents in Group (W) reported discoloration in 2 teeth (18.2%), at 3 and 12 months follow-up only one parent in Group (N) reported discoloration in one tooth (9.1%) and three parents in Group (W) reported discoloration in 3 teeth (27.3%) and the difference between groups was not statistically significant (p -value=0.269). The discoloration was also assessed visually by two clinicians. At 1 week no discoloration was detected in Group (N), while one tooth (9.1%) showed discoloration in Group (W). At 1 month, discoloration was detected in one

tooth (9.1%) in Group (N) and three teeth (27.3%) in Group (W). At 3, 12-months follow-ups discoloration was detected in a single case (9.1%) in Group (N) and three cases (27.3%) in Group (W), and the difference between groups was not statistically significant (p -value=0.269).

The change in colour between baseline and 12 months was quantified for each tooth by measuring the CIE L*a*b* values and calculation of ΔE . At the end of 12 months, it was found that the mean ΔL value of Group (W) was more than Group (N), in a direction indicating decreased luminosity with no significant difference between groups. The mean Δa value at the end of 12 months showed that Group (N) remained in the red values direction, while Group (W) showed a reduction in redness, thus an increasing change towards the green direction. The alterations observed in the WMTA group were significantly greater compared with the other group. The mean Δb value of Group (W) was more than Group (N), in a direction indicating a reduction of yellow colour, thus an increasing change towards the blue direction with no significant difference between groups. The mean and standard deviation values for initial root length in mm were 11.694 (± 1.644)mm for Group (N) and 12.654 (± 1.449)mm in Group (W). There was no significant difference in mean initial root length in both groups (p -value=0.162).

Continued root lengthening was observed in this study, the mean increase in root length in mm and percentage between 12 months follow-up and pre-operative root length in Group (N) was 1.03 (± 0.97)mm, 8.52 (± 3.33)% and in Group (W) was 1.04 (± 0.86)mm, 8.64 (± 4.30)% with no significant difference between both groups.

Regarding the radiographic evaluation, all teeth in both Groups (N) and (W) were free of internal and external root resorption. Also, there was a complete absence of any radiographic signs of infection, accordingly the overall clinical and radiographic success rate was 100% for both Groups (N) and (W).

CONCLUSION

The researchers found that both NeoMTA and conventional WMTA were successful coronal plug materials in the revascularisation of non-vital immature permanent teeth, achieving a high level of clinical and radiographic success. For the primary outcome of discoloration, there was no statistically significant difference between both materials.

IMPLICATIONS FOR PRACTICE

The newer material NeoMTA marketed as an alternative with lesser potential for discoloration did not statistically outperform the conventional MTA material for the primary outcome of discoloration.

REFERENCE

1. Tawfeek HA, El-Bardissy AA, Abou El-Yazeed M, Youssef R, Abd Alsamad AM. Clinical and radiographic evaluation of Noemata versus conventional white mineral trioxide aggregate in revascularization of non-vital immature permanent anterior teeth (A randomized controlled trial). *BDJ open*. 2023 Apr 28;9(1):17.

2. Is iodine effective for decontamination of dental unit waterlines?

One of the more commonly neglected areas of infection control in the dental surgery is related to dental unit waterlines (DUWLs). Dental unit waterlines serve as pipelines to deliver fresh water for cooling and irrigating during dental procedures. Waterlines are made of silicone rubber or polymer tubes. This pipeline is always filled with

water, creating an environment suitable for biofilm formation. Once formed in the waterlines, biofilms are extremely difficult to eliminate¹. According to American Dental Association (ADA) standard, the prevalence of bacterial contamination of DUWLs was estimated to be as high as 85.0%, while the prevalence of pathogenic species such as *Legionella pneumophila* and *Pseudomonas aeruginosa* is 12.0% and 8.0%, respectively¹.

Various microorganisms, including bacteria, fungi, viruses and protozoa contaminate DUWLs. The most common form of microorganisms found in DUWL is gram-negative bacteria, some of which are opportunistic pathogens. These pathogens harm not only vulnerable groups of patients, such as the immunocompromised and the elderly, but also the dental staff in the clinic¹. The Centre for Disease Control and Prevention (CDC) recommends that procedural water for nonsurgical dental procedures contain less than 500CFU/ml of heterotrophic water bacteria¹.

There are many methods to reduce the contamination of DUWLs, including non-chemical and chemical approaches. Treatment by chemical agents can be performed as intermittent or continuous methods. Several products have been introduced for continuous chemical treatment methods, such as chlorine dioxide, hydrogen peroxide, chlorhexidine gluconate and iodine¹. Iodine is a potent oxidising agent that can kill microorganisms such as bacteria by attaching to microbial plasma membranes and inhibiting protein function. The principal mechanism of oxidising agents in killing microorganisms is to disrupt cellular functions and reduce viability¹. Iodine has been used for many purposes, such as wound antiseptic, water disinfection and preventing goitre by adding it to drinking water. There are many forms of iodine, including organic iodide compounds such as bis-glycinate hydroiodide, potassium tetraglycine triiodide, iodophors (iodine with solubilising compounds) and other iodine release systems such as iodine-incorporated resins. The DentaPure Independent Water Bottle Cartridge, a commercially available continuous iodine treatment system, releases a low dose of iodine to decontaminate DUWLs. Despite being widely used worldwide, the effectiveness of this device in real clinical settings has not been reported elsewhere. Petchphayaprai and colleagues from Thailand (2023)¹ reported on an in-vitro study that sought to investigate the efficacy of iodine-releasing cartridges in controlling bacterial contamination and biofilms in DUWLs from 10 similar dental chair units at a dental school.

MATERIALS AND METHODS

Ten similar dental chair units of the same model and use life at the faculty of Dentistry Chulalongkorn University, Thailand were randomly selected. The units were divided into two groups: five units of the control group with no intervention added to the waterlines and five units of iodine treated group in which the waterlines were continuously disinfected by installing iodine-releasing cartridge systems (DentaPure). The system contained non-allergenic iodinated resin beads, which released 2-6ppm of atomic isotopes of elemental iodine (I_2) during a typical dental treatment. During the experimental period, the dental chair units normally operated at official working hours, 5 days a week.

Sample collection was performed every Wednesday, in the middle of the week, to avoid the variability in the data from stagnant water during the holiday. Some 25ml of water

samples were collected from the airtor lines of each dental unit after flushing the pipe for 1 minute. As baseline water contamination, the samples were collected 1 month before installing iodine water treatment cartridge systems. Then the samples were collected every Wednesday continuously for nine weeks.

The water samples were sonicated for 10s to disperse the cluster of microorganisms. Serial tenfold dilution was performed, and 100µl of the samples were plated onto R2A agar plates. All plates were incubated at 35°C for 3-5 days, then bacterial colonies were counted. The numbers of colonies were converted into colonies forming units per ml (CFU/ml). The number of bacteria in each dental chair unit at each time point was compared to the initial amount at baseline, calculating the percent CFU reduction from the baseline data. The log CFU reduction was calculated by taking $\log[A/B]$ (A =the average amount of bacteria each week, B =the number of bacteria at baseline).

At the end of the experiment (at week 9), the DUWLs in the path that delivers water to the airtor line inside the control box of dental chair units were sectioned into 5mm lengths and kept in 0.9% sterile normal saline solution. The procedure was repeated at the same position in every dental chair unit of the control and iodine group. The lines were split in half. The biofilms were swabbed completely from a 5mm length of duct to remove all biofilms and the amount of adenosine triphosphate (ATP) measured by ATP testing kits (3M™ Clean-Trace). These kits can detect the presence of microbial contamination in DUWLs. The amount of ATP in relative light units (RLU) represents the relative bacterial vital activities.

After installing the iodine treatment cartridge for 11 months, the iodine concentration in water samples was determined by an iodide electrode and benchtop pH meter (Orion Star™). The electrode measures iodide ions represented by water electric potential in mV. Then it converts electric potential to iodine concentration by comparing it to the standard iodine solution at 1, 2, 2.5 and 5ppm. The water samples were collected again to measure bacterial contamination that represented the long-term effectiveness of the iodine cartridge.

RESULTS

Dental unit waterlines (DUWLs) of 10 dental chair units were highly contaminated with bacteria, with an average of $41,500 \pm 21,016$ and $61,500 \pm 61,005$ CFUs/ml in the control and iodine groups, respectively. During the experimental period, the highest average CFUs/ml of all DCUs in the control group was $32,750 \pm 3,594$ CFUs/ml (at week 5)

compared to $1,452 \pm 854$ CFUs/ml in the iodine group (at week 7). The bacterial count in the iodine group was lower than 500 CFU/ml in almost all weeks, except weeks 6 and 7, which meet the standard of water contamination recommended by the US CDC for nonsurgical dental procedures. There were statistically significant differences in the bacterial count from DUWLs of the iodine and control groups. The percent CFU reduction in the iodine group ranges from 98% to 100%.

The number of bacteria drastically decreased from the first week of continuous iodine treatment. The average CFUs/ml of bacteria recovered from the airtor lines of the iodine group is 354 ± 541 CFUs/ml, significantly lower than the control group ($18,591 \pm 9,208$ CFU/ml). The average CFU/ml was transferred into log reduction to compare the decontamination efficacy to the sterility assurance level at 6 log reduction. The effectiveness of the iodine treatment was determined in a log reduction ranging from 1.63 to 4.39 log, except in the fourth week when the log reduction could not be calculated because no bacteria was recovered from the sample.

At week 9, the viability of biofilms in DUWLs was assessed by the amount of ATP. Biofilms in the iodine group had slightly lower ATP than the control group, though not statistically significant.

After 11 months of installation, the iodine concentration was measured to determine the potency of the cartridge. The average iodine concentration released in DUWLs procedural water was measured to be 3.6ppm. This amount of iodine was still able to control bacterial contamination in the DUWLs, as demonstrated by the average bacterial CFU/ml ($3,125 \pm 2,499$ CFU/ml) in the iodine group, which was significantly lower than the control group ($59,250 \pm 26,538$ CFU/ml).

CONCLUSION

The researchers found that continuously supplying iodine in DUWLs effectively controls microbial contamination.

IMPLICATIONS FOR PRACTICE

DUWL decontamination is an often-overlooked procedure that can be a potential source of infection for both patients and dental staff, hence DUWL decontamination is an important part of the daily infection control routine at any dental surgery.

REFERENCE

1. Petchphayaprai C, Chotipan C, Sa-Ngiampak P, Thotsaporn K, Ampornarmveth RS. Effectiveness of iodine for continuous decontamination of dental unit waterline. *BDJ open*. 2023 Jul 22;9(1):34.