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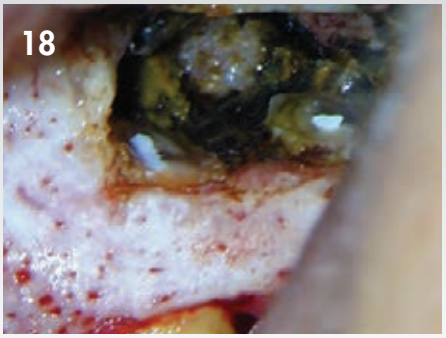

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Making a difference to those in need - Henry Schein partners with Will2Live

Will Hawes founded Will2Live in 2012 because he wanted help people. He needed purpose and could see there was a section of society who had fallen through the cracks. So, what did he do? He started making sandwiches at home and walking the streets of Sydney CBD in search of people sleeping rough. From this day, Will2Live was born and now in 2019, they are serving more than 700 meals a week at Central Station in Sydney. They also distribute water, clothes, toiletries and offer bedding assistance. Most importantly, they offer a listening ear to people who feel like no one cares. By building these relationships they aim to help them feel part of society and four times a year they hold an event with food, music, clothing, toiletries and haircuts!

The Henry Schein Team first met Will when he came to pick up food from a community kitchen where we were holding one of our volunteer days. We instantly connected with Will and his passion for helping people. We have since held BBQ breakfasts with Will2Live where the team get to cook a hot breakfast to hand out but also get to meet the people they are helping. While confronting at times, the team have really enjoyed the experience. Connecting over a warm cup of coffee and an egg and bacon roll, the team have been interacting with a section of society who really need to feel included.

Will has worked tirelessly over the past 6 years and one of his major wins right in the beginning was raising enough money to buy a van. Sadly, the old van has seen better days and needs to be replaced. Henry Schein Cares is happy to be able to help Will2Live purchase a new van so that he can continue to serve the community we live in.

Want to find out more? **Visit their website www.will2live.org.au**

If you have any questions about Henry Schein Cares and other projects we are involved in, please email **scheincares@henryschein.com.au**

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Antibiotic stewardship in dentistry – review of evidence-based clinical recommendations on appropriate antibiotic prescribing in dental practice

Part 1: The antibiotic resistance crisis and the principles and practices of appropriate antibiotic prescribing

Johan Hartshorne[1]

Acknowledgements:
I thank the following individuals for their expertise and assistance in reviewing and revising the manuscript scientifically and technically: Dr Cameron Meyer, Group Clinical Officer, Intercare Group, Pretoria; Dr Carl de Villiers, Clinical Advisory Committee and General Dentist, Intercare Medical and Dental Centre, Glen Marais; Dr Linton Brown, Clinical Advisory Committee and General Dentist Intercare Parow Medical and Dental Centre, Parow; Dr Harry Vermeulen, Clinical Advisory Committee and General Dentist, Intercare Wilgeheuwel Medical and Dental Centre Wilgeheuwel.

Executive summary

Rational

- The efficacy of antibiotics is slowly being compromised by a growing number of antibiotic resistant strains due to inappropriate use of antibiotics.
- Antibiotics are used inappropriately in 75% of cases involving dental conditions.
- Subsequent infections caused by antibiotic resistant pathogens are difficult, and at times impossible, and costly to treat.
- Implementing antibiotic stewardship efforts in dental practice are an opportunity to improve antibiotic prescribing practices and to curb the pandemic issue of antibiotic resistance.

Key Points

- The key to reducing antibiotic resistance and the number of adverse drug reactions is by avoiding unnecessary and inappropriate antibiotic prescribing.
- Antibiotics should be only prescribed when indicated for prophylactic therapy such as infective endocarditis, presence of regional or systemic body manifestations, or to fight infections in patients with immune suppressed or immune compromised conditions.
- A proper dental and medical history and clinical assessment is fundamental in minimizing misdiagnosis leading to overuse of antibiotics, for appropriate antibiotic selection to improve efficacy of antibiotic therapy, and to prevent adverse events and drug interactions.
- Antibiotics should be used in conjunction with, but not as an alternative or replacement to other appropriate interventions, such as endodontic therapy, periodontal debridement, or surgical extraction of a tooth.

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Practical implications

- Narrow-spectrum antibiotics should be prescribed for the shortest duration possible until the clinical cure of the patient is obtained and to minimize disturbance of the normal gut flora.
- Recommend the use of a probiotic to prevent microbial disturbance when prescribing an antibiotic.
- Clindamycin should be used judiciously and with caution due to its high frequency of adverse effects.
- Safety and product cost should always be taken into consideration with antibiotic selection.
- In almost all situations where an oral infection shows signs of systemic spread, proper local management and initiating antibiotic use is of benefit and likely outweighs the risk.
- Every prescribing health care practitioner should have an authorative reference (e.g. MIMS) readily available.

Introduction

Antibiotics represent one of the most successful forms of therapy in medicine. However, the efficiency of antibiotics is slowly being compromised by a growing number of antibiotic resistant pathogens worldwide.[1,2] The overuse of antibiotics means that they are becoming less effective and has led to the emergence of "superbugs". These are strains of bacteria that have developed resistance to many different types of antibiotics. Antibiotic resistance is increasing at an alarming rate whilst a growing list of infections are becoming harder and at times impossible to treat due to antibiotics becoming less effective. [3]

Antibiotic resistance does not mean the body is becoming resistant to antibiotics; it is the bacteria that have become resistant to antibiotics designed to kill them.

The implications of antimicrobial resistance are that microbial pathogens are not killed and continue to grow and exchange genes through horizontal transfer and mutate.[4] Subsequent infections caused by antibiotic resistant pathogens are difficult, and at times impossible to treat.[5,6]

Antibiotic resistance can affect people at any stages of life, as well as healthcare, veterinary, and agricultural industries, making it one of the world's most urgent public health problems.[5,6]

Every time a new antimicrobial is introduced, drug resistance to that antimicrobial occurs swiftly, for antibiotics, antivirals and antifungal therapies.[7] Antimicrobial treatment places selective pressure on the organisms, favouring the emergence of drug resistant strains.

In the USA alone, at least 2 million people are infected with antibiotic resistant bacteria, and at least 23000 people die as a result every year. [5,6] No one can avoid the risk of resistant infections, but some people are at greater risk than others e.g., people with chronic illnesses (i.e. periodontitis, diabetes, COPD, cancers, Alzheimer's disease, autoimmune diseases), immune-suppressed individuals, immune-compromised conditions, frail and elderly.

If antibiotics lose their effectiveness, then we lose the ability to treat infections and to control public health threats.

Antibiotic resistance is implicated in elevated mobidity and mortality rates, require extensive and expanded medical care, as well as increased treatment costs, extended hospital stays, and sometimes requires toxic therapeutic alternatives, and is increasingly being recognized as an emerging global public health threat.[1,2,6] Appropriate antibiotic stewardship by dentists is urgently needed in view of the pandemic issue of antibiotic resistance.[8]

Currently, there is a challenge to accelerate the fight against antimicrobial resistance across the globe.[6] The emerging antibiotic resistance crisis has prompted the World Health organization (WHO) and the Centers for Disease Control and Prevention (CDC) to take action to protect the public.[1,6,9]

Global antibiotic resistance together with the lack of newly developed antibiotics represents an alarming signal for both human and animal healthcare worldwide. [10,11]

Reasons for the antibiotic resistance crisis

• Misuse and overuse of antibiotics

It is suggested that the overuse and misuse of antibiotics is the primary driver and cause of the evolution of bacterial resistance against antibiotics.[3,4,5,12,13]

Various studies have recently reported on the inappropriate use of antibiotics in dental practice.[14-22] Studies suggest that 30% to 50% of prescribed antibiotics are unnecessary or not optimally prescribed.[5,23] In another study it was reported that antibiotics are used inappropriately in 75% of cases involving dental conditions.[24] It is essential to understand that antibiotic therapy will fail if the source of infection is not removed. Primary dental and surgical procedures should always be the first line of care, with antibiotics serving as adjunctive therapy in indicated cases.[25,26] Antibiotics are not a replacement for surgical drainage or debridement.

Indications for the use of systemic antibiotics in dentistry are limited because most dental and periodontal disease is best managed by operative interventions and plaque control measures. The current use of antibiotics in dental practice is best characterized by empirical prescription based on

clinical and bacteriologic epidemiological factors resulting in the use of a very small range of broad-spectrum antibiotics for short periods of time. Prolonged use of antibiotics only serves the purpose of selecting resistant bacterial species.[27] This has contributed towards the development of antibiotic resistance in a wide range of bacteria and subsequent inefficacy of commonly used antibiotics.[28] The increasing antimicrobial resistance over recent years is probably related to the over- and misuse of broad-spectrum antibiotics.[28]

Consequently, there is a clear need for the development of evidence-based antibiotic prescribing guidelines. Educational and policy initiatives to encourage the rational and appropriate use of antibiotics in dentistry and oral medicine are also needed. This may help to curb the increasing incidence of antibiotic resistance and other adverse effects of antibiotic use, including gut microbial dysbiosis, *Clostridiosis difficile* (formerly Clostridium) (*C. difficile*) infection and allergies.

• *Bacterial genetic mutation and adaptation*

Antibiotic resistance occurs naturally through evolution characterized by genetic mutations, acquisition of genetic material or alterations of gene expression and metabolic adaptation through the process of horizontal gene transfer between bacteria.[4,29]Bacteria possess an enormous diversity of genes, which are constantly changing through horizontal transfer of genes allowing antibiotic resistance to be transferred among different species bacteria that allow them sooner or later to counteract the action of newly invented antibiotics.[1,4] In addition, antibiotics remove drug-sensitive competitors, leaving resistant bacteria behind to reproduce in a process of natural selection.[4] Every time a new antimicrobial is introduced, drug resistance to that antimicrobial takes place swiftly, and this occurs for antibiotics, antivirals and antifungal therapies.[7] Antimicrobial treatment thus places selective pressure on the organisms, favouring the emergence of drug resistant strains.

• *Diminishing pharmaceutical investment*

In addition to the overuse and misuse of antibiotics, the lack of new antibiotic development by the pharmaceutical industry, due to reduced economic incentives and challenging regulatory requirements have contributed towards the antibiotic resistance crisis.[2,9,30-36] Of the 18 largest pharmaceutical companies, 15 have abandoned the antibiotic field.[7,37] Antibiotic development is no longer considered to be profitable or an economically wise investment for the pharmaceutical industry.[37]

Until recently we have escaped the dire consequences of antibiotic resistance because there has been a stream of new antibiotics. However, over the last two decades the number of pharmaceutical companies investing in this area has diminished from 18 to 3, inevitably leading to stalled drug development.[7]

Principles and practices for optimal antibiotic prescribing in dentistry [38]

• *Core elements and objectives of antibiotic stewardship*

Antibiotic stewardship assists health care providers with judicious and appropriate use of antibiotics for patient use.

"Appropriate clinical decision-making with regard to antibiotic use requires the clinician to evaluate the needs of the individual patient and provide the best treatment for that patient. At the same time, the clinician should consider what is the best for the long-term sustainability of antibiotics as an effective means of patient care. This dual responsibility is at the core of antibiotic stewardship"[39].

[39]Antimicrobial stewardship has been defined by the Infectious Disease Society of America and the Society for Health Care Epidemiology of America as " an activity that included appropriate selection, dosing, route, and duration of antimicrobial therapy."[40] Although antibiotic stewardship concerns the development of resistant bacteria, the emerging evidence of the causal link between changes in the gut flora and the development of systemic disease makes the endeavour even more important and complex.[41]

The objectives of antibiotic stewardship are to improve prescribing habits with the intention to:

- Improve clinician prescribing and patient use so that antibiotics are only prescribed and used when needed.
- Minimize misdiagnosis leading to overuse of antibiotics.
- Ensure that the right drug, dose and duration is prescribed when an antibiotic is needed.[38,39]

1. Pre-treatment principles and practices

• Correctly diagnose oral bacterial infection

Oral bacterial infections have a predictable presentation in the oral cavity usually characterized by redness, pain, swelling in the tissues around the tooth; advanced infections will often be associated with an exudate (pus). The dental surgeon should take a detailed history and thorough systemic, local and radiographic examination to diagnose the disease as infection. In addition, one should also do a hematologic, serologic and other laboratory examination wherever necessary to diagnose and to evaluate the origin or severity of oral and maxillofacial infections.[42]

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• Consider therapeutic management interventions

Therapeutic interventions, with primary focus on eliminating the pathology that led to the infection, may be sufficient to control a localized bacterial infection.

Therapeutic interventions include periodontal debridement, endodontic treatment, tooth extraction, or incision drainage.

• Consider antibiotics when regional and/or systemic manifestations are present

According to a recent systematic review, antibiotics should only be prescribed when regional and/or systemic body manifestations are present within the previous 24 hours e.g., presence of pronounced oedema (cellulitis), limited mouth opening (trismus), increased heart rate (tachycardia), rapid respiration, lymphadenopathy, difficulty swallowing (dysphagia), general malaise, and fever (pyrexia) [26]

• Consider antibiotics when patients present with immune suppressed or immuno-compromised conditions

Antibiotics should be prescribed to fight infection when there is presence of a disease affecting the host defence system e.g. AIDS, cancer, autoimmune disease, patients on corticosteroid therapy, immune-compromised conditions, diabetes, chronic renal failure, patients who have undergone chemotherapy or radiation therapy or patients that have received organ transplants.[42]

Patients that are immune suppressed or immune-compromised are at higher risk of infection and are more likely to benefit from prophylactic antibiotics, because infections in this group are likely to be more frequent, associated with complications and may be more difficult to treat.[43]

• Weigh possible benefits and risks

All drugs have risks. Weigh the possible benefits versus risks (i.e. toxicity, allergy, adverse effects, *C. difficile* infection) of antibiotics before prescribing. Be aware of the risks of the primary antibiotics used to treat dental infections: penicillin's, azithromycin and especially clindamycin. *C. difficile* infection (pseudomembranous colitis) is often associated with clindamycin and other broad spectrum antibiotic use. This is the most common serious side effect of antibiotic use. Penicillin allergy is also a serious risk. Closely monitor patients with extensive medical problems and those taking multiple medications.

In almost all situations where an oral infection shows signs of systemic spread, proper local management and initiating antibiotic use is of benefit and likely outweighs the risk.

• Prescribe antibiotics only for patients on record and only for bacterial infections you have been trained to treat

Clinicians must know and understand the patient's medical history and be familiar with their dental history for safe and effective patient care.

Familiarity and experience with managing bacterial dental, periodontal and oral mucosal infections are essential for the best perspective and decision-making.

Consultation and referral with a specialist is appropriate when an infection shows signs that it is outside the clinician's area of training and experience, e.g. altered eye movement, suggesting infection has entered into the cranial space, or difficulty swallowing, suggesting that the infection is spreading into deep neck tissues.

• Do not prescribe antibiotics for viral and fungal infections, ulcerations related to trauma, or aphthae in the oral cavity

Viral infections manifest as blisters and constant pain at the site of the blister/ulcer.

Fungal infections usually present with redness and some white areas that can be rubbed off using gauze.

Ulcerations related to aphthous ulcers or autoimmune diseases such as lichen planus, pemphigoid and pemphigus, usually hurt when exposed to acid like orange or tomato juice and salty foods.

Traumatic ulcers incidents are generally recalled by the patient, are not an infection and do not commonly become infected unless the patient is immune-suppressed, or has a medical problem that compromise their ability to heal (i.e. diabetes).

• Implement antibiotic prophylaxis recommendations for the medical concerns for which guidelines exist

The American Heart Association and the American Dental Association have developed guidelines for the prophylactic use of antibiotics to prevent infective endocarditis, in patients with specific cardiac conditions.[44,45]

In most cases, prophylactic antibiotics are NOT recommended for patients with prosthetic joints. If in doubt, consult with the patient's surgeon or physician.

Severely immunosuppressed patients, such as those undergoing chemotherapy, corticosteroid therapy or patients with immune compromised diseases such as AIDS, cyclic neutropenia and uncontrolled diabetes, are at an increased risk of systemic infection from an oral source.[42,43] Clinicians may elect to be more aggressive in initiating antibiotic use in

such patients and may elect to use antibiotics prophylactically to prevent an infection if the intended dental or periodontal procedure may cause bacteremia.

• Assess medical history and conditions, pregnancy status, drug allergies, and potential drug interactions and adverse events that may impact antibiotic selection.

All medications have risks; the antibiotics commonly used in dentistry – penicillin's, clindamycin and azithromycin – are no exception.

A proper medical history should reveal any medications that may risk drug interactions. Primary antibiotics used for dental infections (penicillin's, clindamycin and azithromycin) are not commonly associated with such adverse drug responses. Drugs that inhibit liver cytochrome P450 enzymes are most commonly associated with drug interactions. In dentistry these are metronidazole and erythromycin (both antibiotics) and ketoconazole (an antifungal). Avoid using these drugs in patients taking specific medications that are metabolized in the liver.

The clinician should consult an authorative reference (MIMS), the patient's physician or pharmacists, before prescribing an antibiotic when there is any concern of drug interaction.

2. Prescribing principles and practices

• Ensure that an evidence-based antibiotic reference (i.e. MIMs – Monthly Index of Medical Specialities) is readily available during patient visits

While most clinicians are well versed in the antibiotic choices for oral bacterial infections, it is prudent for the clinician to have at least one of several recognized prescribing reference resources readily available.

• Avoid prescribing based on non-evidence-based historical practices, patient demand, convenience, or pressure from colleagues

Avoid any non-evidenced based pressures that may influence the clinician's decision making in situations where antibiotic use is not indicated. This may lead to inappropriate antibiotic use and result in a poor clinical outcome for the patient.

• Thorough documentation in the patient's file

Clear and complete documentation of the diagnosis of an oral bacterial infection, the treatment steps, and the rationale for antibiotic use (if prescribed) should be made in the patient's record.

• Prescribe only when clinical signs and symptoms of a bacterial infection suggest a systemic immune response, such as fever or malaise along with local oral swelling

A local oral bacterial infection is best and effectively managed through mechanical intervention (e.g. extraction, endodontic therapy, and cleaning and irrigation of the infected site) to eliminate the irritant or foreign body causing the infection. Once effective cleaning and removal of the irritation is accomplished, the body's immune system should clear up remaining infection. A good policy to teach is never to let the sun set on puss.

Antibiotic therapy however, is appropriate if there are signs and symptoms of a systemic immune response.

• Use the most targeted (narrow-spectrum) antibiotic for the shortest duration possible. (2-3 days after the clinical signs and symptoms subside)

Most bacterial organisms associated with oral infections are sensitive to penicillin's, making it the first drug of choice as follows:

Penicillin VK, 500 mg given 4X daily or Amoxicillin, 500mg given 3X daily.

If there is no response in 48 to 72 hours, then amoxicillin protected from beta-lactamase with clavulanic acid (e.g. Augmentin) can be tried, 1000mg 2X daily.

If the patient has a true IgE mediated allergy to penicillin's, then the drug of choice is Clindamycin 300mg given 4X daily.

Patients that are unable to take clindamycin may be prescribed Azithromycin, 500mg given 1X per day.

The number of tablets/capsules prescribed should be enough for 10 days and the patient should be instructed to take the antibiotic as prescribed for two to three days after the clinical signs and symptoms are gone. Antibiotics should be used for the shortest time possible until the patients' clinical cure is achieved.[26]

Consider the most appropriate route of administration. Topical>Oral>IM>IV

Use microbiome protection therapies (i.e. probiotics) for all cases.

Clinicians should urge disposal of unused antibiotics immediately upon completion of treatment.

The duration of antibiotic therapy influences resistant development. A meta-analysis of antimicrobial use in primary care concluded that longer treatment duration was associated with an increased risk of emergence of antibiotic resistance.[46]

• Revise empiric antibiotic regimens on the basis of patient progress and, if needed culture results

All patients taking antibiotics for an oral bacterial infection should be followed closely to make sure the infection is resolving and that there are no adverse effects.

A patient taking an antibiotic as prescribed following a proper incision and drain or mechanical intervention should start to see a positive response within 48 to 72 hours. Patients not improving in that time frame or who are experiencing adverse responses to the antibiotic should be re-evaluated and their antibiotic changed to the next drug of choice.

For poorly responding patients, a consultation with a specialist may be appropriate as well as a culture and sensitivity test to ensure the correct antibiotic has been chosen.

• Discuss antibiotic use and prescribing protocols with referring specialists

All clinicians managing a patient's care should utilize similar evidence-based protocols, including the first, second and third drug of choice, at the proper dosage for the proper duration.

The use of similar protocols improves the care of shared patients and decreases the risk of conflict for the clinicians and confusion for the patient.

3. Patient education

• Educate patients to take antibiotics exactly as prescribed, to take antibiotics prescribed only for them, and not to save antibiotics for future illnesses

Antibiotics are complex drugs with different absorption rates, half lives and elimination mechanisms, all of which influence the prescribed dosage.

Antibiotics must be taken as prescribed to be effective; many antibiotic failures can be traced back to the fact that the patient did not comply with the clinician's recommended dosage.

Clinicians should clearly and unequivocally inform patients of the need to take their medication as directed for two to three days after the clinical signs (fever, swelling, redness) and symptoms (pain) have resolved.

Clinicians should instruct patients to dispose of unused drugs immediately upon completion of treatment and provided guidance on drug disposal options.

Patients who refuse to take a prescribed antibiotic as directed, for any reason, must be instructed to immediately inform the prescribing clinician so an alternative treatment approach can be identified.

4. Staff Education

All members of the dental team should be educated about oral bacterial infections, the office treatment protocols, the rationale for the steps in the infection protocol and the criteria used to initiate antibiotic therapy.

Staff training improves the probability of patient compliance with antibiotic prescriptions.

Classification, characteristics and application of antibiotics commonly used in dental practice

Antibiotics are a subset of antimicrobials (Antimicrobials also include antivirals, antifungal, antiprotozoal). The most commonly used antibiotics in dental practice according to class of antibiotic are summarized in Table 1.

The prudent use of antibiotics requires an understanding of: (i) what is an antibiotic; (ii) why we should use an antibiotic; (iii) when we should use an antibiotic; and (iv) how we should use and antibiotic.[42]

Pathogenic microbial flora and antibiotic sensitivity patterns in odontogenic infections

The most common odontogenic infections are dental caries (99,4%), gingivitis (56,4%), periodontitis (38,4%), peri-apical; (6,4%) and peri-coronitis (3,8%).[47] Maxillofacial spaces, especially the buccal spaces are frequently involved (54%). Most odontogenic infections are caused by bacteria normally found within the oral cavity. Approximately 50% of odontogenic infections are caused by anaerobic bacteria alone, 44% by a combination of aerobic and anaerobic and only 6% by aerobic alone.[48] A recent study by López-Gongález and co-workers reported that bacteria associated with odontogenic infections were mainly anaerobic (65,3%) and aerobic (35,7%) and exibit a high resistance to antibiotics[49]

The efficacy of antibiotics against isolated organisms varies considerably: clindamycin (88%), metronidazole (79%), cefotaxime (72%), erythromycin (72%), amoxiclav (71%), ciprofloxacin 967%), vancomycin (65%), cefadroxil (59%), ceftazidine (59%), azithromycin 58%).[47]

López-Gongález and co-workers reported in their study that the majority of microorganisms (82%) were sensitive to amoxicillin/clavulinic acid.[49]

The main principle of treatment of odontogenic infections is to establish drainage of the abscess either through endodontic therapy or the removal of the tooth. Prescribing antibiotics should be considered an adjunctive therapy to surgical intervention.[50]

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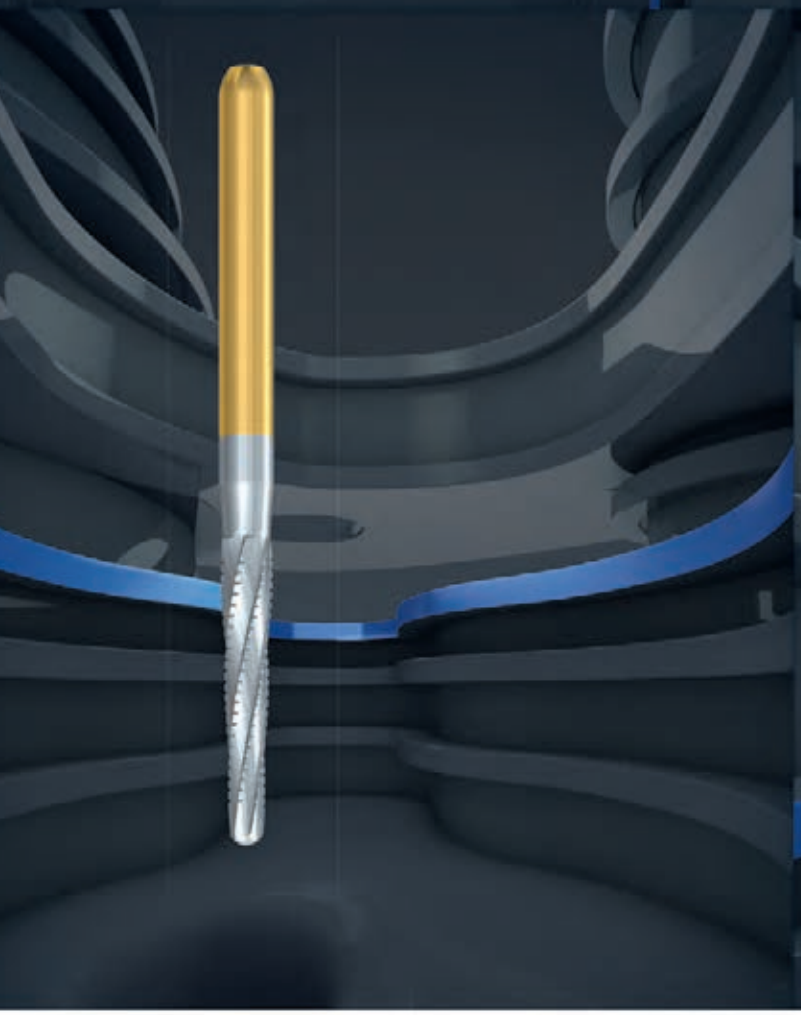

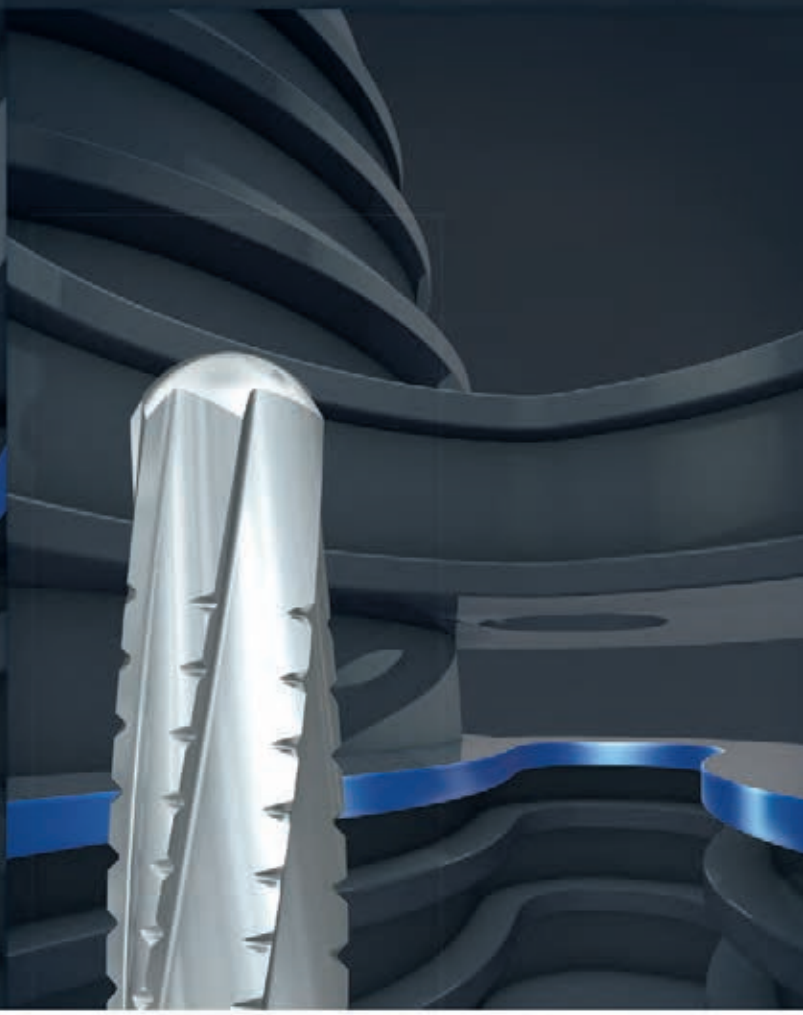

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Table 1: Classification dosage, application and characteristics of commonly used antibiotics in dental practice

Class	Drug names	Dosage	Interval (hr)	Activity	Side-effects
Penicillin	Penicillin VK (NS) Ampicillin (NS) Amoxicillin (NS) *Amoxicillin/ Clavulanic acid (BS)	500mg 500mg 500mg 875	6 (qid) 6 (qid) 8 (tds) 12 (bd	Bactericidal Inhibits cell wall synthesis * Broad spectrum Aerobes Gm-ves Gm+ves	Minimum toxicity Diarrrhea, vomiting, Hypersensitivity allergic reactions
Cephalosporins	1st Generation Cefazolin (NS) Cephalexin (NS) 2nd Generation* Cefaclor (BS) Cefuroxime (BS) 3rd Generation* Cefixime (BS) Ceftriaxone (BS) 4th Generation* Cefpirome (BS) Cefipin (BS)	500mg	6 (qid)	Bactericidal Inhibits cell wall synthesis *Broad spectrum Aerobes Gm +ves Gm-ves	Diarrhea, nausea, vomiting, 5-10% cross reaction with penicillin – allergy Haematologic toxicity
Macrolides	Erythromycin (BS) Azithromycin (BS) Clarithromycin (BS)	500mg 250mg 500mg	6 (qid) 12 (bd) 24	Bacteriostatic Blocks protein synthesis Broad spectrum Gm+ves Gm-ves	Liver toxicity Diarrhea Nausea , vomiting Coumadin interaction
Lincosamide	Clindamycin (NS)	300mg	6 (qid) (max 1,8gm / day	Bacteriostatic Inhibits protein synthesis Gm- aerobes Gm+ aerobes & anaerobes	Pseudomembranous colitis; *C.difficili* Hypersensitivity reaction
Tetracycline	Doxycycline Minocycline (BS)			Bacteriostatic Blocks protein synthesis Gm+ & Gm-aerobes	Diarrhea, nausea, vomiting Tooth discoloration
Fluoroquinolones	Ciprofloxacin Moxifloxacin (BS)	500mg 400mg	12 (bd) 24	Bactericidal Inhibits DNA synthesis Broad spectrum Gm+ves Gm-ves	Avoid in pregnancy Toxic effect on chondrocytes, tendon fractures Inhibits fracture healing
Imidazoles	Metronidazole (NS)	500mg	6 (qid)	Bactericidal Narrow spectrum Inhibits RND synthesis Anaerobes Gm+ves Gm-ves C.difficile	Hepatotoxicity Body fluid discoloration Incompatible with alcohol

(NS = Narrow spectrum; BS – Broad spectrum)

Adverse reactions and unintended consequences associated with prescribing antibiotics in dental practice

Antibiotics are considered the keystone of modern medicine, but their excessive use continues to generate unwanted adverse effects around the world ranging from diarrhoea, to life threatening allergic reactions.[7]

A recent study on antibiotic prescribing in England revealed that the most commonly prescribed antibiotics ranked from least to most likely to cause adverse drug reactions were as follows: amoxicillin<cephalosporins< erythromycin<tetracyclin<azithromycin< metronidazole< amoxicillin+clavulinic acid<clarithromycin<penicillin V< clindamycin.[51] This study confirmed that amoxicillin, the most common prescribed antibiotic by dentists had the highest level of safety of all antibiotics prescribed by dentists. Of all the antibiotics prescribed by dentists, clindamycin was least safe presenting with 15 x greater likelihood to cause an adverse drug reaction and a 30x greater likelihood to cause a fatal adverse drug reaction.[51]

Another study quantified the most prevalent adverse events from antibiotic prescribing amongst adults in Emergency departments in the USA during the period 2011-2015[52], are summarized in Table 2.

Hypersensitivity reactions and cross-reactivity

The most common adverse event to antibiotics manifesting across all antibiotic classes, is sensitivity reactions.[52] (Table 3) They are usually mild and limited to rash or skin lesion in the head and neck region. Antibiotics, especially penicillin's, cause allergic reactions ranging from rash, skin reactions, Stevens-Johnson syndrome to breathing difficulty and anaphylaxis.[53] Life-threatening anaphylactic reactions have occurred in some highly sensitized individuals, but remain rare.[54]

The use of cephalosporins in patients with penicillin allergy has been a concern. The latest literature shows that cross reactivity between penicillin's and 3rd and 4th generation cephalosporins is negligible and it is therefore considered safe to administer a cephalosporin with a side chain that is structurally dissimilar to that of penicillin or to administer a 3rd or 4th generation cephalosporin.[55]

Dysbiosis of the gut microbiome and gastrointestinal conditions

Risks associated with the use of antibiotics include, nausea, vomiting, diarrhoea and stomach cramps because of disturbance of the gut microbiome.[53]

The gut microbiome contains around 100 trillion bacteria that support digestion and the immune system. Aggressive antibiotics can wipe out the good bacteria, whilst strengthening the bad bacteria. Key pathogens, such as *C. difficile* flourishing in the perturbed gut microbiome are immune to antibiotics, resulting in *C. difficile* diarrheal infections.[32] Patients who are more vulnerable to adverse effects include children, elderly, hospitalized, those with chronic inflammatory and/or immune compromised conditions. Recent studies indicate that antibiotic therapy can induce changes in the commensal flora is not always fully reversible and that may represent a risk for further colonization and dysbiosis- and infection with bacteria possessing antibiotic resistance.[56]

Other side effects include the development of fungal infections in the mouth or vagina resulting from an imbalance in the body's normal flora.

Table 2: The prevalence of adverse events following antibiotic prescribing amongst adults

Antibiotic class	Mild allergy	Moderate to severe allergy	Gastro-intestinal disturbances	Other
Penicillin	57,5	23	15,9	
Cephalosporins	59,3	21,7	14,7	
Macrolides	59,4	17,4	18,1	
Lincosamide	48,3	22,9	27,0	
Tetracycline	44,9	19,8	28,3	
Fluoroquinolones	47,6	15,8	25,4	
Imidazoles	43,2	26,2	19.6	6,0

(Adapted from: Geller, Lovegrove, Shehab et al, 2018)[52]

C. difficile infection (CDI)

C. difficile is spore forming, Gr-positive anaerobic bacillus found in the gut, that is the cause of 15-25% of all episodes of antibiotic associated diarrhoea.[6] CDI can result in pseudomembranous colitis, toxic megacolon, colon perforations, and sepsis. Clinical factors associated with increased risk of CDI include age older than 65yrs, and underlying systemic disease. Antibiotics associated with higher risk of CDI include clindamycin, cephalosporins and the fluoroquinolones.[57]

Studies have shown that more than 50% of antibiotics prescribed for children are for upper respiratory tract infection associated with common cold. Because the majority of common cold infections are viral, using antibiotics to treat such infections does nothing to stop the infection. Instead, it creates unwanted side effects. Studies have shown that children given antibiotics for routine upper respiratory tract infections are more susceptible to aggressive antibiotic resistant strains of bacteria commonly known as *Clostridiodes* (formerly *Clostridium) difficile. C. diffcile* associated diarrhea is responsible for 250000 infections in hospitalized patients and 14000 deaths every year among children and adults in the USA.[32]

Peripheral neuropathies

Isolated cases of peripheral neuropathies, leading to numbness or paraesthesia, have been reported with use of metronidazole. The medication should be discontinued instantly if such signs appear.[58]

Hepatotocicity

Some antibiotics are metabolized in the liver, e.g. erythromycin, clindamycin and metronidazole. In patients with liver failure use of such drugs should be restricted.[59]

Drug interactions

Almost all antibiotics can potentiate the effects of Warfarin by inhibiting intestinal flora that produce Vit. K, thus enhancing the anticoagulant effect and increasing the risk of bleeding. Antibiotics that inhibit Warfarin metabolism is ciprofloxacin, clarithromycin, erythromycin and metronidazole.[60]

Fluoroquinolone antibiotics are useful antibiotics in the management of infections. However, several agents, e.g. calcium, iron, magnesium and aluminium, can substantially reduce the absorption of fluoroquinolones thereby causing treatment failure. A good standard of practice is to obtain a full, current medication list from your patient before prescribing antibiotic regimens,[60] or use you MIMS reference guide. It should also be noted that many antibiotics may cause oral contraceptives to fail, leading to unwanted pregnancies.

Conclusion

Rapidly emerging resistant bacteria due to inappropriate use of antibiotics, bacterial mutations and genetic adaptations, and the lack of development of new antibiotic drugs is threatening the extraordinary health benefits that have been achieved with antibiotics over decades. Currently it is being considered as one of the biggest threats to global health, food security, and development.

Evidence from the literature suggests that knowledge regarding antibiotic resistance amongst health care professionals, patients, and the public is still limited. Therefore, the need for educating health care professionals, patients and the public at large is essential to optimize the use of antibiotics, and to curb antimicrobial resistance. Implementing antibiotic stewardship efforts in dental practice is an opportunity to improve antibiotic prescribing practices and to reduce antibiotic resistance.

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The cortical window

Naheed Mohamed[1], Yosi Nahmias[2] and Ken Serota[3]

Introduction

Techniques, materials and innovations in the micro-armamentarium of endodontic microsurgery are seminal to enhanced predictable outcomes by comparison with historical microsurgical procedures.

The superior magnification and illumination of surgical operating microscopes improves the identification of root peripheries, ensures a lesser degree of root reduction and diminishes the size of osteotomies; thus retaining greater residual bone.

Smaller resection angles (perpendicular to the long axis of the root) reduce the number of tubuli exposed. Lateral canals, canal deltas, isthmus connections and micro-cracks can be identified prior to root resection, retropreparation and retro-sealing (Weller et al, 1995)

Studies of positive treatment outcomes for conventional encloclontic surgical therapy show a diverse range of success dependent upon an array of predictors (Garcia-Guerrero et al, 2017; De Chevigny C et al, 2008).

A study by Wang et al reported an overall healed rate of 74% of assessed teeth; root filling length and size of preoperative lesions proved to be important predictors of treatment outcomes (Wang et al, 2004).

Positive treatment outcomes (94%) were demonstrated by microsurgical techniques (Tsesis et al, 2013)

Retreatment of failing encloclontic procedures demonstrate statistically less positive treatment outcomes than those clone by microsurgical techniques (86%); fewer failures ensue (Setzer et al, 2012). These conditions are more readily addressed with microsurgical techniques (Floratos and Kim, 2017)

The computer-guided cortical window approach

A cortical window (bone lid) access to the apical region is less invasive, minimises bone loss and is less traumatic in comparison to alternative techniques.

The perimeter of the window is determined from racliographs of the area. Radiographs are essential to all aspects of encloclontics; however, flat films are two-dimensional images of three-dimensional structures and so data interpretation is subjective.

Cone beam computed technology (CBCT) enables the clinician to visualise structures in sagittal, axial and coronal planes. Three-dimensional imaging provides more substantial data for diagnosis, pre-treatment planning, post-treatment assessment and reassessment evaluations (Ahlowalia et al, 2013; Venskutonis et al, 2014).

A printed stereolithographic surgical template can guide the osteotomies during the

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Figure 1: A variety of piezotomes are commercially available; saw-toothed tips of 8mm to 10mm are essential. Piezotomes ensure precise and safe cutting of mineralized tissues and preserve soft tissues (blood vessels, nerves, and mucosa)

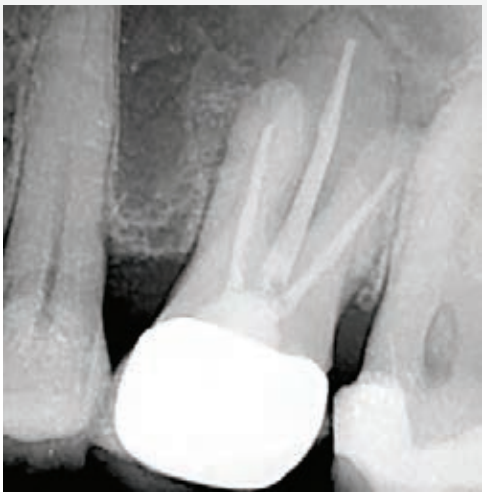

Figure 2: The porcelain-fused-to-metal (PFM) crown appeared to fit appropriately. The root filing demonstrated incomplete sealing and there was no evidence of the expected MB2 canal

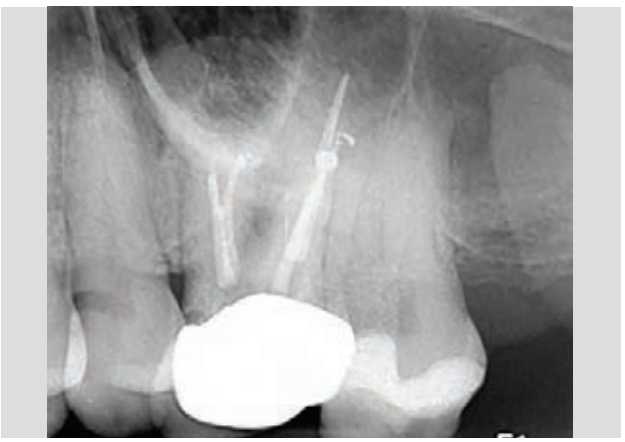

Figure 3: The post-operative radiograph showed four treated canals

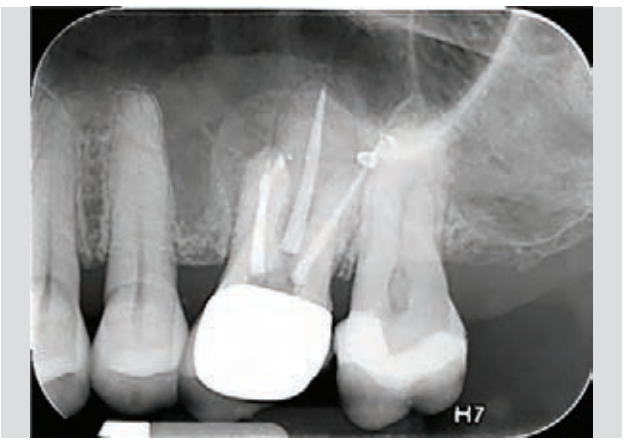

Figure 4: Eighteen-months post-endodontic retreatment therapy. Apical pathology appeared to be present

surgery; minimising deviation from the digital surgical plan. Surgical templates printed from three-dimensional imaging optimise site preparation, the perimeter of the osteotomy, depth of cortical bone, extent of pathology and volume of bone graft required (Kuhl et al, 2015; D'haese et al, 2012; Pinsky et al, 2007; Strbac et al, 2017).

Piezotome osteotomy

Traditional osteotomies use large, round burs which remove significant cortical bone. Delayed healing, increased post-operative pain and other complications may ensue.

With microscopes, piezotomes and ultrasonic tips, a smaller osteotomy is created, thus minimising the aforementioned sequelae.

Piezo surgery enables micrometric saw cuts which preserve cortical bone loss and facilitates preservation of root length by lower resection angles and enhanced visiblity.

In deep spaces, ultrasonic vibrations break clown irrigants into small particles readily washed from the crypt.

Less vascular presence in the crypt minimises use of hemostatic agents (Viscostat) and interference with retro-seal setting time. The use of a piezo surgical devices (Figure

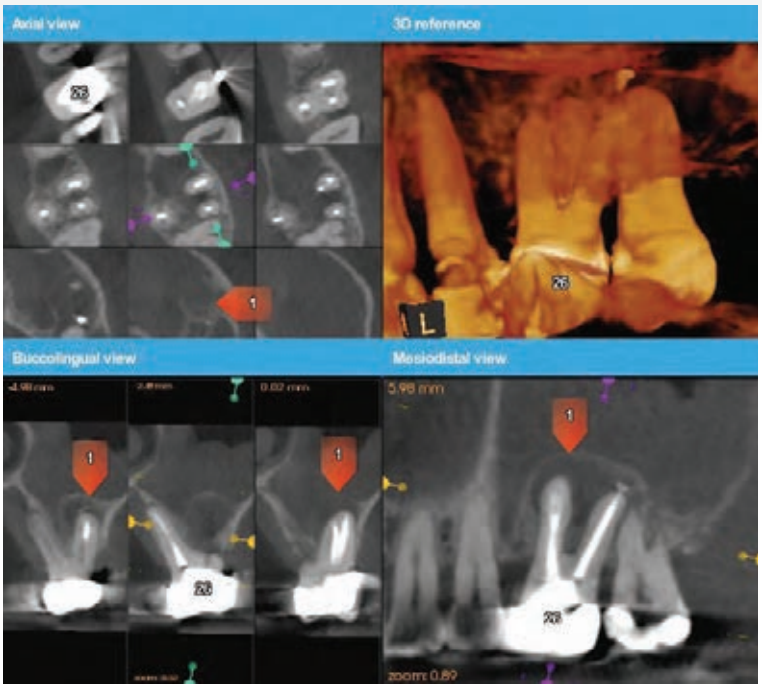

Figure 5: The cone beam computed tomography (CBCT) scan results showed rarefying osteitis and sinus cortical floor elevation along the mesiobuccal and distobuccal roots

1) enables accurate shaping of the cortical window and diminished osseous removal, in contrast to traditional crypt creations which are freehand guided (Abella et al, 2014).

Case report

The patient presented to our surgery with a history of 'sporadic discomfort in the gum' overlying tooth LR2.

A two-dimensional intraoral racliograph revealed a prior history of root canal therapy and a porcelain-fused-to-metal (PFM) crown (both completed approximately 10 years ago) (Figure 2)

Swelling began the evening prior to the appointment; the patient reported that the throbbing necessitated analgesics for relief of the pain. No sensitivity to pressure nor reaction to temperature were noted; the patient could not localise the tooth causing the distress. Treatment options were discussed with the patient; retreatment through the PFM crown was chosen.

Anaesthesia was administered (posterior superior alveolar nerve block - 2% xylocaine with epinephrine 1: 100,00 and infltration facially and palatally 2% xylocaine with epinephrine 1 :50,000). A conservative access preparation was made; decay was identified proximal to the palatal canal and no fractures or cracks were noted.

Cavil was present beneath the composite core and the untreated MB2 canal (Stropko, 1999) was discovered.

A reservoir was made in the gutta percha (Proultra ultrasonic tip). Endosolv E was used to soften the gutta percha (Hwang et al, 2015)

After debridement and shaping, Ca(OH)2 (Ultracal XS) was placed in the root canal space to further enhance disinfection.

Prior to obturation, drainage was noted coming from the MB2 canal; drainage was arrested and the canals root was filled with vertical condensation of warm gutta percha (VCWG) and AH-Plus sealer (Figure 3).

The patient returned in six months for reassessment. Tooth LR2 was within normal limits to percussion, bite, palpation, mobility and probing.

Eighteen months later, the patient returned for a second reassessment appointment (Figure 4). Tooth LR2 was slightly sensitive to percussion and the overlying gingival tissues were inflamed.

The patient was referred for a CBCT; the scan (Figure 5) revealed a common area of rarefying osteitis surrounding the mesial buccal and distal buccal roots which had caused elevation of the sinus floor. As the endodontic pathology had not resolved, treatment options were proposed. The

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Figure 6: The digital rendering of the surgical stent used to guide the cortical bone window osteotomies

Figure 7: The 3D-printed model and surgical stent used to guide our cortical bone window access

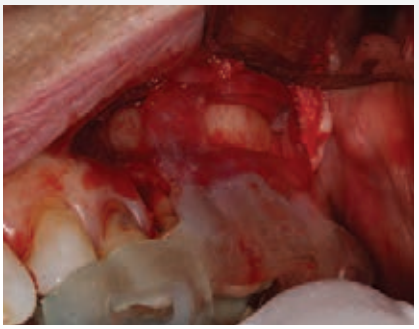

Figure 8: The surgical stent was put in place against the bone to guide the piezosurgical saw osteotomies

Figure 10: The clinical view of the surgical site once the cortical window had been removed and the roots resected

Figure 11: The microsurgical view of the root apical retro-preparation and apical seal

Figure 12: The defect was grafted with allograft cortical bone chips (Straumann Allograft)

Figure 13: The cortical bone window was replaced and fixated in place with gentle pressure

Figure 14: The flap was replaced and sutured with prolene monofilament sutures

Figure 15: The immediate post-operative radiograph

Figure 16: The nine-month post-operative radiograph showed excellent bone regeneration

patient chose to have microsurgical therapy performed.

A 3D-printed stereolithographic template was created by combining the CBCT scan data with an intraoral scan's (3Shape Trios intraoral scanner) digital data. The data was then imported into Codiagnostix software in order to plan our approach and design our cortical window dimensions for optimal access to the roots (Figure 6).

The guided microsurgical approach would facilitate an osteotomy design to minimise the potential for sinus membrane perforation. The JD-printed guide for the cortical window would guide the length and angle of the osteotomies using the piezosurgical saw (Figure 7).

Cervical recession and decay were in evidence about teeth LU and LRl in addition to exposure of the crown margin of tooth LR2.

The cervical area of tooth LR3 was severely abraded. An intra-sulcular full-thickness muco-periosteal fap was raised; a vertical releasing incision was positioned mesial to tooth LRl.

The surgical stent was placed over the maxillary teeth (Figure 8) and a piezotome-guided surgical window was developed using the margins of the stent (Figure 9).

A chisel was used to elevate the cortical plate and root resection performed with Lindemann burs (Figure 10).

The cortical window was placed in sterile saline while the endodontic microsurgery was completed. After resection using Lindemann burs, the root periphery was stained with methylene blue and examined for anomalies and the root canal space was retro-prepared with ultrasonic tips to a depth of three millimetres, creating a reservoir for the retro-sealing materials.

The retro-preparation was rinsed with ethylene-diaminetetraacetic acid (EDTA) and dried with paper points.

Bosworth Super-EBA was placed (Figure 11) and the root end burnished with a multi-fluted carbide bur. Radiographs were taken at the retro-preparation stage and the retro-sealing stage to ensure accuracy of direction and material placement. The defect thoroughly debrided and was grafted with allograft (Straumann Allograft) (Figure 12). The cortical bone window was replaced and ensured to have no mobility (Figure 13)

The flap was closed with Ethicon 5-0 Prolene monofilament sutures (Figure 14) and a post-operative radiograph was taken (Figure 15).

The patient was directed to use 800 mg of ibuprofen and 1000 mg of acetaminophen for pain and to rinse with chlorhexidine.

Sutures were removed in seven days and the patient reappointed for reassessment. The re-evaluation radiograph taken at nine months showed substantial osseous regeneration (Figure 16) and a post-operative CBCT scan was taken after one year, showing complete bone regeneration and continuity of the buccal plate. (Figure 17).

Conclusions

Along with surgical operating microscopes and piezotomes, integration of optical scanners and CBCT Dicom files to JD-printed stereolithographic surgical guides is yet another iteration in the advancement of endodontic microsurgery

This novel, digitally-guided approach used in this case report, along with the intraoperative use of a JD-printed osteotomy guide, allows for greater effciency and accuracy for creation of the access window to the roots.

The technique gives the advantage of bone preservation by allowing the cortical plate to be replaced, yet still provides adequate access for the apical root preparation.

The JD-printed guide provides a control for the osteotomies without risking damage to vital structures. This digitally-guided microsurgical approach provides accuracy, access, control and bone preservation to the endodontic apical surgery procedure.

As we come upon the dawn of a new age of digital dentistry, we can see the future applications to be endless.

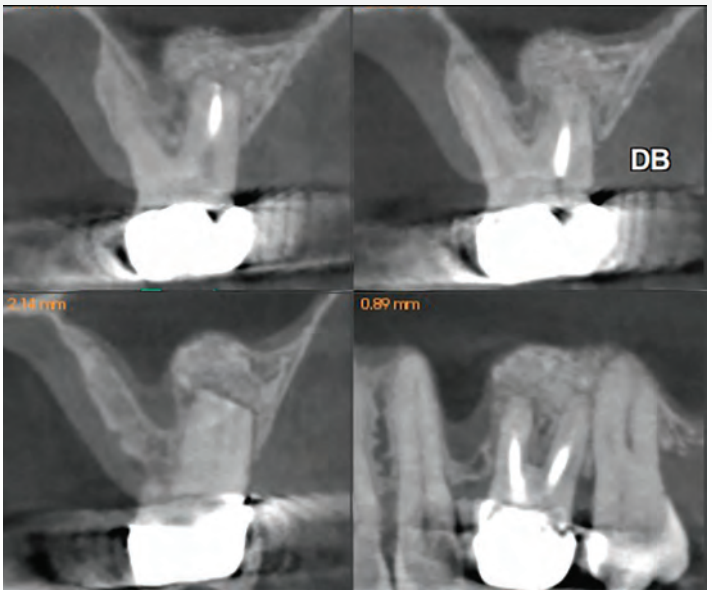

Figure 17: The one-year post-operative cone beam computed tomography (CBCT) scan showed complete regeneration of the defect and buccal plate

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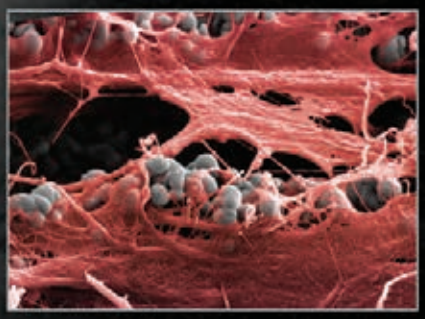

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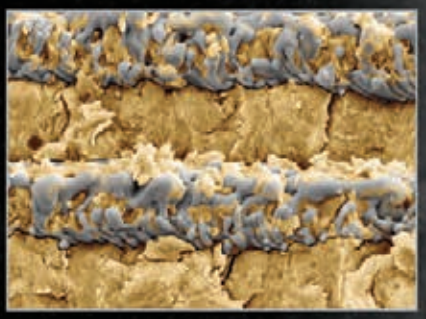

Colorized SEM of Laser-Lok® microchannels shows superior osseointegration[3]

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SPMP17297 REV A OCT 2017

New generation short fibre-reinforced composite restorations of the posterior dentition

Márk Fráter[1] and András Forster[2]

Finding the ideal material(s) for the restoration of posterior teeth, with the aim of re-establishing the original mastication, has long been a central issue in restorative dentistry. Direct restorations have been widely applied to restore posterior teeth due to their low cost, the smaller amount of healthy tooth substance that has to be removed as compared to indirect restorations, and their acceptable clinical performance[1]. Two main causes of posterior restoration failure have been identified: secondary caries and fracture (either of the restoration or the tooth itself)[2,3]. The later phenomena is a result of multiple factors.

Dental fracture patterns depend onthe direction and amount of force applied, and the ability of the tooth to recover from the deformation[4]. Force may be relatively light and repetitive, as in normal mastication, or relatively heavy and repetitive as seen in bruxism, and extremely heavy and sudden in cases of trauma. In the posterior region, forces range from 8 to 880N during normal mastication[5]. Extreme forces can easily lead to crack development in restored teeth, but this can also be true in case of physiological forces applied on the long term. In the "amalgam era"[6] the belief was that the harder the material chosen for restorative purposes, the more chances it had to prevent crack and fracture occurrence. Conversely, according to biomimetic dentistry there is no need for rigid materials. The primary aim is to substitute the missing hard dental tissues (enamel and dentin) with restorative materials closely resembling the natural tissues regarding their mechanical features and properties[7].

According to the early research of Pascal Magne, the ideal materials to replace the brittle, yet stiff enamel should be feldspathic porcelain or highly filled, laboratory composite, whereas the substitution of dentin should be performed with microhybrid composite resin[8]. From the year 2000 several studies emphasised the importance of a third type of tissue (or layer): the dentino-enamel junction (DEJ) (Figure 1)[8,9].

The DEJ has been histologically described as a collagenous interphase between these two bio-mechanically vastly different tissues, partly connecting and unifying them, and partly forming a stress-absorbing layer protecting the underlying elastic dentin and the vital pulpal tissues. This is the reason why multiple cracks can be seen in the enamel of aged teeth, yet they rarely reach and compromise the supporting dentinal

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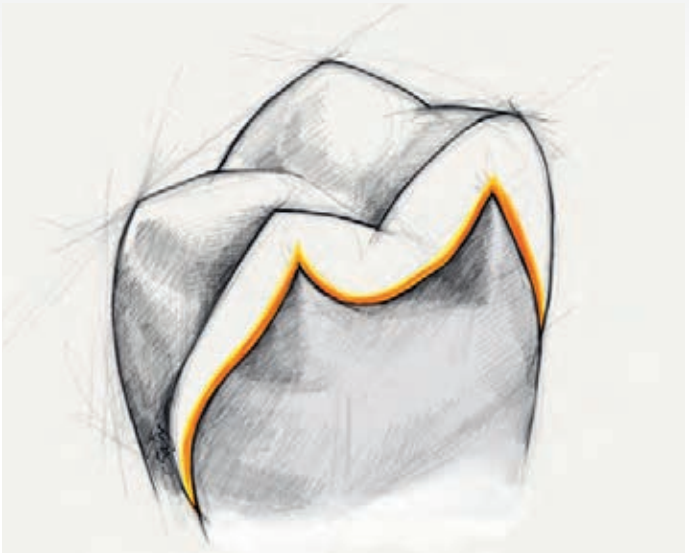

Figure 1: Illustration of a molar showing the natural changes of enamel thickness, the natural histoanatomy of the dentin and the position of the dentino-enamel junction. bIllustration by Dr. Tekla Sáry.

base, therefore usually remain asymptomatic. So far, this latter function of the DEJ has not been successfully mimicked by any restorative material. The excellent biomechanical properties of the DEJ can divert and blunt enamel cracks through considerable plastic deformation, providing a functional shielding mechanism and allowing synergy between enamel and dentin. This is the mechanism that enables right, serving a fundamental function, and when restoring a tooth according to biomimetic principles one should also consider this layer - not only dentin and enamel.

In 2013, a short fibre-reinforced composite (SFRC) (everX Posterior, GC) was introduced to the market with the goal to substitute the missing dentin with a material having a similar behaviour; additionally, the material has clinically shown to be also able to mimic the stress-absorbing properties of the DEJ simultaneously. Fibre-reinforced composites have been used in dentistry for the past 30 years but their true potential and function is just being realised.

The reinforcing effect of the fibre these natural tissues to withstand a lifetime of mastication. Therefore, the DEJ might be considered a specialised tissue type of its own fillers is based on stress transfer from the polymer matrix to the fibres[10], which is influenced by the size of the fibres and the connection between the fibres and the matrix. The actual average size of the glass fibres in the SFRC material is 1-2 mm, thus exceeding the critical fibre length and making stress transfer possible (Figure 2).

Additionally the fibres are silanised and are therefore able to chemically connect to the matrix. As a consequence of these features, the SFRC is able to reinforce the dental structures even in case of extreme loading conditions. Since these fibres show random orientation, they can reduce the polymerisation stress generated by the composite resin in all directions[11,12]. This makes it possible to use the material in layers up to 4mm. However, the in vitro research carried out by the authors has shown that everX Posterior applied in 2-3mm thick layers with oblique layering gave the best results regarding the fracture resistance of posterior molar teeth among the restored groups[13].

Furthermore, this technique showed the highest number of repairable fractures once fracture occurred. Thus this technique (2-3 mm thick layers with oblique layering) seems to be the most beneficial.

When following the biomimetic restorative principles, the indications for the usage of everX Posterior are dentin substitution in medium and large cavities in posterior teeth, which means that in practice the surfaces of these modern direct restorations should be made of microhybrid or nanohybrid composite covering the SFRC "dentinal core" in at least 1 mm thickness everywhere.

The other revolutionary indication of SFRC is in case of indirect restorations or repair of damaged restorations. The SFRC material contains a semi-interpenetrating polymer matrix (semi-IPN), which consists of both linear and cross-

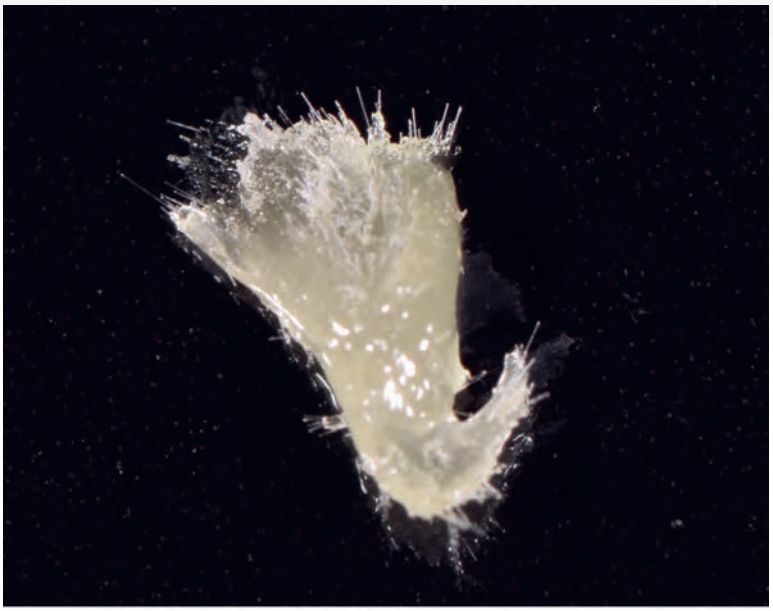

Figure 2: The unique size of the short fibres is visible when the SFRC material is extruded from the unitip.

linked polymer phases. The linear phase can be dissolved if a suitable adhesive resin is added on its surface, thus enabling the reactivation of the material and also true chemical bonding to it[14].

Unfortunately this is not the case with conventional composite resins, because once the active oxygen inhibition layer is lost from their surface, the cross-linked polymers cannot be broken up anymore. This leads to little if any reactivity left for free radical polymerisation bonding and therefore, no actual chemical bonding can take place. This unique structure leads to the fact that if the core build-up is made with the usage of SFRC, this layer will not only act as a stress-absorber and crack stopper interphase, but will also have the ability to chemically adhere to the indirect restoration placed on it, if adhesive cementation is applied. In clinical settings this can be managed with the following steps: first cleaning the surface from any debris or biofilm, and then applying a pure resin bonding agent (eg. GC StickRESIN).

With the above mentioned unique features, everX Posterior brings the restorative possibilities in the posterior region to a new level, and also opens new horizons for future restorative techniques. Therefore it seems justified to state that SFRC materials will shortly change the face of posterior restorative procedures.

After removing an old, cracked MOD composite filling, the form was optimised and the dentin and DEJ were substituted using a SFRC as core build-up. The missing enamel shell was then restored with a GRADIA® PLUS overlay.

The patient presented with a distal carious lesion on tooth 15. After preparation and cleaning, a matrix was placed and the OD cavity was transformed into a Class I by building up the approximal wall with Essentia Universal composite (GC), according to the centripetal technique. The internal missing dentin was then substituted with a SFRC (everX Posterior, GC) and occlusally covered with a layer of microhybrid composite (Essentia Universal).

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Clinical case report: Restoring tooth 16 according to biomimetic principles with everX Posterior and a GRADIA® PLUS overlay.

Figure 1: Initial situation showing an MOD composite restoration with a vertical crack inside the filling causing pain for the patient

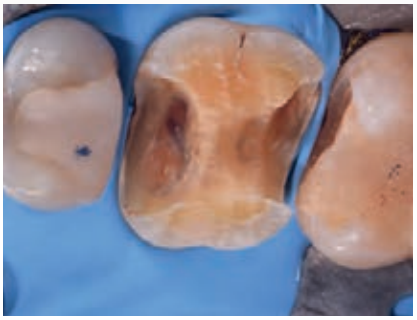

Figure 2: Prepared cavity

Figure 3: Core build-up with SFRC (everX Posterior, GC)

Figure 4: Situation before impression-taking

Figure 5: GRADIA® PLUS overlay

Figure 6: Before adhesive cementation

Figure 7: After adhesive cementation

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Clinical case report: Restoring tooth 15 with a direct fibre-reinforced composite restoration.

Figure 1: Initial situation showing distal change of transparency indicating caries.

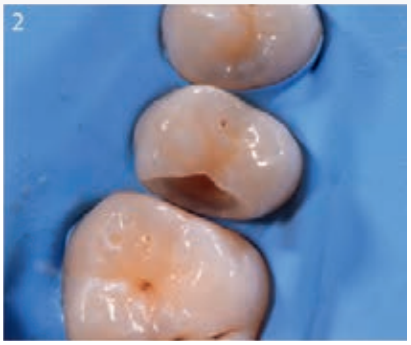

Figure 2: Prepared OD cavity

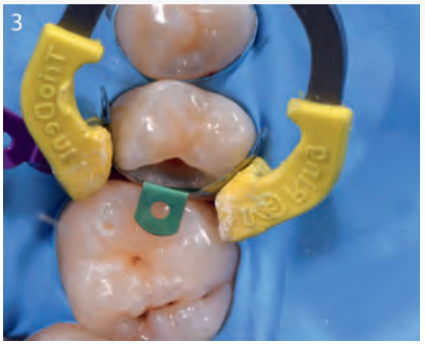

Figure 3: Placing a sectional matrix

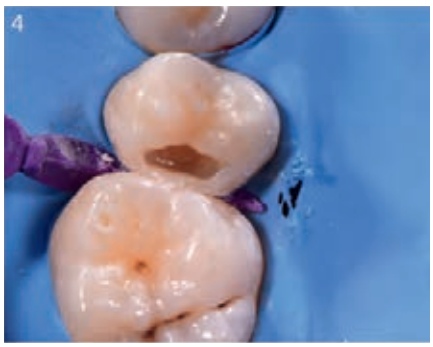

Figure 4: Building up the interproximal wall with a microhybrid composite (Essentia Universal, GC)

Figure 5: Substituting the missing dentin with a SFRC (everX Posterior, GC)

Figure 6: Final restoration after finishing - SFRC covered with microhybrid composite (Essentia Universal) occlusally

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Class II Division 2 deep bite treatment using a combination of fixed orthodontic appliances and an acrylic splint

Johan Christian Julyan[1] and Marius Coetsee[2]

Abstract

This case report describes the management of a 15 year old female patient that presented with a Class II Division 2 malocclusion and a severe deep bite. Intra-oral examination showed severely retroclined incisors and a unilateral posterior crossbite. Other findings included a deep curve of Spee and moderate crowding in the maxilla and mandible. The treatment plan made use of a pre-adjusted fixed MBT bracket system with the use of a removable acrylic splint in the mandible to facilitate bite opening for the first 6 months of treatment. A non-extraction treatment protocol was used to prevent any further deepening of the bite. The treatment resulted in improvement of the deep bite and incisor angulation as well as a Class I molar and canine relationship with improved function and aesthetics.

Keywords: Orthodontic treatment, Class II Division 2, Deep bite, Acrylic splint, Fixed orthodontic treatment

Introduction

Class II malocclusions are very common and can be subdivided into Class II Division 1 or Class II Division 2. Both divisions have their own set of clinical appearances and treatment difficulties. Characteristics of Class II Division 2 malocclusions include: retroclination of two or more of the maxillary incisors; retroclined mandibular incisors; a Class II molar relationship and an increased overbite or deep bite (vertical overlap of the maxillary incisors to the mandibular incisors). A very important feature of Class II Division 2 malocclusions is the high position of the lower lip in relation to the maxillary incisors contributing further to the retroclination of the maxillary incisors.[1]

The majority of Class II Division 2 malocclusions present with a deep bite.[2] A deep bite is however not limited to Class II Division 2 cases and is seen as a characteristic of many other malocclusions. Deep bites can be as a result of over erupted maxillary incisors, over erupted mandibular incisors, or a combination of both. In many of the patients that present with a deep bite the incisors are retroclined.[3] Underdevelopment of the mandible is seen in most Class II Division 2 cases and flaring of the mandibular anterior teeth and retroclination of the maxillary anterior teeth results due to a compensatory mechanism.[4] In Class II Division 2 cases the main complaint typically includes the increased vertical overlap of the incisors, crowding of the maxillary and mandibular arches and decreased overjet.[5]

The treatment success lies in correcting the antero-posterior, vertical and transverse discrepancies. Correcting the inter-incisal angle is also paramount for a stable long term result.[6] Potential treatment alternatives for Class II Division 2 malocclusion include maxillary molar distalisation, extraction of maxillary first premolars and mandibular second premolars or extraction of only first premolars in the maxilla.[7] Overbite reduction

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Figure 1 (a-h): Pre-treatment photographs.

is often critical to correct the incisor relationship of Class II Division 2.[8] Overbite reduction can be achieved by incisor intrusion or by extrusion of the buccal segments with minimal intrusion and proclination of the incisors.[9]

Different treatment options exist for the correction of Class II Division 2 malocclusions depending on the baseline presentation. Removable appliances can be used during the growth phase and in the post-adolescent phase the treatment aims to achieve dentoalveolar compensation with the use of fixed orthodontic appliances.[10,11,12,13] When the maxilla is the cause of the malocclusion, distalization of the maxillary teeth or extraction treatment is often considered.[14,15,16] Other techniques include the use of intermaxillary elastics or fixed rigid or flexible bite jumping Class II correction appliances.[17,18,19,20,21,22] Another option includes the use of orthodontic treatment in combination with orthognathic surgery.[23]

Class II Division 2 malocclusion treatment in an adolescent patient can often lead to an excellent result if growth, compliance and treatment mechanics are favourable.[24]

Case Report

A 15-year-old female patient (Figures 1 a-h) presented to private practice with a main complaint that she "doesn't like her front teeth". Nothing abnormal was detected in her medical history.

Upon clinical examination the patient presented with a Class II Division 2 malocclusion with a very deep bite. Extra-oral examination revealed that the patient was brachycephalic with a convex profile. She had good facial symmetry and her maxillary midline was co-incident with her mid sagittal plane. She presented with competent lips.

Figure 2: Pre-treatment orthopantomogram.

Intra-oral examination revealed that the patient was in her permanent dentition stage. She had healthy gingiva but buccal caries on tooth 45. She had an Angle Class II molar and canine relationship bilaterally. In occlusion she had an overjet of 1 mm and an increased overbite, also referred to as a deep bite or deep overbite. There was a unilateral posterior crossbite (26:36) and moderate crowding in the maxilla and mandible with retroclined incisors.

Radiographic findings

The radiographic analysis of the patient's initial orthopantomogram showed a permanent dentition stage with the maxillary and mandibular second molars erupting. There were also early signs of impacted third molars in the mandible but no other abnormalities. (Figure 2).

The cephalometric analysis (Table 1), conducted before treatment, revealed a Class II skeletal relationship. Figures 3 (a and b), show the pre-treatment cephalogram and the cephalometric analysis done with Dolphin® orthodontic software.

Diagnosis

Soft tissue

The patient presented brachycephalic with a convex profile.

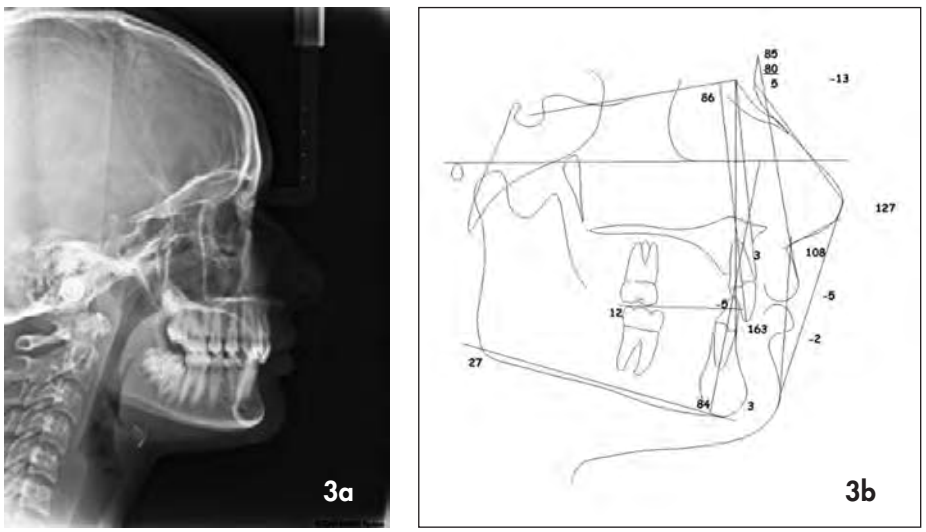

Figure 3: (a) Pre-treatment cephalogram and (b) cephalometric analysis.

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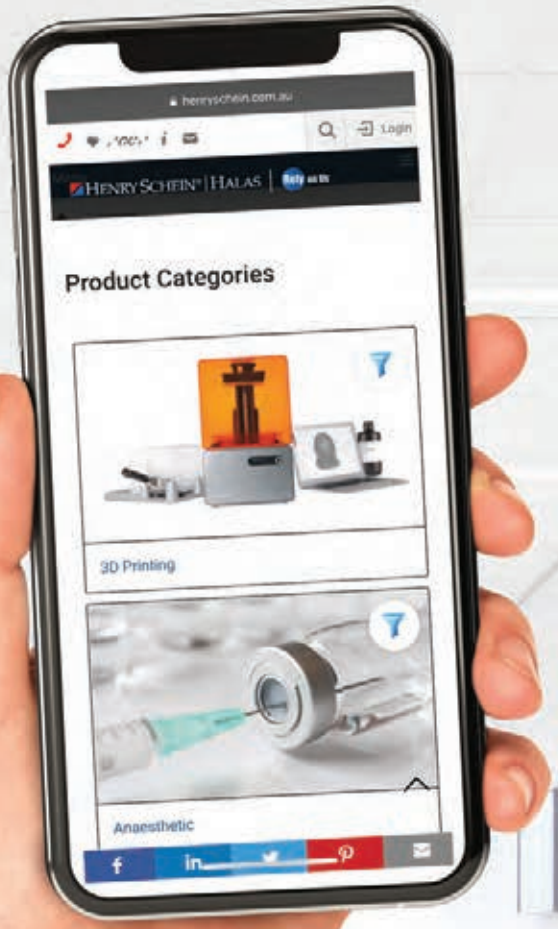

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Table 1: Pre-treatment cephalometric analysis

Cephalometric values	Normal	Pre - Treatment
SNA (°)	82.0	85.3
SNB (°)	80.9	79.8
ANB (°)	1.6	5.6
WITS (mm)	-1.0	3.8
Interincisal angle (°)	130.0	163.2
U1 – SN (°)	102.4	85.9
U1 – NA (mm)	4.3	-4.0
U1 – NA (°)	22.8	0.6
L1 – NB (mm)	4.0	-0.8
L1 – NB (°)	25.3	10.7
FMIA (L1 – FH) (°)	63.5	78.9
IMPA (L1 – MP) (°)	95.0	84.1
Lower lip to E-Plane (mm)	-2.0	-2.5
Upper lip to E-plane (mm)	-3.3	-4.8
Soft tissue convexity (°)	135.7	127.3
Convexity (A-NPo) (mm)	1.5	3.2
Nasolabial angle (°)	102.0	107.9
Facial angle (°)	87.2	91.4
Upper lip thickness at A-point (mm)	17.0	11.4
Upper lip thickness at Vermilion border (mm)	13.1	14.2

Skeletal

Class II skeletal malocclusion [Steiner - ANB (5.6°) and WITS (3.8)] with a prognathic maxilla [SNA (85.3°) and Convexity (3.2 mm) and a horizontal growth pattern.

Dental

Angle Class II Division 2 with retroclined and retrusive maxillary and mandibular incisors. An overbite of 100% and an overjet of 1 mm due to the retroclined maxillary incisors. The patient had a severely enlarged interincisal angle of 163.2°.

Treatment objectives

The treatment objectives were: to improve the deep bite and achieve a Class I molar and canine relationships with well aligned maxillary and mandibular arches; to improve the incisor inclination and interincisal angle; and to ensure good interdigitation with a functionally and aesthetically acceptable result.

Treatment options

There are different ways to treat an Angle Class II Division 2 malocclusion. When making use of functional appliances in Class II Division 2 malocclusions a working overjet first needs to be developed by proclining the maxillary incisors. The treatment options for this Class II Division 2 malocclusion included camouflage or surgical correction seeing as the patient was already past her growth spurt.

Camouflage treatment which makes use of fixed orthodontic treatment in conjunction with inter-arch elastics and/or extractions and/or skeletal anchorage depending on the severity of the case.

Surgical correction which includes a combination of fixed orthodontic treatment and orthognathic surgery. This treatment option can only be done after the age of 18 years.

The treatment option of choice in this case was to do camouflage by making use of fixed orthodontic appliances and inter-arch elastics with the addition of an acrylic splint in the mandible to facilitate in treating the severe deep bite.

Treatment Plan:

The following steps were followed for the chosen treatment plan:

1. Completed all necessary basic restorative dentistry, tooth 45 buccal caries was restored using composite.
2. Impressions were taken for the fabrication of an acrylic splint for the lower arch to extend from the 35 to the 45.
3. Pre-adjusted MBT (022 slot) fixed orthodontic brackets were placed and a standard wire progression followed in the maxilla. Buccal tubes were placed on the 46 and 36 in the mandible with inter-arch elastics to facilitate over-eruption of the mandibular first permanent molars to open the bite.
4. Every month the acrylic occlusal guard was adjusted to facilitate over-eruption of the posterior teeth.
5. After contact was achieved up until the second premolars the acrylic splint was removed and MBT pre-adjusted fixed orthodontic appliances were placed on all the remaining mandibular teeth.
6. Class II elastics were utilized to reduce the overjet and correct the Class II molar and canine relationships.
7. Teeth were torqued and the case finished on 0.019 x 0.025 natural arch stainless steel archwires.
8. Ensured good interdigitation of the permanent teeth in order for them to settle in the new Class I position.
9. Retention - Placed fixed retainers in the maxilla and mandible and a clear removable retainer in the maxilla.

Progress of Treatment

The MBT pre-adjusted orthodontic system was used to conduct the treatment (Figures 4 a-e). The fixed appliance system was placed only in the maxilla at the start of treatment with an acrylic splint (AS) in the mandible. A button was placed palatal of tooth 26 and buccal tubes were placed on the 36 and 46 to serve as attachments for the inter-arch elastics that facilitate the over eruption of the mandibular posterior teeth to open the bite. The inter-arch elastic of the 26 to the 36 extended from palatal of the 26 to buccal of the 36 to correct the unilateral posterior crossbite of the 26 with the 36 (Figure 4 e).

Once the first permanent molars were in contact the acrylic splint was trimmed to extend only from the 34 to the 44 and orthodontic brackets were placed on the 35 and 45 with inter-arch elastics to facilitate over eruption of the mandibular second premolars. Once the molars and second premolars were in contact the acrylic splint was removed and fixed appliances were placed on the rest of the mandibular teeth, see (Figures 5 a-e).

Once the maxillary and mandibular teeth were aligned and in stainless steel wires (Figures 6 a-c), Class II inter-arch elastics were used to reduce the overjet and correct the Class II molar and canine relationships, see Table 2. The Alignment in the maxilla and mandible was done using Nickel Titanium (NiTi) archwires and the case was

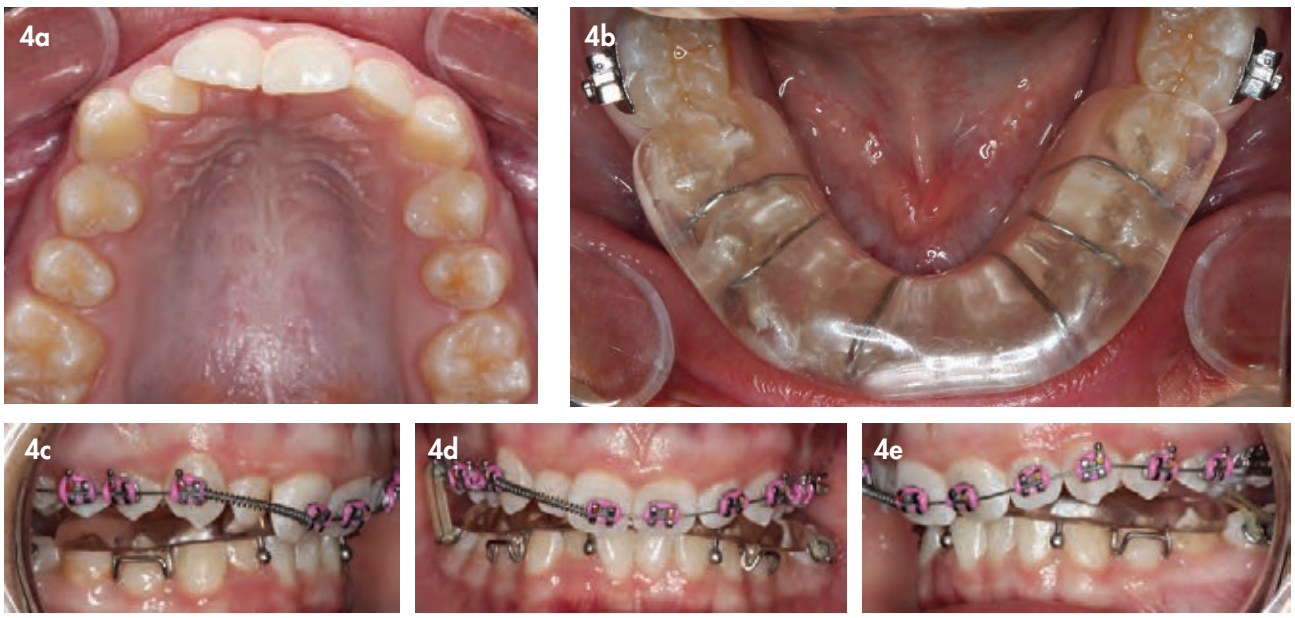

Figure 4 (a-e): Start of treatment with maxillary fixed appliances and mandibular acrylic splint.

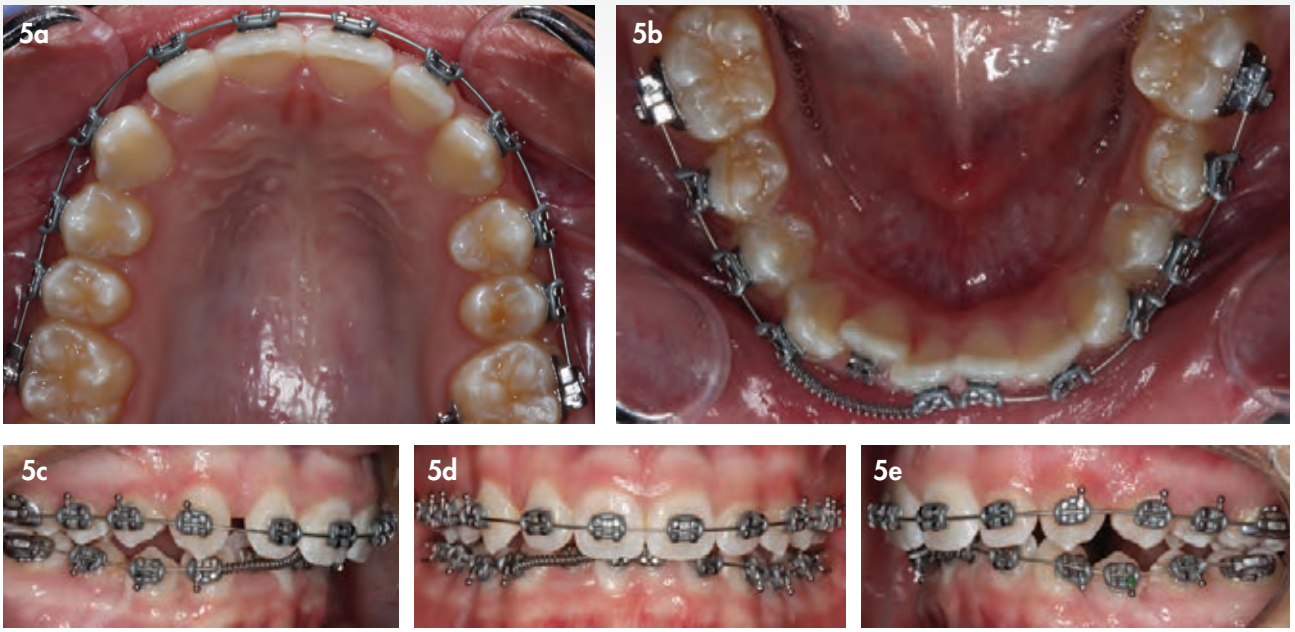

Figure 5 (a-e): Placement of mandibular fixed appliances.

finished on stainless steel (SS) wires. The following archwire sequence was used, see Table 2.

The final archwire for both arches was a 0.019 x 0.025 SS. The Inter-arch Class II elastics that were used during the treatment were stopped for the last 2 months of the treatment to evaluate if the patient had a stable Class I bite.

Table 2: Archwire and Inter-arch elastics sequence used for the treatment

Archwires		Inter-arch elastics	
Maxilla	**Mandible**	**Size and force**	**Direction**
0.014 NiTi	AS with buccal tubes on 36 and 46	4 Oz 4.8 mm	Teeth 16 to 46 (buccal) and 26 to 36 (through the bite)
0.016 NiTi	AS with buccal tubes on 36 and 46 and fixed brackets on 35 and 45	4 Oz 4.8 mm	Teeth 16,15 to 46,45 and 26,25 to 36,35
0.018 NiTi	0.014 NiTi	-	-
0.018 NiTi	0.016 NiTi	-	-
0.018 NiTi	0.018 NiTi	-	-
0.018 x 0.025 NiTi	0.018 x 0.025 NiTi	-	-
0.019 x 0.025 SS	0.019 x 0.025 SS	6 Oz 6.4 mm	Class II (maxillary canines to mandibular first permanent molars)

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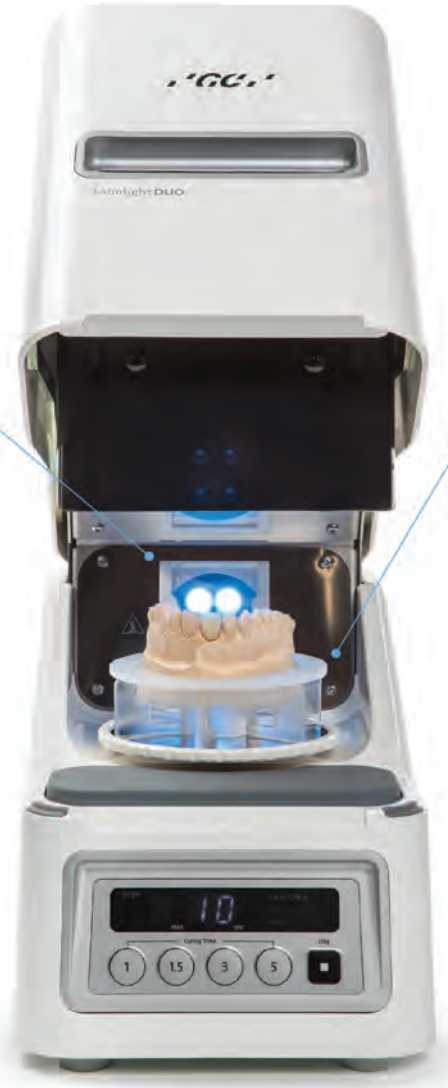

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Figure 6 (a-c): Final archwire for both arches (019 x 025 SS).

Treatment outcome

The treatment resulted in well aligned arches with Class I molar and canine relationships (Figures 7 a-h). The deep bite improved significantly with the maxillary and mandibular midlines corresponding to the patient's midsagittal plane and the teeth were settled in the new occlusion. The unilateral posterior crossbite was resolved and the inclination and interincisal angle of the maxillary and mandibular incisors improved.

Comparison of Initial and final orthodontic study models

A comparison was made of the pre-treatment and post-treatment orthodontic study models to show the change that

Figure 7 (a-h): Post-treatment photographs.

occurred from all the different views (Figures 8 and 9 a-e).

Frontal view: Vertical and transverse correction showing deep bite correction and correction of the unilateral posterior crossbite of tooth 26 with 36.

Lateral views: Improvement in the anteroposterior dimension with correction of the Class II molar and canine relationships to Class I as well as correction of the retroclined maxillary and mandibular incisor inclinations.

Maxillary and mandibular occlusal views: Well aligned arches without any residual spaces or rotations.

Cephalometric values

Table 3 below shows the values of the cephalometric analyses from the start to the completion of treatment and

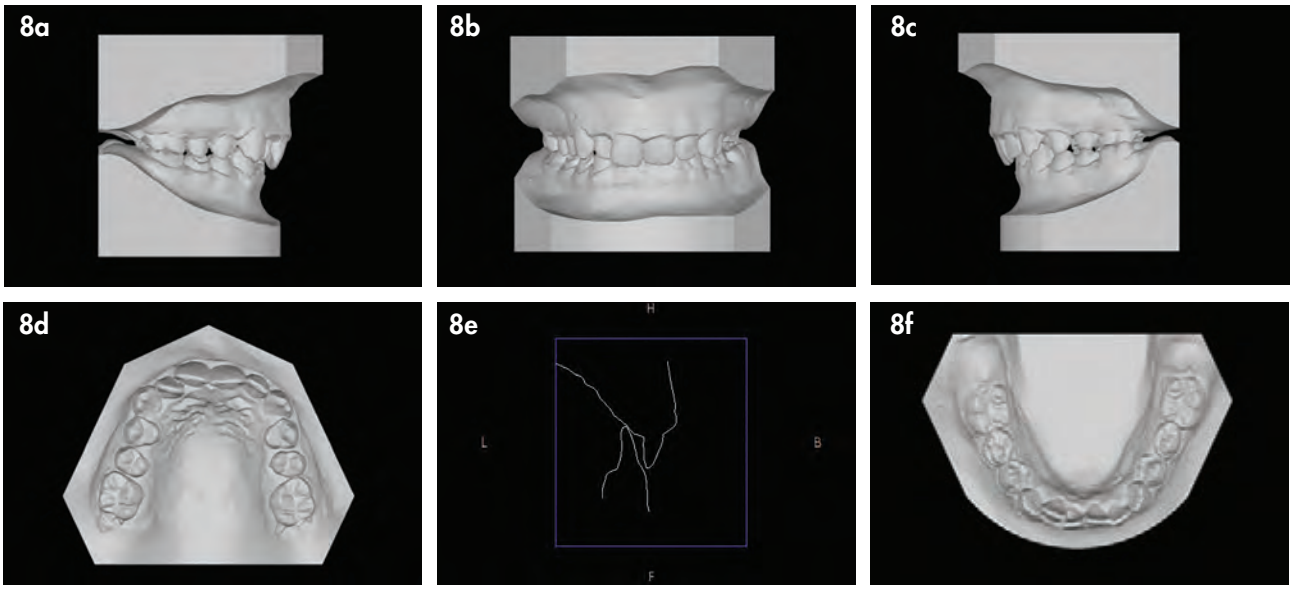


Figure 8 (a-f): Pre-treatment orthodontic study models.

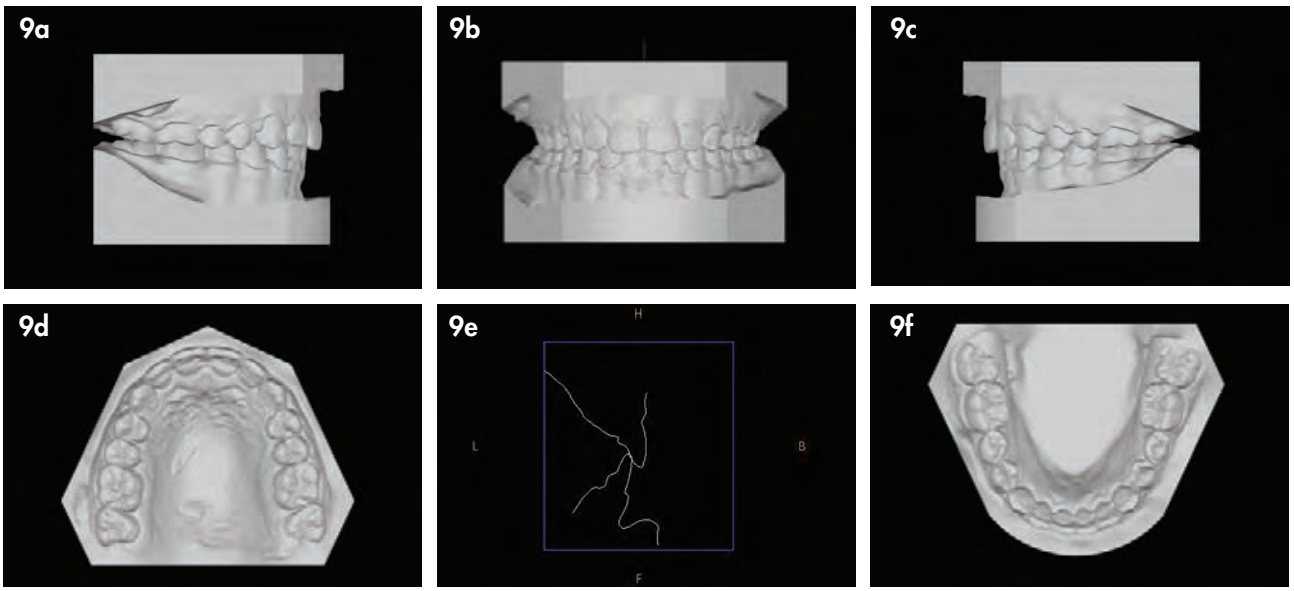


Figure 9 (a-e): Post-treatment orthodontic study models.

Figures 10 (a and b) shows the cephalograms before and after treatment.

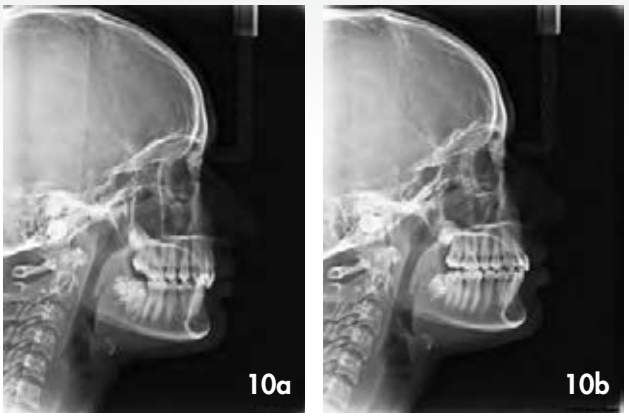


Figure 10 (a and b): Cephalograms before treatment (a) and after treatment (b).

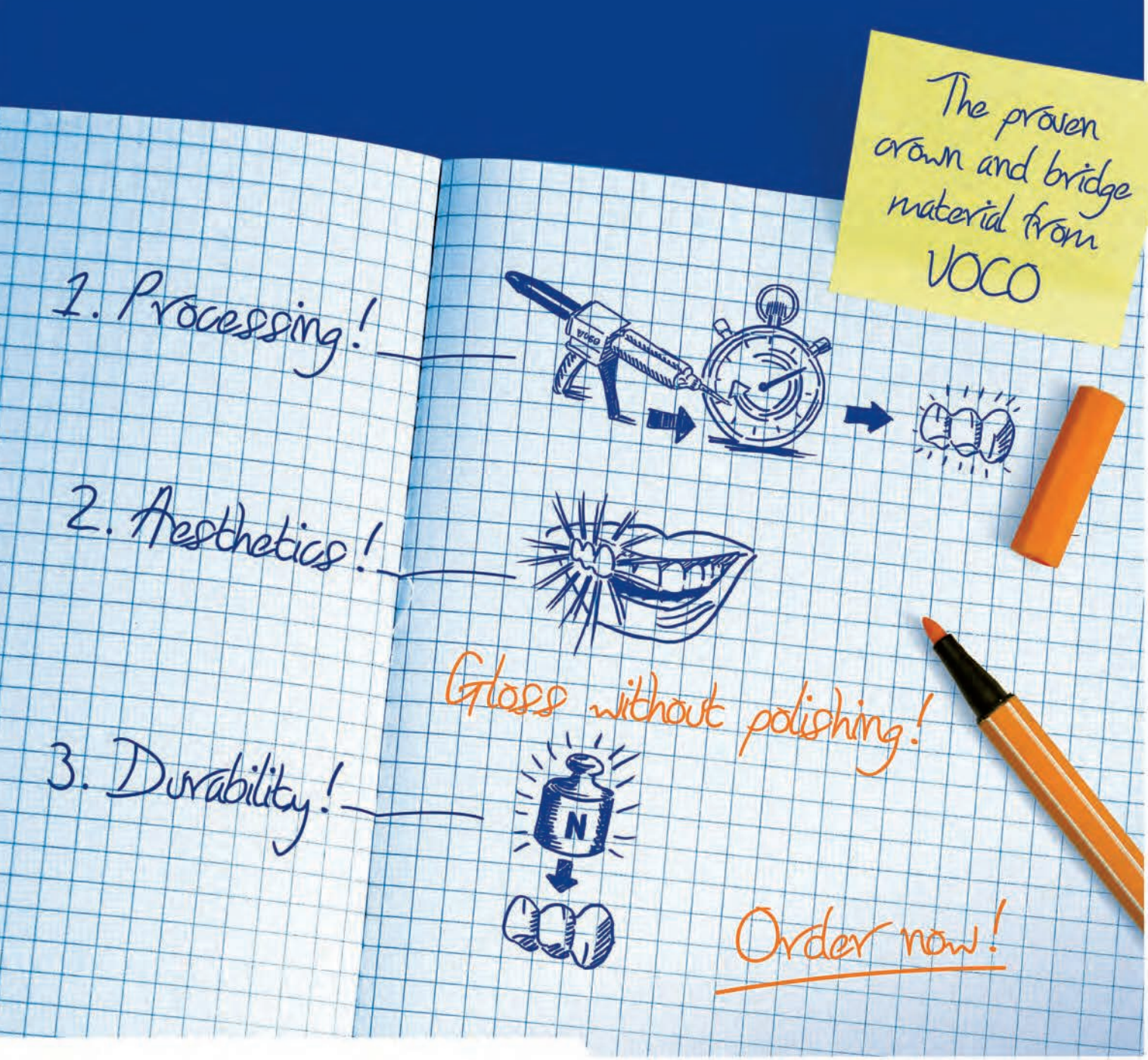
Discussion

It is estimated that between 2% and 5% of a population have a Class II Division 2 malocclusion.[25,26,27] Class II Division 2 malocclusions are regarded as difficult to treat and they have the tendency to relapse after treatment.[28,29] Relapse tends to occur more frequently in adult cases than adolescents.[17]

A recurring deep overbite, crowded maxillary incisors and a steep axial maxillary incisor inclination is often seen after retention.[11] The maxillary incisor inclination should be corrected as close as possible to normal, keeping in mind that overcorrection is more prone to relapse.[30,31] An interincisal angle of less than 140 degrees after treatment is an important treatment objective to ensure long term stability.[32] The presence of a high lower lip line is frequently seen in Class II Division 2 malocclusion patients and is said to cause the steep maxillary incisor inclinations as well as the high frequency of relapse.[33,34,35] Removing the excessive overlap of the maxillary incisors by the lower lip is therefore an

Table 3: Cephalometric values before and after treatment

Cephalometric values	Normal	Pre - Treatment	Post treatment
SNA (°)	82.0	85.3	80.8
SNB (°)	80.9	79.8	76.6
ANB (°)	1.6	5.6	4.2
WITS (mm)	-1.0	3.8	2.3
Interincisal angle (°)	130.0	163.2	135.5
U1 – SN (°)	102.4	85.9	95.5
U1 – NA (mm)	4.3	-4.0	0.6
U1 – NA (°)	22.8	0.6	14.7
L1 – NB (mm)	4.0	-0.8	4.1
L1 – NB (°)	25.3	10.7	25.6
FMIA (L1 – FH) (°)	63.5	78.9	63.2
IMPA (L1 – MP) (°)	95.0	84.1	98.3
Lower lip to E-Plane (mm)	-2.0	-2.5	-0.9
Upper lip to E-plane (mm)	-3.3	-4.8	-4.2
Soft tissue convexity (°)	135.7	127.3	128.3
Convexity (A-NPo) (mm)	1.5	3.2	2.3
Nasolabial angle (°)	102.0	107.9	95.9
Facial angle (°)	87.2	91.4	90.6
Upper lip thickness at A-point (mm)	17.0	11.4	12.3
Upper lip thickness at Vermilion border (mm)	13.1	14.2	14.1



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important objective when treating Class II Division 2 cases.[30]

It has been found that molar correction appeared to be stable after orthodontic treatment [36], but it's also important to remember that the amount and direction of mandibular growth after treatment has an influence on the stability of the overbite correction as well as the molar relationship after treatment of Class II Division 2 cases. [37,38] A minimum of 5 years is recommended to follow up treated Class II Division 2 cases since many skeletal, soft-tissue, and dental variables have shown significant changes from 2-5 years post-retention.[39]

Although there is some controversy surrounding the dentofacial characteristics of Class II Division 2 malocclusions,[40,41] some general agreement does exist and includes a normal maxillary prognathism in combination with a retrognathic mandible when the B-point is used as the reference.[42,43] Another characteristic feature is the retroclination of the maxillary incisors as well as a deep bite.[1] In severe cases vertical skeletal factors are evident. [44,45] When a high lower lip line is present with its associated resting pressure on the maxillary incisors, a retroclination of the maxillary incisors is commonly seen. [28,29]

Evidence from prospective studies show that in order to maximise favourable soft tissue and dentoalveolar changes during treatment, the facial growth pattern should be diagnosed early and the correction of the deep overbite done as soon as possible. [46] The increased overbite can be corrected with several techniques, but the success thereof will largely be determined by how well the interincisal angle is altered. [47] The interincisal angle can be corrected by proclining the maxillary or mandibular incisors or a combination of both. The mandibular incisor should occlude onto the cingulum of the maxillary incisor after the interincisal angle has been altered. [48] In order to ensure that the corrections to the interincisal angle and overbite is maintained in Class II Division 2 malocclusion cases, a long term retention protocol should be followed. [49]

Prospective international studies are required (either case control or randomized control trials) to provide stronger evidence on the treatment options and stability for Class II Division 2 malocclusions in children and adolescents.[39]

Conclusion

Class II Division 2 remains one of the most difficult malocclusions to treat.

A deep bite is a common feature in Class II Division 2 malocclusions and can be corrected using various techniques. In this case the use of a removable acrylic mandibular splint in combination with MBT fixed orthodontic appliances were used to correct the deep bite and Class II Division 2 malocclusion.

The success of this case was completely dependent on the compliance of the patient regarding wearing of the acrylic splint and inter-arch elastics to correct the deep bite, unilateral posterior crossbite and Class II molar and canine relationships.

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Conservative smile makeover using resin infiltration and microabrasion

Shiraz Khan[1]

Introduction

A patient with severe hypomineralisation defects was offered comprehensive indirect restorative treatment to give a dream smile. This case study demonstrated the advances in minimal intervention dentistry and outlines an ultraconservative approach to improving the patient's smile; but, above all, quality of life.

The dentist's armamentarium has vastly increased in the last decade, with what seems an exponential improvement in technology and materials at dentist's disposal to treat patients.

Use of techniques such as orthodontics, Icon resin infiltration, air abrasion and direct composite restorative techniques, not only provided this patient with an aesthetic result, but also a result that, biologically speaking, cost less, and subsequently will extend the longevity of her teeth. Ultimately, this case fulfils the goals of the 'daughter test', while maximising aesthetics.

As described by Banerjee (2013), minimal intervention dentistry (MID) is a contemporary approach to dentistry that requires ultraconservative operative management of patients. The ethos and philosophy behind this approach aims to keep teeth functional for life (Frencken et al, 2012).

As we are aware the nature of management of caries, broken teeth generally requires some form of loss of tooth tissue. In the example of dental caries, a cavity will present, but the preparation process requires loss of tooth structure to access the lesion, adequately remove bacteria and debris, for a restoration to be placed. Advances in the materials and techniques have made early caries management significantly less intrusive on the tooth's structure.

For instance, the use of air abrasion for cleaning stained fissures, with cavities only just forming in dentine, can be managed in a way without the need for spurious preparation, and the creation of retention and resistance form (Hedge and Khatavkar, 2010).

This has been complemented with parallel advances in adhesive dentistry, which can achieve significant bond strengths to enamel and dentine that has been considered as central to minimally invasive restorative dentistry (Burke et al, 2017).

The process of MID does not only apply to operative management of dental

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Figure 1: Preoperative situation

Figure 2: Pre-restorative orthodontics

Figure 3: Pre-restorative whitening

Figure 4: Split dam isolation due to fixed retainer

Figure 5: Finalisation of isolation with Liquid-Dam

Figure 6: First Icon etch cycle application

Figure 7: Washing and drying of tooth post-etch cycle

caries. The process of being able to improve self-confidence associated with smiling is also a central pillar of any aesthetic dentistry.

Kelleher (2010) summarises the needs to not be driven down cosmetic or aesthetic procedures by patients for improvement in appearance. The subsequent biological cost associated with conventional management strategies for improvement of appearance, such as crowns or veneers, directly opposes the key facet of ensuring teeth remain functional for life.

This does not imply that crown and veneer restorations are not indicated in aesthetic dentistry, but rather, what are the alternative treatment options for improvement in aesthetics for patients.

These should all be presented to the patient in order of biological invasion, relative risks and benefits and appropriate costs. While, as dentists, we are providing a service for patients, as outlined by the 'daughter test', if a provider is unhappy with undertaking a certain treatment modality, refusing treatment should not be considered taboo. Instead, having the patients interest and health should be at the forefront of any treatment plan or proposed treatment options.

Figure 8: Application of Icon Dry (test-drive for infiltration)

Figure 9: Re-etch application for two further cycles with air abrasion

Figure 10: Application of Icon Dry (test-drive for infiltration)

Figure 11: Further etching and air abrasion result

Figure 12: Application of Icon Dry (test-drive for infiltration) showing satisfactory masking

Figure 13: Resin infiltration application

Figure 14: Light curing after three minutes

Figure 15: Re-resin infiltration application, accounting for shrinkage stress

Case Presentation

A 25-year-old female was a self-referring patient who wanted to improve her smile. Having had previous 'smile consultations' the patient was quoted £25,000 for 10 upper ceramic veneers to guise the appearance of these hypoplastic teeth. She was also keen to have such work done; however, the patient had moved job and the practice was difficult to reach.

Medically, the patient was fit and well, not taking any regular medication, with no known allergies. The patient was also a regular dental attendee and would see the hygienist at routine, six-monthly intervals. The patient would rarely eat sugary snacks, and would mainly consume water.

Extraoral examination was unremarkable with no deviations, clicks or crepitus on opening. The intraoral soft-tissue was unremarkable with no ulcerations/patches or discolourations to note. And the hard-tissue was free from dental caries, mild wear and no fractured teeth.

Diagnosis

The patient was diagnosed with the following:

- Chronic marginal gingivitis
- Retained lower Es with poor prognosis
- Severe generalised enamel hypoplasia
- Orthodontic crowding.

The patient was generally caries free; however, the discussion regarding the lower Es was queried about the long-term prognosis. A decision-making process would be made between the orthodontist and patient regarding space creation, and longevity of these retained lower Es.

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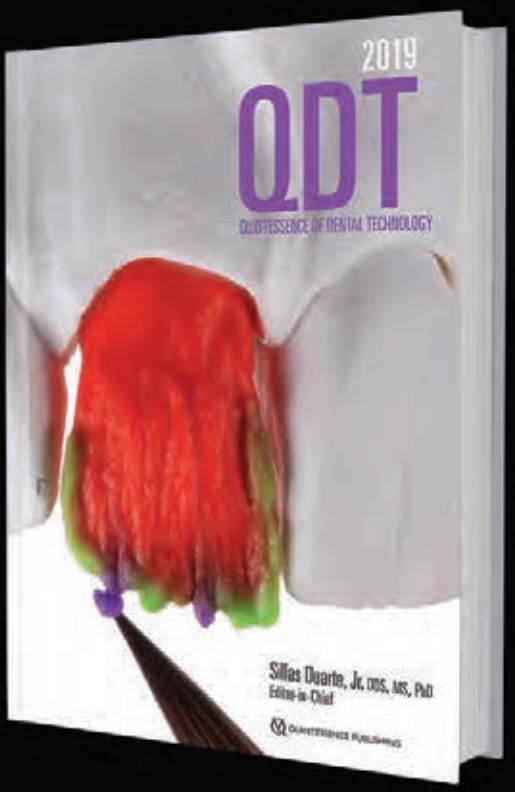

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Mieleszko/Saito/Chu • Dual- or Co-Axis Macro-Designed Implants for Restorations in the Esthetic Zone

Figure 16: Light curing after two minutes

Figure 17: Immediate post-infiltration picture

Figure 18: Application to achromatic composite to restore vestibular defect

Figure 19: Polishing

Figure 20: Immediate postoperative result

Figure 21: Preoperative smile

Figure 22: Postoperative smile

Figure 23: Preoperative (post-orthodontic) retracted anterior uppers

An initial phase of supra and subgingival scaling and prophylaxis would be undertaken prior to any aesthetic-restorative dentistry.

Discussions with the patient

In the patient's words, they were keen to 'improve the appearance of her teeth, mainly the white spots'. The case was presented to the patient with a large screen and discussions of what the 'aesthetic concerns' were. The patient had not previously considered orthodontics; however, would consider pre-restorative orthodontics. Furthermore, the patient was also advised that although veneers are an aggressive treatment strategy, this would be the only method of disguising the white spots.

The discussion then opened up regarding more minimally invasive methods for white spot lesion removal. The patient had never heard of Icon, and initially did not believe this would work. The patient was advised this is a severe case of enamel hypoplasia and the subtle preparation to the enamel surface would likely be required, in the form of air abrasion; however, this would be the most conservative way to manage this case.

Subsequent bonding would also likely be required to fill the defects where the Icon/air abrasion had taken place; however, the patient would be able to mask the lesions without the need for drilling/shaping the teeth for full/part coverage indirect restorations.

Treatment options for the patient

As discussed in the earlier introduction, all of the treatment options are required to be discussed with the patient, including their relative merits and downfalls, in order to

Figure 24: Postoperative retracted anterior upper

Figure 25: Postoperative retracted upper lateral views

ascertain adequate consent (GDC standards). In this case, we discussed the restorative options in ascending order of level of invasion:

1. Do nothing – although this negates the reason for the patient's appointment
2. Whitening – this will lead to the whitening of the white spots in addition to the natural tooth; therefore, this may worsen the scenario
3. Microabrasion – the is a minimally invasive manner to reduce white spot appearance; however, usually requires very superficial white lesions
4. Icon resin infiltration – this will require fine enamel preparation and several cycles, but would be the least invasive way to get complete blending of the white spot lesions
5. Direct composite restoration – this will require enamel and dentine removal of the white spots for these to be subsequently restored
6. Direct composite veneers – this may still require enamel preparation, but either an application of a base opaque layer to mask the white areas or subtle enamel preparation, or opaque composite application; losing the vitality of the teeth
7. Indirect veneer restorations – although flexibility with material choice, due to longevity, and ability to hold lustre and polish for extended periods of time, porcelain would likely have been the restorative material of choice. This is the most invasive option, and will likely cost the most.

Icon resin infiltration

Enamel hypoplasia and other traumatic dental injuries can appear on teeth as white, yellow or brown discolourations. Hypoplasia is characterised by reduced enamel thickness, pits and opacities, as well as other irregularities. Although the hardness remains intact, there is a large variation in size and severity (Andreasen et al, 1971).

The appearance of white spots occurs due to variation of refractive indices between enamel crystals and the medium inside the porosities (opacities) (Andreasen et al, 1971). The difference between water and air is 1.33 and 1.0, which is sufficient to see a difference in dispersion of light.

Icon resin infiltration is a process that allows alteration of the refractive index of opaque white spots to RI 1.62, which appears similarly to enamel RI 1.65; thereby leading to masking of white spots (Torres et al, 2011). This does not require removal of the white spot, but instead access to the white lesion and use of a low-viscosity resin, which infiltrates the lesion driven by capillary forces (Meyer-Lueckel and Paris, 2008) and subsequently blends the RI of the white spot to the surrounding enamel. As Kim et al (2011) also found resin-infiltration is a more than suitable treatment approach and modality in masking white spot lesions.

Treatment rationale

As listed, the options vary greatly in cost, both financially and biologically. The patient was thrilled about having natural looking teeth; however, as part of education, the patient was debating whether veneer restoration would be the treatment modality of choice.

The fundamental core aspect in the decision-making process was not financial, more biological. Adopting the 'daughter test' (Kelleher, 2010) mentality, most practitioners would be happy to minimise intervention on the patient if a suitable aesthetic outcome was achievable.

The patient was advised that likely a combined approach may solve this case in the most conservative method as possible. If the patient was interested in having her teeth aligned, this would provide an optimally aesthetic result without having to over-prepare certain teeth to make the indirect restorations all aligned.

Final treatment plan

1. Full mouth supra and subgingival scaling and prophylaxis
2. Orthodontic alignment (carried out by orthodontist with fixed labial)

Figure 26: Before and after standard, monochrome and hyper-contrasted views

Figure 27: Before and after result

3. Whitening
4. Icon resin infiltration and labial bonding UR3-UL3 (to correct concavities post-Icon etch).

Composite bonding

As outlined by Dietschi et al (1995), any restoration from class III to V can adequately satisfy many aesthetic concerns when restored with composite resin. These articles outline the use of varying opacities of composite, dentine and enamel, to recreate natural-looking effects and restorations. Focusing more on this case, the likelihood of requiring such advanced layer techniques may be completely omitted.

There will be sufficient underlying dentine, and enamel, with the exception of the UL1 incisal edge, which may require dentine. Composite bonding can be completed in isolation, without resin-infiltration; however, as outlined above, Icon uses hydrochloric acid to enable subtle, but minimal, enamel erosion that will lead to a defect being created.

This defect will then be covered by composite resin. Therefore, the function of the composite is not to mask the 'remaining' white spot, if any, but rather to create a smooth homogenous surface that fills the void created by the Icon etching (and/or air abrasion).

This is so much the case that the composite chosen will often be achromatic in nature, which subsequently allows the natural tooth colour to shine through the resin material. Although the material has undergone significant advancements in the past two decades, the material, and indeed the bonding, does degrade over time. As outlined by Drummond (2008), the main mode of failure of composite is either degradation of the resin matrix, or the interface between the filler and resin matrix.

Evidence also seems to suggest that failures in less than five years tend to be more technique associated, while those after five years tend to be due to secondary caries, rather than failure of the composite itself. Concomitantly, this reflects the requirement for adequate isolation (Cajazeira et al, 2014) during all adhesive procedures, and effective oral hygiene prior to commencing any restorative dentistry.

This case the composite of choice was Tokuyama Asteria Estillite Composite restorative material. This is a nano-hybrid composite material that not only has excellent filler proportion (82% b/w), but, in the author's experience, has great handling characteristics, and excellent final polish.

By contrast, a study by Moraes et al (2009) describes nano-hybrid composites as having inferior properties to nano-filled composites; however, in a non-load bearing

situation such as this case, it is extremely unlikely that the physical properties will play a significant role in long-term success.

Furthermore, using various forms of surface treatments will ensure the composite repair provides, predictable, effective bonding and repair, should there be any fractures (Margareta et al, 2010). This, ultimately, leads to composite being the restorative of choice.

Treatment sequence

The patient undertook supra and subgingival scaling and prophylaxis prior to commencement of treatment. The orthodontic treatment included 14 months of labial (ceramic) fixed braces to improve alignment, relieve crowding and improve gingival level symmetry.

The patient was placed in fixed and removable retention indefinitely. The patient was requested to remove the fixed retainer prior to any bonding/Icon, however, the patient was very anxious during the composite removal of the brackets during the debond procedure, and subsequently requested if this could be left.

The patient then undertook two weeks of home-whitening using 10% carbamide peroxide for seven days, and 16% carbamide peroxide for a subsequent week. The system used in this case was Enlighten. There is importance in ensuring a minimum period of 14 days from cessation of whitening to start of bonding. Not only does the improved value of tooth substrate begin to stabilise but also a statistically significant reduction in bond-strength (Garcia-Godoy et al, 1993).

After two weeks of whitening, followed by two weeks for stabilisation, the patient was booked in for the restorative appointment. A preoperative shade assessment was undertaken with white enamel (WE) from Tokuyama Asteria Estillite composite being a mutually agreed shade match, by patient, dentist and nurse.

The upper premolar-premolar were isolated using Unodent heavy rubber dam. There was a modified split dam approach as the patient kept their bonded retainer on. This was modified using Liquidam. The pellicle of was subsequently removed 4-4 using a slow handpiece and a prophylaxis brush.

The process of resin infiltration occurs as follows. Icon etch contains, 15% hydrochloric acid, which is applied for two-minute intervals. This translates to approximately 50µm enamel removal. The etch is washed for 30 seconds, then Icon Dry an 99% ethanol-based liquid, is placed over the teeth.

This is the most significant aspect of any Icon treatment as it gives the opportunity to review whether the lesion will be adequately masked or not, a test-drive if you will of what the tooth will appear like after resin-infiltration.

In this case, as can be seen by the severe hypoplasia, there will likely be a requirement for subtle enamel preparation to access the white spot. This is repeated for three to four cycles.

If sufficient improvement is not noted, then you would consider adjunctive measures. In this case, the UL1 specifically was treated with air abrasion. This was using 27µm aluminium oxide particles for 30s at pressure of two bar. Then a reapplication of Icon etch was used. After two further cycles of etching and air abrasion, the Icon dry showed satisfactory masking of the white spot lesion.

Therefore, it was time to infiltrate with resin. Resin infiltration requires a two-minute application and agitation on the teeth, followed by a one minute for the resin to remain undisrupted on the teeth. This is followed by excess removal and teeth separation (using floss) and curing for 30 seconds on each tooth. A second application is repeated for two minutes and cured to account for contraction shrinkage.

We are then able to restore the void with composite resin. Here, it is important to stage that the use of composite is not to mask the white spot, rather to fill the void; therefore, the use of an achromatic enamel is sufficient.

In this case Asteria Estillite was used, using WE to fill the voids. This was applied generally 2-2. As research suggests (Wiegand et al, 2011), using adhesive with Icon increases the bond strength. In the authors experience, bottle 2 from Optibond FL is used routinely.

This is subsequently cured for 30 seconds and the labial composite increment is placed. The final increment is cured under an oxygen barrier medium to remove the oxygen inhibition layers and optimised stability and hardness (Strnad et al, 2015). In this case, liquid strip (Ivoclar Vivadent) was used. Finally, a combination of Soflex discs (3M ESPE) and Astropol were used (Ivoclar Vivadent) as these have also proven to have the smoothest topography under SEM (Marghalani, 2010).

Conclusion and reflection

MID is proving to provide dentists alternative skills under their armamentarium. However, the most significant point, is these additional techniques are proving to allow the teeth incur less biological cost, while maximising their longevity.

While this case demonstrates a fair result, the treatment had surpassed all patient expectations. The key in this case is long-term evaluation, and to consider how this case will fair in 12 months, five years and 10 years.

However, a significant advantage is that composite can be stably repaired, added and subtracted; therefore, rendering this the treatment of choice in this 25-year old female patient. Although this was not an absolutely perfect result, the patient was delighted with the treatment, as she was managed in an ultraconservative manner.

The patient undertook supra- and subgingival scaling and prophylaxis prior to commencement of treatment.

Although composite bonding was undertaken, what is shown by this case is the relevance of the infiltration of the white lesions, and not removal, which led to masking of all the white spots. The composite was merely adjunctive to reduce the concavities created by HCl etching. Therefore, this case demonstrates the power of Icon Resin infiltration.

Advances in adhesion, composite technology and resin infiltration approaches, not only make this a feasible treatment option, but rather, the treatment option of choice in such cases; and, ultimately, would be what we would consider as suitable treatment if this patient was any clinician's daughter.

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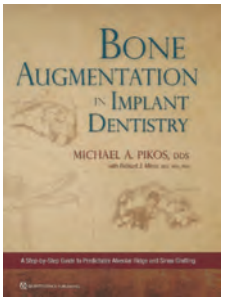

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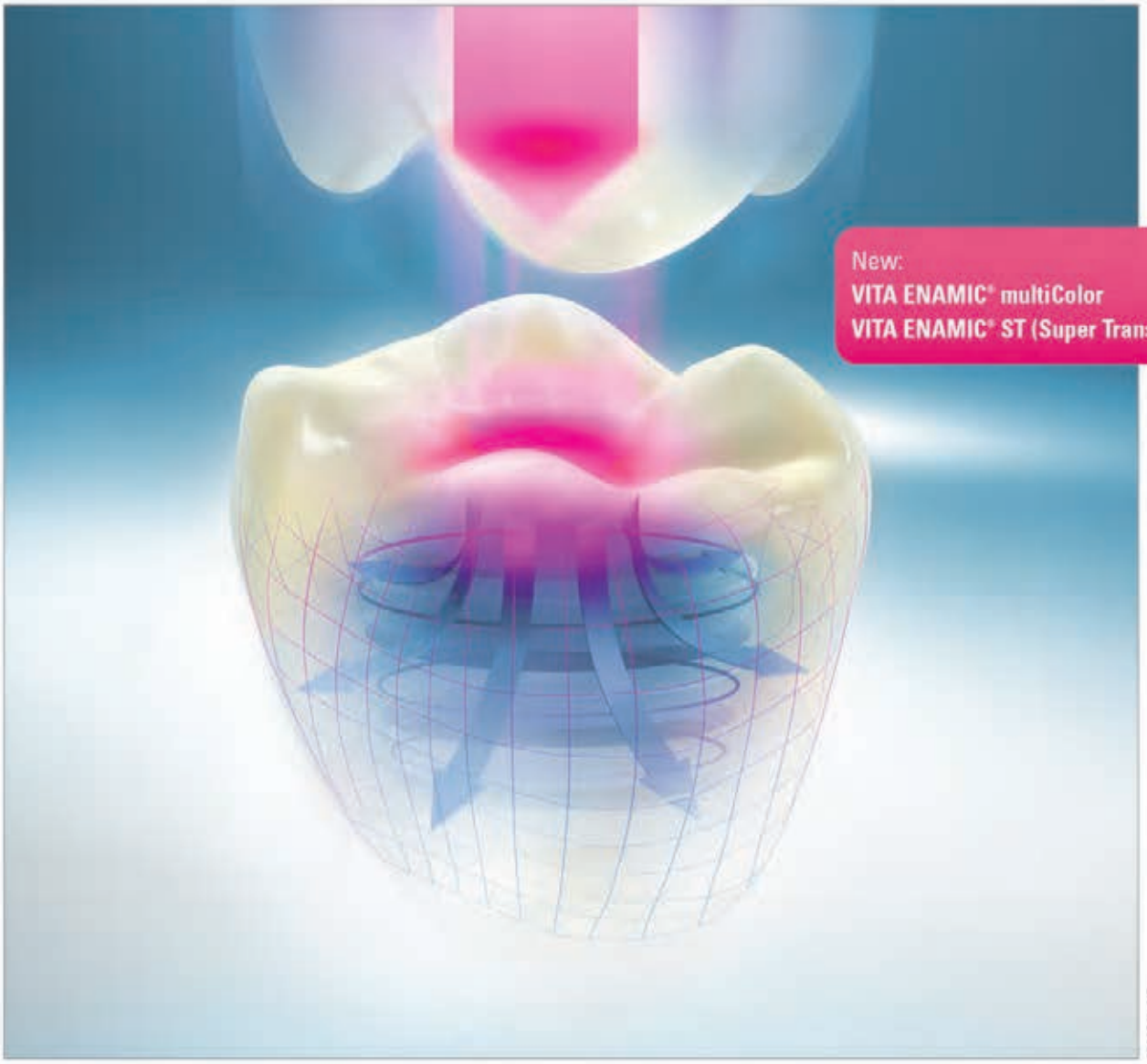
VITA ENAMIC® redefines load capacity.*

The first ceramic with dual network structure for unsurpassed absorption of masticatory forces



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VITA ENAMIC®

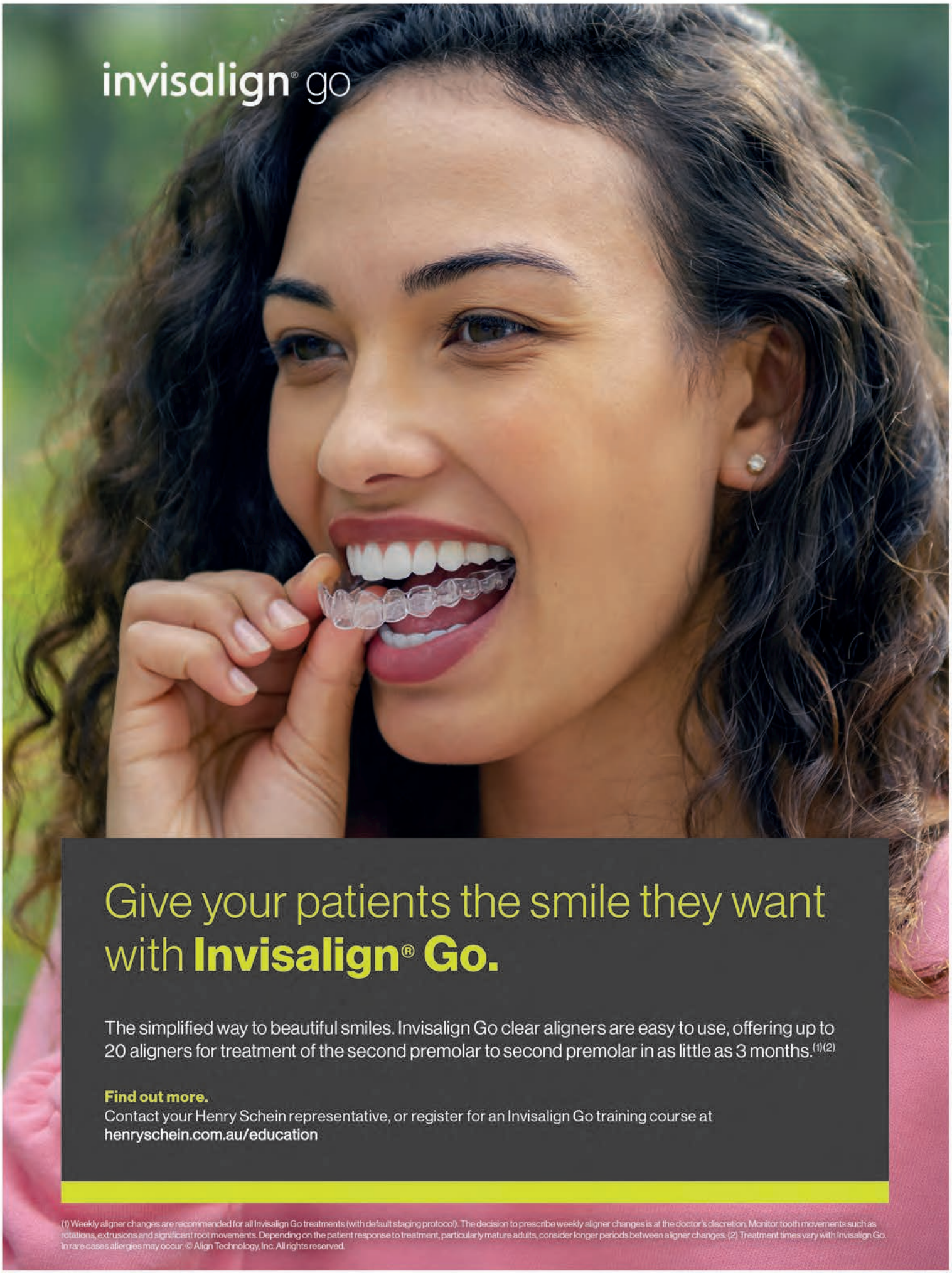
- enormous load capacity since masticatory forces are absorbed
- reduction of wall thickness possible to achieve restorations that require minimal preparation
- highly precise and particularly accurate results
- tooth-like material properties
- fast and easy to process with no furnace required

*) In addition to a high degree of elasticity, this innovative ceramic guarantees outstanding load capacity after adhesive bonding.

www.vita-enamic.com facebook.com/vita.zahnfabrik

VITA – perfect match.

VITA



Give your patients the smile they want with **Invisalign® Go.**

The simplified way to beautiful smiles. Invisalign Go clear aligners are easy to use, offering up to 20 aligners for treatment of the second premolar to second premolar in as little as 3 months.[1][2]

Find out more.
Contact your Henry Schein representative, or register for an Invisalign Go training course at **henryschein.com.au/education**

(1) Weekly aligner changes are recommended for all Invisalign Go treatments (with default staging protocol). The decision to prescribe weekly aligner changes is at the doctor's discretion. Monitor tooth movements such as rotations, extrusions and significant root movements. Depending on the patient response to treatment, particularly mature adults, consider longer periods between aligner changes. (2) Treatment times vary with Invisalign Go. In rare cases allergies may occur.

Orders 1300 65 88 22 www.henryschein.com.au

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