DENTAL TRIBUNE

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$3B worth of deals signed at AEEDC

DT Pakistan Report

DUBAI - With ever growing visitor and exhibitor base, more than $3 billion worth of business deals were signed at the 22nd UAE International Dental Conference & Arab Dental Exhibition (AEEDC) in Dubai, which attracted 50,000 visitors and participants from 133 countries.

Dr Abdul Salam Al Madani, executive chairman of the AEEDC Dubai Conference and Exhibition and the Global Scientific Dental Alliance, said: "We are very proud with the great improvement that AEEDC Dubai has witnessed this year, as the value of business deals has increased this year, which is expected for an exhibition like AEEDC Dubai; this goes in line with the increase in the number of hospitals and dental colleges, in addition to the growth of the healthcare and educational sector in the GCC and the world."

Dr Mohammed Jafar Abedin, scientific vice-chairman of AEEDC Dubai, said: "At AEEDC Dubai, we highlight 'evidence-based dentistry', which uses scientific evidence to guide decision-making in dentistry, that has always played a pivotal role in raising awareness about the best practices in the industry." "In order to help contribute to the overall well-being of patients around the world, we have committed ourselves to raising the standards of healthcare, while at the same time introduce cutting-edge tools and technologies to enhance the quality of dental education accessible to everyone attending the event." On its third day, AEEDC Dubai featured the subject of radiography and the effective techniques of 2D and 3D radiographic interpretation, aiming to improve the diagnostic skills of radiology specialists, as part of a symposium held under the title 'Radiology Symposium: Radiology in Oro-Dental Medicine'.

Dr Setareh Lavasani, director of oral and maxillofacial radiology and advanced imaging at California's Western University, said: "Dentistry has witnessed tremendous advances and with them, the need for precise diagnostic tools, specially imaging methods, have become mandatory. Radiographic interpretation in the diagnosis of 2D dental radiographs is widely prevalent but recently with the revolutionary introduction of cone beam computed tomography and the addition of the 'third dimension' to dental imaging, dental practitioners are provided with such information about the Maxillofacial structures of their patients, that was previously unthinkable." However, Dr Lavasani warned "dentists using such 3D technology need to act responsibly, as without proper training and the complexity of normal anatomical structures viewed in 3D, there is an inherent risk of missing crucial information, which can result in incorrect diagnosis". The third day also played host to the GCC Preventive Dentistry Session, under the title "Prevention begins early",

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Government exchequer or public money: A Conundrum

DT Pakistan Report

ISLAMABAD - The Drug Regulatory Authority of Pakistan paid Rs.280 million from the public exchequer, senate committee was informed. The Senate Standing Committee on National Health Services and Regulations (NHSR), met in the presence of Senator Sajjad Hussain Turi.

Matters regarding the implementation status of the recommendations issued by the committee in previous 3 years and mechanism of establishment of a slaughterhouse in the federal city were discussed.

DRAP officials informed the senate committee, that the department paid 280 million over the past 3 years as 'rent' for the building, as the issue of the allotment of land for constructing their own building is a distant dream.

The committee in its earlier recommendations, had directed the ministry of NHS to construct a building for the DRAP to save a huge amount worth Rs.4.5million, being paid every month, on account of rent.

The chair was displeased with the explanation of DRAP officials, upon claiming 'public money' as 'government funds.' - "It is not the government's fund,

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PMDC decides to reform medical, dental curriculum

DT Pakistan Report

ISLAMABAD - The interim Council of the Pakistan Medical and Dental Council (PMDC) decided to bring the medical and dental curriculum on a par with global standards. The council, the top decision-making body of the medical and dental education regulator in the country, met here with PMDC President Justice (R) Mian Shakirullah Jan in the chair. Khyber Medical University Peshawar VC Professor Arshad Javed, in his presentation, called for reforms in medical and dental curriculum.

He said several steps were taken in the past but the PMDC was not able to revise the

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GCC public sector dentists urge preventive dentistry

DT Pakistan Report

DUBAI - Keeping and maintaining a set of strong healthy teeth is not all about aesthetics-about staying beautiful and being able to flash that beautiful smile confidently-but staying healthy throughout life in order to fulfil one's responsibilities and purpose. It is against this background that dentists in the Gulf who have chosen to be in the public health sector and academe are for more comprehensive educational and awareness campaigns on oral hygiene and dental care.

The campaigns include family trips and exposures to the dentists and the dental clinics. Parents must play an active role, because their ignorance will cause their children's future.

Future and practising dentists must be encouraged to specialise in preventive approaches rather than concentrate more on treatments, because the overall health issue is one's well-being from the cradle to the tomb.

The aforementioned observations were made at the lectures and consequent discussions at the "GCC Preventive Dentistry Session-Prevention Begins Early" on the last day of the "22nd UAE International Dental Conference & Arab Dental Exhibition" held at the Dubai World Trade Centre.

The session that tackled research studies conducted across the region among children and their families on the impact of the disregard for oral hygiene and dental care from birth resulting in failing health, was chaired by GCC States Health Ministers Council-Executive Board scientific adviser Prof. Abdullah Al Shammery and Dubai Health Authority (DHA)-Dental Services director Dr Tariq Khoory.

On the sidelines of the meet, lecture presenters DHA-Dental Services Department-Dubai Primary Health Care dentist Dr Shiamaa Shihab Ahmed Al Mashadani and Oman Ministry of Health-Dental Services head Dr Huda Al Bahri, and delegate Princess Noura University-Clinical Affairs (Saudi Arabia) vice dean Dr Abeer Al Shami concurred that all health insurers must give their share by considering oral hygiene and dental care, including the preventive measures in their policies and packages.

They replied to the question he said at the open discussions on why some insurers and some members of the medical community have seemingly cast aside oral hygiene and dental care, taking these as simply aesthetics and not about one's general health and well-being. Al Mashadani said it is critical that insurers are on equal footing with families and the educational and health sectors on preventive dentistry, because neglect will lead to a grim world of unhealthy sick individuals.

She wondered how children would be able to consume their food and eat

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OPINION

Regulating drug laws

By Muhammad Hamid Zaman

On an afternoon of January 31st in Lahore, dozens of academics, physicians, public health professionals, hospital administrators and even government professionals took the time out to come to the Lahore University of Management Sciences to discuss the sharp cliff of infectious diseases in the country. A cliff, from where every year, we tend to throw the people down, mostly the poor and the vulnerable, into death, doom and financial destruction. Of the topics that were discussed, none were scarier than the growing threat of antibiotic resistance. The situation where the arsenal of our best drugs to control and cure infection is rendered useless. The scenario which in many situations is already playing out in our urban and rural areas, means that routine procedures in surgery that require infection control are becoming challenging. From the birth to post-natal care, from getting treatment for typhoid to controlling the spread of TB, every procedure and treatment is becoming more difficult, more expensive and less likely to succeed.

While the discussion at times was heated, and people expressed frustration with the government and the ill-executed 18th amendment, there was agreement that the best solutions are right in front of us. Whereas there is a whole list of things that can and should be done, there are two straight forward acts, present squarely within the government's mandate, that can save us billions in cost and improve the lives of millions of our citizens.

The first is having a prescription drug law that separates over-the-counter drugs from those that require prescriptions from bonafide doctors. This is urgently needed and well within the scope and mandate of the government. Not a single group of physicians or public health experts would disagree with such a law. We need to protect the drugs, and the people. Similar laws exist around the world to protect citizens and their health.

Widespread sale, use and abuse of antibiotics are responsible for our antibiotic resistance apocalypse. People are able to buy any antibiotic of their choice, without any understanding of care or caution. Pharmacists are equally to blame, for they are glad that their sales continue to scale new heights. Unaware public uses antibiotics as an ordinary pain killer, using them with every sneeze and

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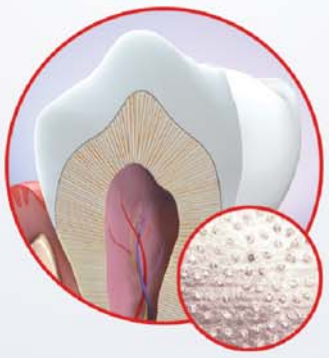

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Reference: 1. Li Y et al. J Clin Dent. 2011; 22(Spec Iss):113-120. **2.** Nathoo S et al J Clin Dent 2009: 20 (Spec Iss):123-130. **3.** Ayad F et al. J Clin Dent. 2009; 20 (Spec Iss): 10-16.

Dental health of children in Germany among the best globally

DT International

GREIFSWALD, Germany - According to new research, nearly 80 per cent of 12-year-old sixth-graders in Germany have caries-free permanent dentition, making Germany top internationally, alongside Denmark, in terms of dental health in this age group. However, early childhood caries is still too common in the country and affects the healthy development of some children.

These latest figures come from the epidemiological accompanying investigations for group prophylaxis carried out on behalf of the Deutschen Arbeitsgemeinschaft für Jugendzahnpflege (DAJ), a German organisation dedicated to maintaining and promoting the oral health of children and adolescents. For the study, more than 300,000 children in the country underwent dental examinations in the 2015/2016 school year.

As part of the representative study, which the DAJ commissioned for the sixth time since 1994/1995, a dental team headed by the Greifswald paediatric dentist Prof. Christian Splieth determined the children's oral health status in three age groups: 12-year-old pupils in the sixth grade, 6- to 7-year-old first-graders and, for the first time, 3-year-old kindergarten children. The examinations were conducted in ten federal states of Germany.

The unit of measure used to assess oral health was the dmf/DMF index. The study found a DMF score of 0.44 for the 12-year-olds studied, and 78.8 per cent of the children in this age group had a healthy dentition. Both values were the best ever achieved in Germany.

In the 6- to 7-year-old schoolchildren, however, who still mainly have primary teeth, the dmf score was 1.73. In this age group, only 53.8 per cent had a healthy dentition. This was only a slight improvement in the national average compared with the values recorded in the last DAJ study, conducted in 2010, for some federal states even had a slight deterioration. Thus, this age group was found to still have a higher caries burden than the group of 12-year-olds.

The epidemiological study found a dmf score of 0.48 for the 3-year-olds. This means that 13.7 per cent of this age group already had dental caries, while 86.3 per cent had healthy teeth. The data underpins what has already been suggested on the basis of previous regional studies and clinical experience: caries of the primary dentition occurs very early in some cases. A relatively small group of children had severe caries (3.57 dmf), which is very difficult to treat and often only under anaesthesia.

The findings show that there is social polarisation of caries already at a very early stage; however, they also suggest that the implementation of the DAJ recommendations published in 2016 for the prevention of early childhood caries for day care centres and parents was a step in the right direction and must be further expanded. The new findings will be evaluated in the coming months for further possibilities for prevention. - ***DT Europe***

Study shows positive influence on dental caries using a multilevel approach

DT International

SAN FRANCISCO, U.S. - According to a new study, a multilevel approach that includes a dental caries risk assessment, aggressive preventive measures and conservative restorations can dramatically reduce caries incidence. The findings, which support earlier research demonstrating positive results of the assessment and treatment method in a university setting, show that the protocol has the potential to transform dental care for high-risk patients.

"We put the 2012 UCSF [Caries Management by Risk Assessment] clinical study into the real world and showed it works," said lead author Dr. Peter Rechmann, Professor of Preventive and Restorative Dental Sciences at the University of California, San Francisco (UCSF) School of Dentistry. "The patients at high caries risk who used prescription products went down significantly over time in their risk level. Those in the control group also reduced their risk to a lesser degree, simply by using over-the-counter products that also protect teeth and affect the bacteria."

Caries Management by Risk Assessment (CAMBRA) is a method that was originally developed in 2003 by a team led by then Dean of the UCSF School of Dentistry Prof. John Featherstone. The method adopts a multilevel approach in which dentists collect patients' dental and medical histories, conduct

clinical examinations to assess caries, and utilize behavioral approaches and chemical treatments to optimize protective factors.

For their two-year study, Rechmann and his colleagues recruited 30 dentists to take part, 18 from private practices and three from community clinics. The study involved 460 patients aged between 12 and 65, split into two groups: the CAMBRA group and control group, with 239 and 221 participants, respectively. In the CAMBRA group, high-risk patients received prescription fluoride toothpaste, a chlorhexidine antibacterial rinse, xylitol mints and a fluoride varnish. The control group received regular fluoride toothpaste, an assumed inactive mouthrinse, sorbitol candies and a nonfluoride varnish.

In follow-up visits at six, 12, 18 and 24 months, new carious lesions or changes in caries risk level were recorded. According to the results, a significantly greater percentage of high-risk participants were classified as

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Australian senate support for medical device reforms welcomed

DT International

CANBERRA, Australia - A senate committee report recommending the passage of legislation that changes the way the Therapeutic Goods Administration (TGA) regulates medicines and medical devices has been welcomed by the Australian Dental Industry Association (ADIA). It delivers a long-standing legislative reform that ADIA has been lobbying politicians of all political persuasions to deliver on for nearly a decade.

"This bill contains important reforms that will cut the red tape associated with introducing into the Australian market new and innovative patient treatment and diagnostic options," said ADIA CEO Troy Williams.

The bill will reportedly also make changes that support amendments to the Therapeutic Goods Act 1989 made in 2017. The reforms will allow the TGA to authorise Australian companies to undertake conformity assessments, a significant departure from past practice where only the TGA could perform such evaluations.

"This legislation, combined with the legislative changes made last year that ADIA also secured, creates a far more efficient system for dental product manufacturers to introduce new products to the Australian market. Whereas previously the TGA was the sole source of authority, the increasing use of overseas regulators and third-party Australian conformity assessment bodies will provide alternatives without compromising patient safety," said Williams.

Williams went on to say that ADIA has been pushing

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new

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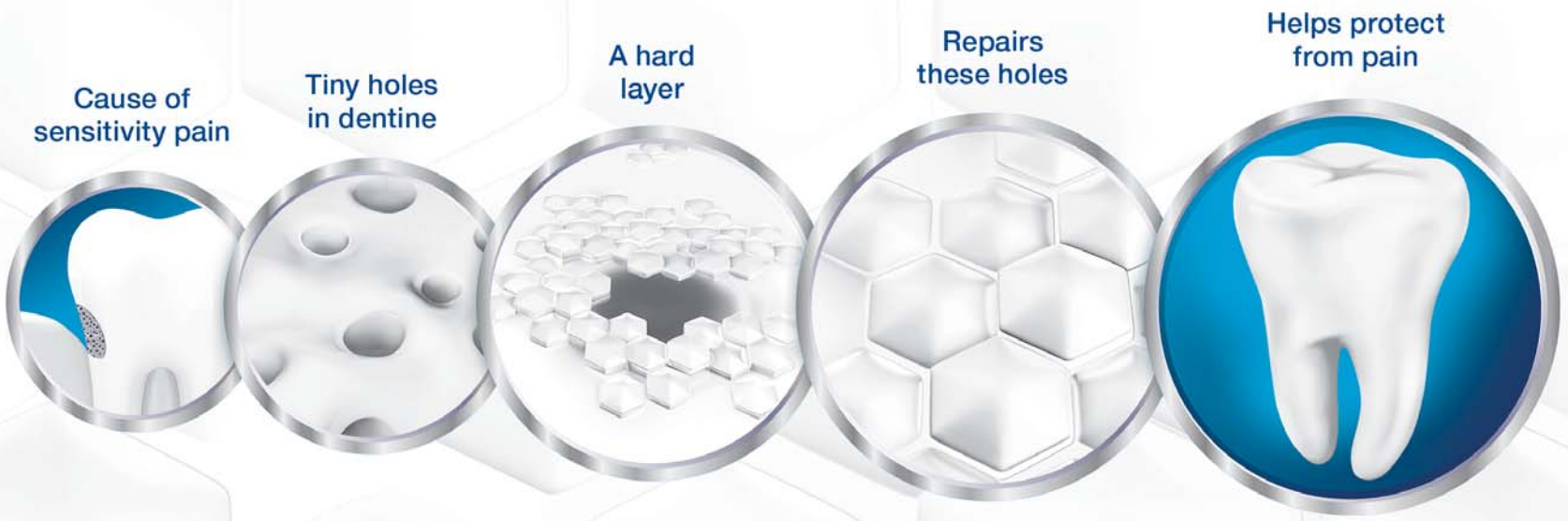

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Mastering the implant digital workflow

By Ross Cutts

Whether we like it or not, we are embracing the digital era in our brave new world. Many dental practices are now becoming paper-free—a digital innovation—and even using tablet computers to record patient details and medical histories. We are continually surprised by the rising age of the technologically savvy patient, particularly those of a certain generation who perhaps we assume would be less so than the perceived iPhone generation.

This change in the patient demographic and attitude towards technology is filtering through to us in the dental profession. The nuts and bolts of implant dentistry tends to lend itself more readily to the digital revolution of dentistry in the UK and now globally. Many practitioners opposed to or reluctant to embrace it are actually being influenced by it through shifting workflows in dental laboratories, even where more traditional clinical practices are followed chairside. Quite often, wet impressions are poured and stone models are scanned to produce STL files for laboratories to process during crown and bridge unit manufacturing.

As an implant clinician, one does not have to invest in a CT scanner or chairside intra-oral scanner—there are ways that other centres and laboratories can provide these services. However, having these tools at one's disposal greatly increases one's efficiency and means one is not reliant on external services for one's patients.

"If you fail to plan—then you plan to fail"—Benjamin Franklin

So how do we begin the implant digital workflow? Successful implant treatment begins with thorough case assessment and planning of the proposed restoration. This is important for all cases, not just what we deem the complex ones. Even the most experienced implant clinician can miss a potential treatment planning hazard, especially during a busy day. Accurate study model casts are an essential part of this; however, we can now use intra-oral scans preoperatively to begin the digital workflow. We take a scan rather than impressions to form digital models. Our laboratory can then use these to create digital wax-ups of proposed treatment outcomes.

We are routinely used to 2-D radiographic imaging techniques in dentistry, but with the availability and access to CBCT scanning devices now, we are able to assess bone quantity and quality of proposed implant surgical sites. With ever-reducing doses of 3-D imaging and improving accuracy, we are able to use CBCT scans, combined with clever software packages such as coDiagnostiX (Dental Wings), to plan safe and accurate implant placement and restoration. We are able to preoperatively plan precise implant placement with safe surgical margins away from important anatomical structures, such as the inferior alveolar nerve or maxillary sinus. From this, we are then able to design and either mill or print a surgical guide to use for precise implant placement.

Even with assisted surgery or guided surgery, there are sometimes certain restrictions that prevent us from achieving the most ideal implant placement, such as this case shown where posterior access in the second molar region was reduced, so achieving the perfect parallel was extremely difficult.

There are fully guided systems available that allow for absolutely precise implant placement, but these are fraught with complexities and should be reserved for experienced clinicians. The accuracy of surgical guides should not be used to make up for a lack of surgical competency however.

There are many factors to be considered when using surgical guides, including whether the guide is tooth-, soft tissue- or bone-supported. Tooth-supported allows the greatest degree of accuracy.

If tooth-supported,

- are there windows in the guide that direct full seating of the guide?
- are the teeth that support exact positioning of the guide mobile? Any mobility adds a degree of inaccuracy.
- is the guide made from a direct intra-oral scan or a scan of a study model? If scanning a study model, is this an accurate stone model representation? Otherwise, there is the risk of poor seating and inaccuracy of the guide.

If soft tissue-supported, mobility completely negates any accuracy of the guide, so it should only be used for a pilot drill and then a more conventional surgical protocol adopted.

If bone-supported,

- raising of a very large surgical flap is likely.
- it is very difficult to ensure accurate full seating of a bone-supported guide in the precise planned position and this relies upon external fixation. Once the implants are placed in situ and fully integrated, we then have a choice of conventional wet impression techniques versus digital intra-oral scanning. For the majority of cases, intra-oral scanning is extremely predictable and reliable—more so than conventional techniques—with milled (and lately printed) models having excellent properties and less accumulation of processing errors. However, deeply placed implants relative to adjacent teeth with deep contact points are very difficult to scan and pick up. Straumann tissue level implants offer a very straightforward restorative platform to scan from.

With greater numbers of implants and fewer teeth to act as reference points, intra-oral scanning becomes less reliable—particularly across the arch—so we need to exercise caution and be aware of its limitations. We have used composite flow stuck to the soft tissue to increase reference points for our scanners, increasing their ability to stitch images more accurately together. With this in mind, we cannot assume the scan is accurate and any framework fabricated would be non-passive; therefore, we must use other methods to verify the scan's accuracy. We have found locking temporary abutments within a composite framework intra-orally the easiest and most reproducible way to do this. It then allows us to design and mill a truly passive framework by Createch and a temporary acrylic bridge.

Conclusion

There are many opportunities to opt in and out of using technology regarding the digital implant workflow. For anyone considering capital investment, the most important question to ask is, how will or can this improve the outcomes I provide to my patients, and then determine whether that warrants the expenditure. Too often are we subjected to sales pitches of the next biggest thing by company sales representatives and gadgets and gizmos end up by the wayside.

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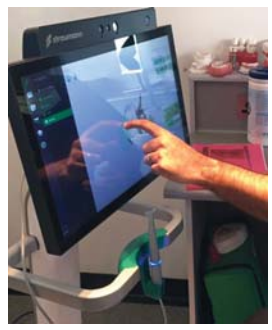
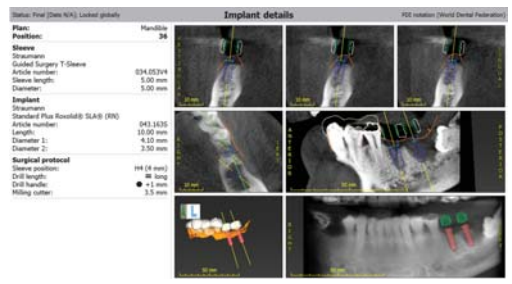

IOS Scanner

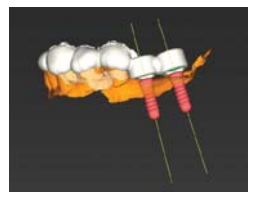

Printed Models


2-D Radiograph


3-D Radiograph



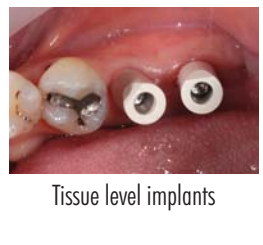
CoDiagnostiX Screenshot


CoDiagnostiX screenshot of guide production


Printed Surgical Guide


Post-op radiograph of implant placement


Surgical placement of LL67 implants


Tissue level implants


Scan Bodies


Crowns on model


Composite flow material used to increase scanning reference points


Composite flow material used to increase scanning reference points


Verification jig locked in situ to verify passive implant positioning


Createch framework showing the fit surface


Final metal-ceramic bridge in situ

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Dentinal defects after root canal preparation

By Dr Taha Özyürek

Vertical root fractures are one of the most frequent complications seen on teeth having endodontic treatment, and generally result in the extraction of tooth (Haueisen et al. 2013). The root canal treatment procedures may cause dentinal stress and consequently dentinal cracks. The emerging dentinal fractures may transform into vertical root fractures under functional loads (Barreto et al. 2012).

The physical and mechanical properties of nickel titanium (NiTi) rotary file systems my affect the incidence of cracks on dentinal surface (Adorno et al. 2011). Moreover, the type of movement used in shaping the root canals may also influence the incidence of dentinal defects. Liu et al. (2013) have reported that a continuous rotational movement causes more dentinal defects than reciprocation movement, while Bürklein et al. (2013) have reported that reciprocation movement causes more dentinal defects.

WaveOne (WO; Dentsply Maillefer) NiTi singlefile system was recently modified to WaveOne Gold (WOG; Dentsply Maillefer). While maintaining the reciprocation movement of the file, its cross-section, dimensions and geometry were changed. The cross-section of the file was altered to a parallelogram, having two cutting edges. Moreover, the off-centre design that ProTaper Next (Dentsply Maillefer) files have is used in WOG files too. The most significant change in files is the Gold heat treatment method. Gold heat treatment is based on reversing the M-Wire technology employing the pre-production heat treatment, and by heating the file after production and then slowly cooling it. The manufacturer company claims that this new heat treatment increases the flexibility of files (WaveOne Gold Brochure).

Another NiTi rotary file system made using the Gold heat treatment procedure is the recently introduced ProTaper GOLD (PTG; Dentsply Maillefer) system. Similar to ProTaper Universal (PTU; Dentsply Maillefer) system, this model consists of three shaping (SX, S1 and S2) and five finishing (F1, F2, F3, F4 and F5) files. PTG uses the continuous rotation movement at the same torque and speed settings with PTU, but the manufacturer claims that PTG files are two times more resistant to the cyclic fatigue under favour of flexibility offered by the Gold alloy (ProTaper Gold Brochure). From the aspect of metallurgical character, PTG NiTi files have not only the 2-stage specific transformation feature but also high Af temperature similar to controlled memory (Shen et al. 2011).

Recently, the patented treatments have been involved in the innovative production of new HyFlex EDM files (HEDM; Coltène/Whaledent, Altstätten, Switzerland). The main feature of these files is that they are manufactured via an electro-discharge machining (EDM) process. The EDM is a non-contact machining procedure used in engineering for manufacturing the parts that would be difficult to machine with conventional techniques. The removal of material is performed by pulsating electric current discharges that flow between an electrode and the work piece are immersed in a dielectric medium. The electric current partially melts and evaporates small portions of the material in a well-controlled and repeatable manner. The material is therefore superficially removed, leaving an isotropic surface, characterised by regularly distributed craters (Pirani et al. 2015).

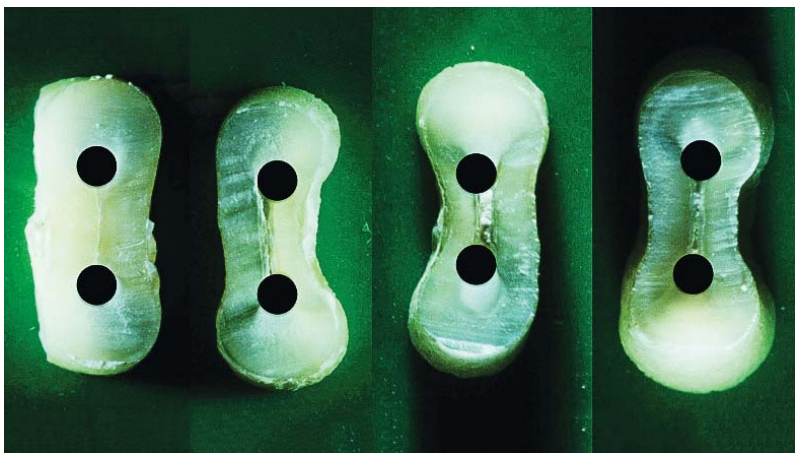
In our comprehensive literature review, no study examining the dentinal defects caused by HEDM NiTi files during root canal shaping procedure was found. For this purpose, the aim of this in vitro study was to compare the incidences of dentinal defects that HEDM, WOG and PTG NiTi files create during shaping the mesial canals of mandibular molar teeth. The null hypothesis of present study was that there would be no difference between the dentinal defect formation incidences of HEDM, WOG and PTG NiTi files.

Material and methods

Specimen selection

After obtaining the ethical committee approval, 80 mandibular molar teeth that were extracted due to periodontal reasons and had < 20° of canal curvature (Schneider 1971) and two separate mesial canals were involved in this study. The soft and hard tissues around the teeth were mechanically removed using a periodontal curette. Moreover, the distal roots of teeth were removed under water-cooling. The crowns of teeth were removed from the enamel-cement junction under water-cooling, allowing 16 mm of root length. The radiographic images of teeth were taken in mesio-distal and bucco-lingual directions. Teeth that were found to have calcification, history of previous root canal treatment, involving internal and/or external resorption, or were fractured and/or had immature roots were excluded. The selected teeth were kept in distilled water at 4 °C for the experimental procedures.

The roots of teeth were wrapped with aluminium foil and then embedded into acrylic resin (Imicryl, Konya, Turkey) (Capar et al. 2014). After the acrylic set, the teeth were taken out from the resin, and the foils were removed. To simulate the periodontal ligament, the resin blocks were filled with viscous silicon impression material (Express XT Light Body Quick; 3M ESPE, Neuss, Germany) and the specimens were then placed into the resin blocks again.



Samples of slices obtained at different distance from the apex presenting dentinal defects. (a) Control Group, (b) HyFlex EDM, (c) WaveOne Gold, and (d) ProTaper Gold.

Root canal preparation

The canals of teeth were penetrated using a #10 K-file (Dentsply Maillefer) until the tip of file was seen from the apex. The working length was set to 1 mm shorter than this length. For all of the specimens, the glide path was created ensuring the apical diameter of 0.20 mm. For every specimen, 20 ml 1 % sodium hypochlorite (NaOCl) was used during the preparation. The entire procedure was executed by the same endodontist, having 5 years of experience. The teeth were randomly divided into 4 groups, 20 teeth in each. And then, the following procedures were performed.

Group 1: HyFlex EDM

Using the torque-controlled endodontic motor (X-Smart; Dentsply Maillefer), the root preparation of the specimens in this group was performed by using a HEDM 25/.~ NiTi single-file system according to the manufacturer's instructions at 500 rpm and 2.5 Ncm torque.

Group 2: WaveOne GOLD

Using the torque-controlled endodontic motor (VDW Reciproc GOLD; VDW, Munich, Germany), the root preparation of the specimens in this group was performed by using a WOG Primary (25/.07) NiTi single-file system according to the manufacturer's instructions in "WaveOne ALL" programme.

Group 3: ProTaper GOLD

Using the torque-controlled endodontic motor (X-Smart; Dentsply Maillefer), the root preparation of the specimens in this group was performed by using a PTG NiTi rotary file system's S1 (18/.02), S2 (20/.04), F1 (20/.07) and F2 (25/.08) files according to the manufacturer's instructions at 300 rpm and 3 Ncm torque.

Group 4: Negative control

No intervention was made to this group and they were assigned to the negative control group.

Assessment of dentinal defects

Under water-cooling (Isomet; Buehler Ltd, Lake Bluff, IL, USA), the roots of 80 specimens were cut perpendicular to the tooth axis at 3, 6, and 9 mm distant from the apex, and 3 slices were obtained from each specimen. Trans-illumination was applied to the slices from 1 mm distance in mesial, distal, buccal, and lingual directions using a LED (LED Light; Denshine Technology, China) device. The digital images (4 images from each slice) were taken under x25 magnification using a digital camera connected to stereomicroscope (Olympus BX43, Olympus Co, Tokyo, Japan). In order to eliminate the bias of observers, the canals on digital images were masked using a circular drawing. A total of 960 digital images—240 from each group—were examined to determine if any cracks were present. The images obtained were then randomly assigned to two experienced endodontists, who were not involved in the preparation of the specimens, in order to determine the presence or absence of dentinal defects. To define crack formation, two different categories were made (i.e. 'no crack' and 'crack) to avoid the confusing description of root cracks. 'No crack' was defined as the root dentine without cracks or craze lines either at the internal surface of the root canal wall or the external surface of the root. 'Crack' was defined as all lines observed on the slice that either extended from the root canal lumen to the dentine or from the outer root surface into the dentine (Shemesh et al. 2009) (Fig. 1).

Statistical analyses

In examining the intergroup incidence of dentinal defects, a Chi-Square test was used. The level of statistical significance was set to 5 %. The statistical analyses were performed using SPSS 21 (IBM-SPSS Inc., Chicago, IL, USA) software.

Results

In the present study, 960 images

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