# Debonding and Fixed Retention in Orthodontics

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## An Evidence-Based Clinical Guide

*Edited by*

*Theodore Eliades*
*DDS, MS, Dr Med Sci, PhD, DSc, FIMMM, FRSC, FInstP, FDS RCS(Ed)*
*Professor and Director, Clinic of Orthodontics and*
*Pediatric Dentistry, Center of Dental Medicine,*
*University of Zurich, Switzerland*

*Christos Katsaros*
*DDS, Dr med dent, Dr hc, Odont Dr/PhD*
*Professor and Chair, Department of Orthodontics and Dentofacial*
*Orthopedics, School of Dental Medicine/Medical Faculty,*
*University of Bern, Switzerland*

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# Contents

# List of Contributors

***María Arregui***
Department of Odontology
Faculty of Dentistry
Universitat Internacional de Catalunya
Sant Cugat del Valles
Barcelona, Spain

***Georgios N. Belibasakis***
Department of Dental Medicine
Karolinska Institutet
Huddinge, Sweden

***Christoph Bourauel***
Department of Oral Technology
School of Dentistry
University Hospital Bonn
Bonn, Germany

***T. Gerald Bradley***
School of Dentistry
University of Louisville
Louisville, Kentucky, USA

***William Brantley***
Division of Restorative and Prosthetic Dentistry
College of Dentistry
The Ohio State University
Columbus, OH, USA

***Christian J. Day***
Department of Orthodontics
Bristol Dental School
University of Bristol
Bristol, UK

***Theodore Eliades***
Clinic of Orthodontics and Pediatric Dentistry
Center of Dental Medicine
University of Zürich
Zürich, Switzerland

***Teresa Flores***
Department of Orthodontics
Faculty of Dentistry
Universitat Internacional de Catalunya
Sant Cugat del Valles
Barcelona, Spain

***Lluís Giner-Tarrida***
Department of Odontology
Faculty of Dentistry
Universitat Internacional de Catalunya
Sant Cugat del Valles
Barcelona, Spain

***Angélica Iglesias***
Department of Orthodontics
Faculty of Dentistry
Universitat Internacional de Catalunya
Sant Cugat del Valles
Barcelona, Spain

***Masahiro Iijima***
Division of Orthodontics and Dentofacial Orthopedics
Department of Oral Growth and Development
Health Sciences University of Hokkaido
Ishikari, Tobetsu, Hokkaido, Japan

***Anthony J. Ireland***
Department of Orthodontics
Bristol Dental School
University of Bristol, Bristol, UK

***Andreas Karamouzos***
Department of Orthodontics
Faculty of Dentistry
School of Health Sciences
Aristotle University of Thessaloniki
Thessaloniki, Greece

***Christos Katsaros***
Department of Orthodontics and Dentofacial Orthopedics,
School of Dental Medicine/Medical Faculty
University of Bern
Bern, Switzerland

***Katerina Kavvadia***
Department of Dentistry
School of Medicine
European University Cyprus
Nicosia, Cyprus

***Dimitrios Kloukos***
Department of Orthodontics and Dentofacial Orthopedics,
School of Dental Medicine/Medical Faculty
University of Bern
Bern, Switzerland

***Despina Koletsi***
Clinic of Orthodontics and Pediatric Dentistry
Center of Dental Medicine
University of Zürich
Zürich, Switzerland

***Effimia Koumpia***
Department of Orthodontics
Faculty of Dentistry
School of Health Sciences
Aristotle University of Thessaloniki
Thessaloniki, Greece

***Thaleia Kouskoura***
Department of Pediatric Oral Health and Orthodontics
University Center for Dental Medicine, University of Basel
Basel, Switzerland

***Spyridon N. Papageorgiou***
Clinic of Orthodontics and
Pediatric Dentistry
Center of Dental Medicine
University of Zürich
Zürich, Switzerland

***Pawel Pazera***
Department of Orthodontics and
Dentofacial Orthopedics,
School of Dental Medicine/
Medical Faculty
University of Bern
Bern, Switzerland

***Andreu Puigdollers***
Department of Orthodontics
Faculty of Dentistry
Universitat Internacional de
Catalunya
Sant Cugat del Valles
Barcelona, Spain

***Jonathan R. Sandy***
Department of Orthodontics
Bristol Dental School
University of Bristol
Bristol, UK

***Iosif Sifakakis***
Department of Orthodontics
School of Dentistry
National and Kapodistrian
University of Athens
Athens, Greece

***Eser Tüfekçi***
Department of Orthodontics
School of Dentistry
Virginia Commonwealth
University
Richmond, VA, USA

***Anastasios A. Zafeiriadis***
Department of Orthodontics
Faculty of Dentistry
School of Health Sciences
Aristotle University of
Thessaloniki
Thessaloniki, Greece

# Preface

The completion of orthodontic treatment includes two important phases, which have not received the proper attention in the broader orthodontic literature and are therefore highly individualized, empirically driven and with limited evidence: debonding and fixed retainer bonding.

The first includes the detachment of the orthodontic appliance from the enamel and the subsequent grinding of the adhesive layer (or, more recently, the thick composite attachment block used in aligners). This stage entails a relatively large number of materials and processes that are influenced by the bonding process, because etching-mediated bonding results in a more cumbersome and catastrophic debonding procedure than glass-ionomer bonding, for example. Depending on the composition of the appliance used, this process includes using debonding pliers or ultrasound, laser or heat probes to detach the bracket; many types of burs with different cutting efficiencies in slow- or high-speed handpieces and an array of polishing tools are also used.

Fixed retainer bonding includes many types of wires and configurations bonded with various types of composite resins requiring different handling, even for the same materials. Some side effects have been reported related to the placement technique or the wire activation over time: the coaxial wires used have a significant resilience and therefore store a recoverable elastic deformation, which is then given back to the wire-adhesive-tooth complex, resulting in either fracture of the wire-adhesive interface or unwanted tooth movement.

For this plethora of materials, instruments and handling modes, the information transferred to the trainee or practicing clinician is often dictated by the bias of the supervising instructor for postgraduate students or the content of relevant weekend courses – the sort that have saturated the professional community – rather than the result of an evidence-based approach.

The objective of this textbook is to provide succinic and clinically relevant information on the underlying mechanisms of success or failure for these two fundamental phases of treatment. The book is structured around two axes: debonding and resin grinding, and fixed retainer placement.

The first section covers aspects of the topic that have not yet been found in relevant texts, including methods of appliance removal, cutting efficiency of burs, grinding and enamel effects, complicated interfacial characteristics of attachments with enamel and aligners, airborne pathogens and aerosol produced during resin grinding, and future materials utilizing biomimetic approaches for bonding, among others.

The second section provides an analysis of the materials utilized in fixed retainer bonding, with emphasis on resin, wires, their effect on material deformation during mastication or placement, and release of bisphenol-A from fixed retainer resin adhesives, as well as clinical effectiveness and unwanted effects of fixed retainers on tooth position.

We hope the book will serve as a source of information serving education and practice alike.

*Theodore Eliades*
*Christos Katsaros*

# Section A

# Debonding

# 1

# Cutting with Rotating Instruments and Cutting Efficiency of Burs

*María Arregui[1], Lluís Giner-Tarrida[1], Teresa Flores[2], Angélica Iglesias[2], and Andreu Puigdollers[2]*

[1] *Department of Odontology, Faculty of Dentistry, Universitat Internacional de Catalunya, Sant Cugat del Valles, Barcelona, Spain*
[2] *Department of Orthodontics, Faculty of Dentistry, Universitat Internacional de Catalunya, Sant Cugat del Valles, Barcelona, Spain*

## 1.1 Introduction

The retention phase is a crucial part of orthodontic treatment. Its importance keeps increasing since patients look for a long-lasting 'perfect' result for aesthetic reasons, even though some degree of relapse is always expected. For this reason, life-long retention is more commonly advised every day by clinicians (Padmos et al. 2018).

Many studies have analysed the retention phase in terms of stability, retention material, adhesion, clinician and patient preference and hygiene (Al-Moghrabi et al. 2018; Eroglu et al. 2019; Gugger et al. 2016; Sifakakis et al. 2017), but none of the literature has focused on the consequences of retention on the enamel. Unlike bracket debonding, the detachment of lingual retainers is usually accidental and may be caused by excessive force, adhesive material wear or retainer rupture. The enamel could be altered due to the applied load that caused the rupture in the adhesive interphase or the removal of remaining adhesive or retainer materials (Ryf et al. 2012).

*Debonding and Fixed Retention in Orthodontics: An Evidence-Based Clinical Guide*, First Edition. Edited by Theodore Eliades and Christos Katsaros.

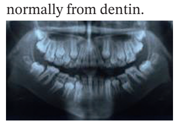
Cleaning and polishing procedures for remnants of adhesive materials are as variable as retention protocols. No consensus has been reached on the ideal protocol for adhesive removal (Janiszewska-Olszowska et al. 2014). The various techniques include using hand instruments, rotatory instruments (high- and low-speed), sandblasting, ultrasound and bur and disc materials including tungsten carbide burs, diamond burs, composite burs, rubber burs and Sof-Lex discs (Eliades 2019; Janiszewska-Olszowska et al. 2015; Shah et al. 2019). This is a critical moment, as the aim is to remove the material with no or minimal damage to the enamel structure and without overheating the pulp due to friction caused by the instruments. To do so, it is extremely important to carefully select the burs and rotary instruments to be used. For this reason, it is important to have a good understanding of the cutting efficiency of the burs, which type of bur is most suitable, the bur's longevity and the maximum number of uses due to loss of effectiveness. It is also important to take into account the characteristics of the rotating instruments: rotational speed, torque or power, water spray coolant, etc., to avoid damaging the tooth.

In this chapter, we will discuss aspects of the retention phase concerning enamel preservation and the consequences of temporarily adhesive procedures, such as appliances bonding, on the enamel surface. We will analyse the repercussions of adhesive procedures for retention materials, especially considering that life-long retention may require one or more rebonding procedures (Jin et al. 2018). We will also deal with the correct selection of burs for the removal of cement from brackets and fixed retainers; the subsequent final finishing with polishing tools to help recover the enamel aesthetics; and the most advisable protocol for removing fixed retainers, whether for final removal or for a rebonding procedure.

## 1.2 Enamel Surface and Damage Associated with Debonding Techniques: Burs and Polishing

Thanks to advanced microscopy technology and mineral property analysis techniques, the composition of enamel and its properties before and after adhesive treatments have been widely studied. The vast majority of studies are based on the vestibular surface because there is significant

**Table 3.1** Enamel defects and orthodontics: amelogenesis imperfecta.

| | AI oral phenotype | Enamel findings | Radiographic findings | Type of enamel defect | Enamel defects and tooth development | Bonding considerations |
|---|---|---|---|---|---|---|
| Amelogenesis imperfecta (AI)<br>(Witkop 1989) Prevalence is 1 : 700 to 1 : 14000 depending on the population studied. | Hypoplastic (HPAI)<br>60–73% of AI<br> | Enamel of reduced thickness. Surface smooth, rough, pitted or grooved | Enamel contrasts normally from dentin.<br> | Quantitative | Aposition | Smooth –<br>Pitted +<br>Debonding concerns |
| | Hypomaturation (HMAI)<br>20–40% of AI<br> | Normal thickness of enamel, moulted appearance, soft, chips away<br>Calculus formation | Enamel has same radiopacity as dentin. | Qualitative | Pre-eruptive maturation | Bonding and debonding concerns<br>Alternative orthodontic methods |

### 4.2.3 Tooth Colour Measurement and Quantification Thresholds

There are two common methods of analysing *in vivo* the apparent tooth colour: visual determination and instrumental measurement (Billmeyer and Saltzman 1981). Visual determination by comparing teeth and shade guides is considered highly subjective but remains the most frequently applied method in dentistry for colour communication (van der Burgt et al. 1990). However, several factors such as external light conditions, experience, age and fatigue of the human eye and inherent limitations of the contemporary shade guides can influence the consistency of visual colour selection and specification (Billmeyer and Saltzman 1981; Preston 1985; Rubino et al. 1994). The demand for objective colour matching in dentistry, coupled with rapid advances in optical electronic sensors and computer technology, has made instrumental measurement devices a supplementary adjunct to visual tooth colour evaluation (Paravina and Powers 2004). Nowadays, commercial systems, including tristimulus colourimeters, spectroradiometers, spectrophotometers and digital colour analysers, are used in clinical and research settings for objective colour specification (Joiner 2004) (Figure 4.3).

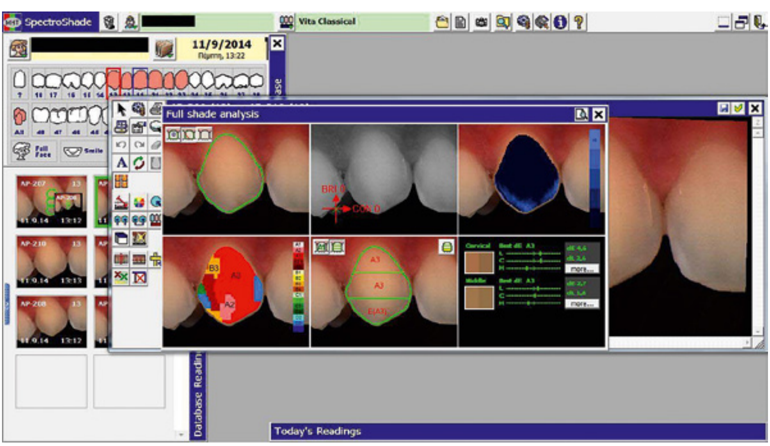



**Figure 4.3** Full shade analysis of an upper-right canine with reflectance spectrophotometer software (SpecroShade Micro; MHT, Zurich, Switzerland). The patient's name is masked for anonymity.

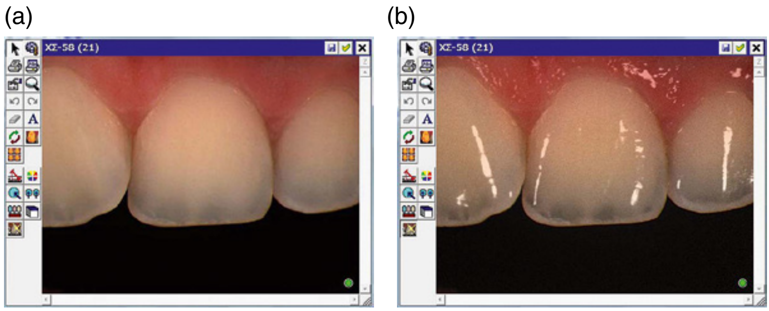


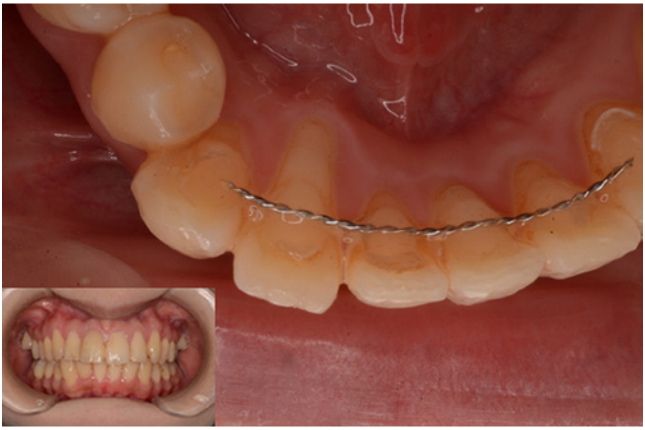

**Figure 4.6** Spectrophotometric recordings of an upper-left central incisor. (a) The recorded image is polarised by default. (b) Using the gloss icon tool on the spectrophotometer, the tooth appears with reflections of the incident light (SpecroShade Micro; MHT, Zurich, Switzerland).

(Figure 4.6). *Gloss* is represented by the degree of shine of a surface and is essentially a measure of the difference in the angles formed between the incident and reflected light. The ratio of the angle of specular reflection over that of incidence, defined as *reflectance*, has been shown to be dependent on SR. Increased roughness causes the development of multiple reflecting sites within the same area, with different directions of prism orientation, leading to random or diffuse reflections. Polishing can eliminate enamel SR, which may improve light reflection (Trakyali et al. 2009).

Tooth surface gloss affects the look and vitality of teeth (Terry et al. 2002). On the labial surface of anterior teeth, light reflected from tertiary anatomy adds to vitality, while when this anatomy is worn with age, less vitality is apparent (Figure 4.7). The enamel surface morphology affects the amount and type of reflection. A rough surface permits more diffuse reflection, whereas a flat and smoother surface allows more specular reflection: e.g. the amount of light reflection at enamel surfaces *in vivo* following toothbrushing can be enhanced significantly (Redmalm et al. 1985).

Etching, cleaning and polishing procedures may affect the compositional pattern of enamel surfaces subjected to debonding. Acid etching creates microporosities and increases the surface area of enamel accessible for bonding. This facilitates the infiltration of enamel with bonding resin (tags). Even if there is no subsequent bonding, alterations are found

(a)



(b)

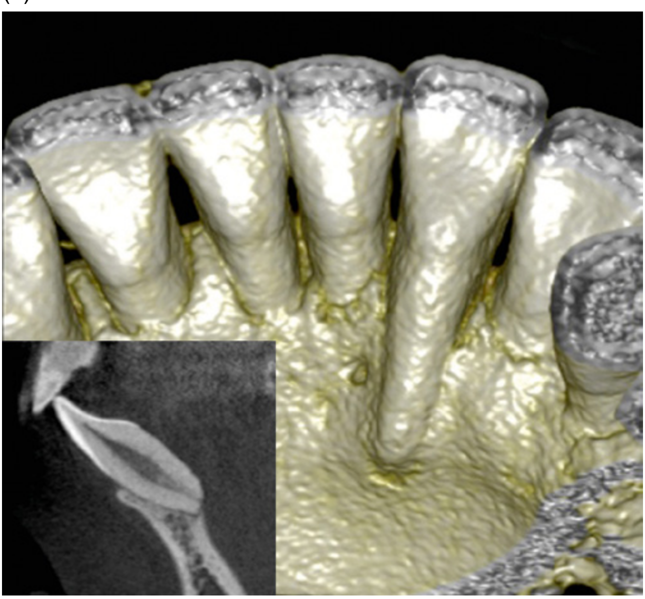


**Figure 10.3** (a) Another example of unexpected tooth movement during the retention period, arising again from increased root lingual torque of the lateral incisor. (b) cone-beam computed tomography (CBCT) images.

## 12.6 Side Effects of Fixed Retainers – Unwanted Tooth Movement

Separate from the failure of fixed retainers through breakage, debonding or loss is unwanted movement of the retained tooth unit(s) through the transfer of forces by an active retainer that remains attached and clinically intact. These changes in the position of the retained teeth are distinct from and unrelated to the original malocclusion and cannot be characterised as relapse. They manifest most frequently as inclination and torque changes and are progressive (Figure 12.3). The first published

(a) (b)

**Figure 12.3** (a) Torque difference between the mandibular central incisors at the two-year post-treatment control, due to activation of the .0195-in three-strand heat-treated twist flex retainer; the left central incisor shows excessive lingual root torque, while the right central incisor shows buccal root torque. This difference in torque is also expressed as a difference in the height of the clinical crowns. These tooth movements took place even though the bonded retainer was in situ. (b) Buccal inclination and distobuccal rotation of the left mandibular canine at the one-year posttreatment follow-up, due to activation of the .0195-in three-strand heat-treated twist flex retainer. *Source:* Adapted from Katsaros et al. (2007).

report of such unwanted retainer effects by Katsaros et al. (2007) was followed by a number of others, and a recent systematic review by Charavet et al. (2022) has identified 20 studies, mostly case reports and case series, describing such events. Although re-treatment in these cases is usually possible, permanent damage such as bone dehiscence, gingival recession or loss of tooth vitality due to severe root displacements outside the bony envelope cannot be excluded, particularly if the complications remain undetected at an early stage (Farret et al. 2015; Pazera et al. 2012; Shaughnessy et al. 2016) (Figures 12.4 and 12.5).

Various case-series and retrospective and prospective studies have reported on the prevalence of retainer-related tooth movement in the anterior mandible (Cornelis et al. 2022; Gera et al. 2022; Katsaros et al. 2007; Klaus et al. 2020; Kucera and Marek 2016; Renkema et al. 2011). They reported a prevalence between 1.1% and 17%, with average post-retention times between six months and five years. The sample size, observation time, retainer dimensions and assessment methods differ between the studies and could partly explain the wide range. A single retrospective

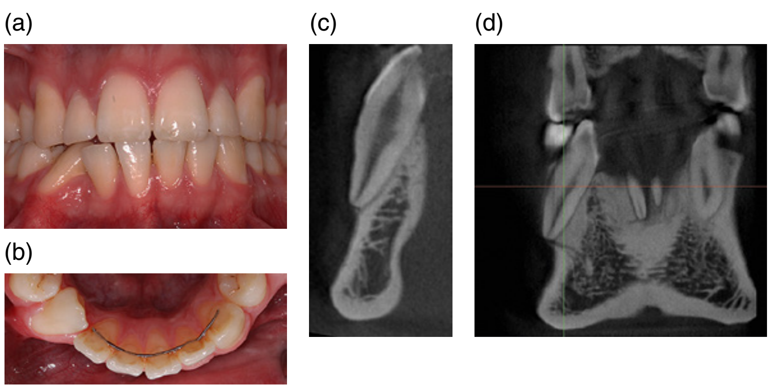



**Figure 12.4** (a, b) Excessive torque on the right mandibular canine four years post-treatment. Although the patient had noticed the unusual position of his mandibular right canine, he asked for a clinical check only when his mandibular retainer broke between the mandibular right canine and lateral incisor. Despite the massive buccal position of the root, almost no gingival recession is present. (c, d) Cone-beam computed tomography scan: the root of the canine was completely out of the bone on its buccal side. However, the nerve and the vascular bundle followed the apex, and the tooth's vitality was preserved. *Source:* Adapted from Pazera et al. (2012).