Second Edition

Handbook of Clinical Techniques in Pediatric Dentistry

Edited by Jane A. Soxman

WILEY Blackwell

Handbook of Clinical Techniques in Pediatric Dentistry

Handbook of Clinical Techniques in Pediatric Dentistry

Second Edition

Edited By

Jane A. Soxman, DDS
Allison Park, Pennsylvania, USA

WILEY Blackwell

This edition first published 2022

Edition History
John Wiley and Sons Inc (1e – 2015)

Registered Office
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA

Editorial Office
111 River Street, Hoboken, NJ 07030, USA

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.

Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

Library of Congress Cataloging-in-Publication Data

Names: Soxman, Jane A., editor.
Title: Handbook of clinical techniques in pediatric dentistry / edited by Jane A. Soxman.
Description: Second edition. | Hoboken, NJ : Wiley-Blackwell, 2022. | Preceded by The handbook of clinical techniques in pediatric dentistry / edited by Jane A. Soxman. 2015. | Includes bibliographical references and index.
Identifiers: LCCN 2021028073 (print) | LCCN 2021028074 (ebook) | ISBN 9781119661047 (paperback) | ISBN 9781119661078 (adobe pdf) | ISBN 9781119661108 (epub)
Subjects: MESH: Dental Care for Children – methods | Pediatric Dentistry – methods | Tooth Diseases – therapy
Classification: LCC RK63 (print) | LCC RK63 (ebook) | NLM WU 480 | DDC 617.6/45 – dc23
LC record available at https://lccn.loc.gov/2021028073
LC ebook record available at https://lccn.loc.gov/2021028074

Cover Design: Wiley
Cover Images: © Jane A. Soxman

Set in 9.5/12.5pt STIXTwoText by Straive, Chennai, India

10 9 8 7 6 5 4 3 2 1

Contents

Foreword

As a dentist for over 40 years, my career has been a blend of teaching and research pursuits and the private practice of pediatric dentistry. The integration of sound scientific and evidence-based information with everyday clinical practice has immeasurable value to the clinician. The two must go hand in hand. The practicing dentist must be able to deliver care based on sound scientific principles, while maintaining the practicality of delivering that care in a busy private practice.

Dr. Soxman is ideally suited for this task. As a practicing pediatric dentist for nearly 38 years, she has numerous publications, presented countless continuing education courses throughout the United States, as well as contributing to pediatric dental and general practice residency programs for many years. This love of education and translating scientific evidence into clinical know-how is what makes this second edition of *The Handbook of Clinical Techniques in Pediatric Dentistry* so valuable.

It often seems that not much changes in the world of pediatric dentistry, but the addition of several new chapters in this edition of the book tells a different story. Since the publication of the first edition there have been several significant trends in dentistry for children, and the addition of these chapters reflects those trends. Issues such as caries risk assessment, the noninvasive management of caries, an increased desire for more esthetic restorative options for children, and sleep disordered breathing in children are all clinical concerns that have increased in importance, hence their inclusion in this edition.

Dr. Soxman has chosen 19 others to contribute to this textbook, and like the blend of her own professional career, her collaborators are a blend of many well-known pediatric dentists in private practice, as well as several accomplished academicians and researchers. I have had the pleasure of knowing, working with, and collaborating with several of these individuals. The result of Dr. Soxman's collaboration is a well-illustrated, simplified, step-by-step approach to most common clinical challenges that a practitioner who treats children needs to know. While the book is scientifically solid, its strength, as in the first edition, is the clinical relevance and presentation of techniques that have been practiced with proficiency by those writing about them.

it is a pleasure to endorse a book of this caliber. It can serve not only as a textbook for those still learning, but as a reference manual for those who have been practicing for several years. Congratulations to Dr. Soxman and her collaborators on producing this updated, comprehensive textbook. I am confident that those clinicians who put into practice what they read in this text will be well served. But more importantly, so will the children who are treated by those clinicians be well served!

William F. Waggoner, DDS, MS, FAAPD, FACD
Las Vegas, NV

Preface to the Second Edition

The second edition of *The Handbook of Clinical Techniques in Pediatric Dentistry* offers dental students, postgraduate dental residents in both pediatrics and general practice, along with practicing dentists and hygienists, succinct evidence-based guidance with supporting photographs, for treatment in the primary and young permanent dentitions. This second edition aims to provide the most recent advances and modifications, along with new methodologies for dental treatment.

Since publication of the first edition, treatment of dental caries at the lesion level has shifted from invasive to less invasive or noninvasive methods. This more conservative approach is a major development in clinical dentistry. The purpose of providing less invasive or noninvasive techniques for dental care is to arrest, reverse, or curtail caries progression without use of local anesthesia, the rubber dam, or the dental drill, and/or to preserve tooth structure. These modalities also may avoid sedation in order to provide quality care for a fearful, special healthcare needs, or uncooperative patient. Pediatric patients, who are too young to cooperate for definitive treatment, can be safely treated, while protecting the developing psyche, without the possible risks with sedation or general anesthesia. This second edition begins with a new chapter, "Non-Invasive and Minimally Invasive Treatment of Dental Caries."

Another new chapter, "Caries Risk Assessment," is included too. The aim of this chapter is to provide a guideline for hygienists and dentists to identify caries risk, enabling the structure of an individualized preventive care plan, along with appropriate management of both noncavitated and cavitated carious lesions.

Other new chapters are "Management of Esthetic Concerns," "Traumatic Injury to the Primary Incisors," "Interceptive Orthodontic Treatment in the Mixed Dentition," "Clinical Examination of the Infant," "Clinical Examination of the Patient with Special Healthcare Needs," "Sleep Disordered Breathing in Children," and, finally, "Pediatric Oral Medicine." Most of these chapters were written by contributors with particular expertise and interest in the subject matter.

Other chapter additions and revisions for the most up-to-date clinical guidelines are included for molar–incisor hypomineralization and the latest research findings on stainless-steel crowns. Behavior guidance and local anesthesia chapters are enhanced by an educator who is known and published with a focus in those two topics. New findings from a systematic review and meta-analysis on nonvital pulp therapy are included in the chapter on nonvital pulp therapy for primary teeth. Indirect pulp therapy for primary teeth has gained popularity as a less invasive vital pulp treatment and is described in the chapter on vital pulp therapy. Finally, the indications and procedures for both indirect and direct pulp therapy in the young permanent dentition complete the mission to provide the most recent evidence-based treatment at the time of this second edition's publication.

Jane A. Soxman, DDS

Preface to the First Edition

While speaking at an annual session of the American Dental Association, Wiley Blackwell publications requested that I meet with a commissioning editor. He inquired whether I had ever considered writing a book and if so, on what subject. My response was without hesitation. Over the past 20 plus years as a national speaker in continuing education and as a seminar instructor for general practice residents, I recalled the myriad of questions asked. I had often thought that a book on clinical techniques would provide much needed guidelines and directions for dental students, general dentists, and graduate general practice and pediatric dental residents. This book would include step-by-step descriptions, augmented with clinical photographs of routinely performed procedures and evidence-based recommendations.

The Handbook of Clinical Techniques in Pediatric Dentistry provides the clinician with an increased level of expertise and skills for timely identification and intervention for various presentations in the developing dentition. It also clearly describes procedures for treatment in the primary and young permanent dentitions. The most commonly encountered treatment needs are discussed, with the goal of increasing clinician and staff confidence, while decreasing chair time and stress. What you will learn and incorporate into your practice will be of tremendous benefit to you, your staff, and the children for whom you care.

Jane A. Soxman, RN, DDS
Allison Park, Pennsylvania, USA

Acknowledgments

My vision for this second edition was to expand the content, including timely topics of relevance written by educators with particular interest and expertise in their chapter topics. Fortunately, every invited contributor joined this endeavor. I am honored and grateful for the contribution of each that fulfilled my intentions for this second edition. The first edition contributors also deserve recognition with updates to the majority of the chapters. This book is embellished with photographs to significantly enhance each chapter, providing a better comprehension of the written text. I sincerely thank each contributor for his or her time and effort to create this second edition, which will surely enhance confidence and the quality of care provided to our youngest patients. I would like also to acknowledge two of my staff members, Karen Evans and Denise Cafeo, who were immediately available to assist with any problem, complying with our guidelines and downloading the exceptional photographs. Finally, once again, for her attentiveness to the quality of the photographs, her patience, her steadfast devotion to me, and her gentle nature in caring for our patients, I dedicate this second edition of *The Handbook of Clinical Techniques in Pediatric Dentistry* to my assistant of 28 years, Beth Ann Sutter.

Jane A. Soxman, DDS

List of Contributors

Editor

Jane A. Soxman, DDS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Private Practice Pediatric Dentistry
Allison Park, PA, USA
Division of Dental Medicine, Allegheny General Hospital
General Practice Dental Residency Seminar Instructor
Pittsburgh, PA, USA
Veterans Affairs Pittsburgh Health Care System
General Practice Dental Residency Educational Consultant
Pittsburgh, PA, USA
Adjunct Assistant Professor of Pediatric Dentistry
Department of Pediatric Dentistry
University of Pittsburgh School of Dental Medicine
Pittsburgh, PA, USA

Contributors

Ehsan N. Azadani, DDS, MS
Diplomate American Board of Pediatric Dentistry
Assistant Professor Division of Pediatric Dentistry
The Ohio State University College of Dentistry and Nationwide Children's Hospital
Columbus, OH, USA

Joe H. Camp, DDS, MSD
Retired
Adjunct Professor, University of North Carolina School of Dentistry
Chapel Hill, NC, USA

Paul S. Casamassimo, DDS, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Professor Emeritus
Division of Pediatric Dentistry, The Ohio State University College of Dentistry
Columbus, OH, USA

Giulia M. Castrigano, DMD, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Assistant Professor
Division of Dentistry, Cincinnati Children's Hospital
University of Cincinnati Affiliate
Cincinnati, OH, USA

James A. Coll, DMD, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Private Practice Pediatric Dentistry 1974–2013
York, PA, USA
Clinical Professor, Department of Pediatric Dentistry
University of Maryland Dental School
Baltimore, MD, USA

Theodore P. Croll, DDS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Private Practice Pediatric Dentistry
Doylestown, PA, USA
Adjunct Professor Pediatric Dentistry
University of Texas Health Science Center at San Antonio Dental School
San Antonio, TX, USA
Clinical Professor, Pediatric Dentistry, Case Western Reserve School of Dental Medicine
Cleveland, OH, USA

Elizabeth S. Gosnell, DMD, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Department of Pediatrics
University of Cincinnati College of Medicine
Associate Professor Division of Pediatric Dentistry
Cincinnati Children's Hospital Medical Center
Cincinnati, OH, USA

Christel M. Haberland, DDS, MS, FAAPD
Diplomate American Board of Pediatric Dentistry
Diplomate American Board of Oral and Maxillofacial Pathology
Chair, Department of Pediatric Dentistry
James B. Edwards College of Dental Medicine
Medical University of South Carolina
Charleston, SC, USA

Constance M. Killian, DMD
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Private Practice Pediatric Dentistry
Doylestown, PA, USA
Adjunct Associate Professor of Pediatric Dentistry
University of Pennsylvania School of Dental Medicine
Philadelphia, PA, USA

Ari Kupietzky, DMD, MSc
Diplomate American Board of Pediatric Dentistry
Clinical Instructor Department of Pediatric Dentistry
The Hebrew University–Hadassah School of Dental Medicine
Jerusalem, Israel

Jeanette MacLean, DDS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Private Practice, Pediatric Dentistry
Glendale, AZ, USA

Stanley F. Malamed, DDS
Dentist Anesthesiologist
Emeritus Professor of Dentistry
Ostrow School of Dentistry of USC
Los Angeles, CA, USA

AnnMarie Matusak, DDS, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Assistant Professor, University of Cincinnati
Director, Pediatric Dentistry Residency Program Division of Dentistry
Cincinnati Children's Hospital Medical Center
Cincinnati, OH, USA

Roshan V. Patel, DMD
Private Practice Pediatric Dentistry
Fort Worth, TX, USA

Cristina Perez, DDS, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Diplomate American Board of Orofacial Pain
Associate Professor and Chief, Division of Pediatric Dentistry
Director, Pediatric Dental Residency Program
University of Kentucky
Lexington, KY, USA

S. Thikkurissy, DDS, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Professor & Robert Creedon Chair
Division of Dentistry
Cincinnati Children's Hospital
University of Cincinnati Affiliate
Cincinnati, OH, USA

Janice A. Townsend, DDS, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Chief, Department Dentistry
Nationwide Children's Hospital
Columbus, OH, USA
Chair, Division of Pediatric Dentistry
The Ohio State University College of Dentistry
Columbus, OH, USA

J. Timothy Wright, DDS, MS
Diplomate American Board of Pediatric Dentistry
Bawden Distinguished Professor and Chair
Division of Pediatric and Public Health
Adams School of Dentistry
University of North Carolina
Chapel Hill, NC, USA

Patrice B. Wunsch, DDS, MS
Diplomate American Board of Pediatric Dentistry
Fellow American Board of Pediatric Dentistry
Vice Chair, Department of Pediatric Dentistry
Professor, School of Dentistry
Virginia Commonwealth University
Richmond, VA, USA

1

Noninvasive and Minimally Invasive Treatment of Dental Caries

Jane A. Soxman, Jeanette MacLean, and Christel Haberland

Noninvasive clinical techniques for the pediatric dental patient provide alternative standard of care treatment with therapeutic interventions that offer methods to arrest or slow caries progression until definitive treatment can be safely performed with pharmacologic modalities or the child can cooperate for treatment. These techniques typically require no rubber dam isolation or local anesthesia, both of which often incite fearful or avoidance behavior. Soft tissue trauma, with cheek/lip or tongue chewing, the most common adverse event reported by members of the American Academy of Pediatric Dentistry, is no longer a postoperative issue (Calvo *et al*., 2019). Parents/guardians are often reluctant to accept sedation or general anesthesia for treatment, particularly if other options are presented. Deep sedation or general anesthesia poses increased risks for toddlers and should be reserved for instances where dental disease outweighs the benefits of active surveillance or noninvasive or minimally invasive treatment with interim therapeutic restoration or medicaments to slow or arrest caries progression (Lee *et al*., 2013, 2017; Stratmann *et al*., 2014; Orser *et al*., 2018; AAPD, 2019–2020a). The incidence of recurrent caries, reported to be as high as 79% after general anesthesia, also supports the cost-effective alternative of noninvasive or minimally invasive treatment (Almeida *et al*., 2000; Amin *et al*., 2010; Lin & Lin, 2016; Oubenyahya & Bouhabba, 2019; AAPD, 2019–2020d). Noninvasive or minimally invasive treatment for early childhood caries, prior to the need for emergency care, would not only enhance quality of life for a child, but significantly reduce treatment costs with hospitalizations and emergency room visits (AAPD, 2019–2020e). Additionally, medical circumstances may prohibit pharmacologic modalities.

Nonrestorative, noninvasive, or minimally invasive treatment is defined as the management of caries at the lesion level and with minimal loss of sound tooth structure. These interventions can be used in both cavitated and noncavitated carious lesions and for both the primary and permanent dentitions. The decision to use a particular modality of treatment should be determined by considering the type of carious lesion (noncavitated or cavitated), the dentition (primary or permanent), and the tooth surface involved (occlusal, facial/lingual, or interproximal). Other factors to be considered are patient centered and include caries risk analysis (CRA; discussed in Chapter 24). In October 2018, the American Dental Association (ADA) published evidence-based guidelines on nonrestorative treatments for carious lesions that included the following: 38% silver diamine fluoride (SDF), 5% sodium fluoride varnish, 1.23% acidulated phosphate fluoride gel, 5000 ppm fluoride (1.1% sodium fluoride) toothpaste or gel, casein phosphopeptide and amorphous calcium

Handbook of Clinical Techniques in Pediatric Dentistry, Second Edition. Edited by Jane A. Soxman.

phosphate (CPP-ACP), and resin infiltration (Slayton *et al*., 2018). Other treatments for caries that atraumatically remove minimal or no tooth structure offer evidence-based alternatives for uncooperative children or those with special healthcare needs. These techniques include interim therapeutic restoration (ITR) and the Hall technique (HT) for stainless-steel crowns (AAPD, 2019–2020b, c).

38% Silver Diamine Fluoride

38% SDF is a topical antimicrobial and remineralizing agent used for desensitization and caries arrest. Systematic reviews and meta-analyses have demonstrated that SDF is capable of arresting an average of 80% of cavitated caries lesions, with the highest rates of arrest occurring with biannual application (Slayton *et al*., 2018). The procedure is quick, simple, painless, inexpensive, and well tolerated by young, phobic, and medically frail patients, making it particularly advantageous for pediatric and geriatric patients, and those without access to dental care (Horst *et al*., 2016). Parents tend to prefer SDF treatment in posterior teeth; however, 70–76% prefer SDF even for anterior teeth when it presents an alternative to sedation and general anesthesia (Figure 1.1a, b) (Crystal *et al*., 2017).

A 38% SDF solution is 25% silver, 8% ammonia, and 5% fluoride. One drop (0.05 mL) of Advantage Arrest™ 38% SDF (Elevate Oral Care, Palm Beach, Florida, USA) contains 2.24 mg of fluoride and 4.74 mg silver (Crystal & Niederman, 2016). A study on the short-term serum pharmacokinetics of SDF found fluoride exposure was below the US Environmental Protection Agency (EPA) oral reference dose, and while the silver exposure exceeded the dose for cumulative daily exposure over a lifetime, its occasional use (typically biannual application) was well below the concentrations associated with toxicity (Vasquez *et al*., 2012). One drop per 10 kg of body weight is considered a safe dose and, depending on the size of the lesion(s), may treat as many as 5–6 teeth (Horst *et al*., 2016). There are no reports of adverse outcomes or known side effects, other than the trade-mark black stain of active caries, transient metallic taste, and potential gingival irritation, similar to a bleach burn, which resolves on its own in a few days.

Indications for SDF treatment:

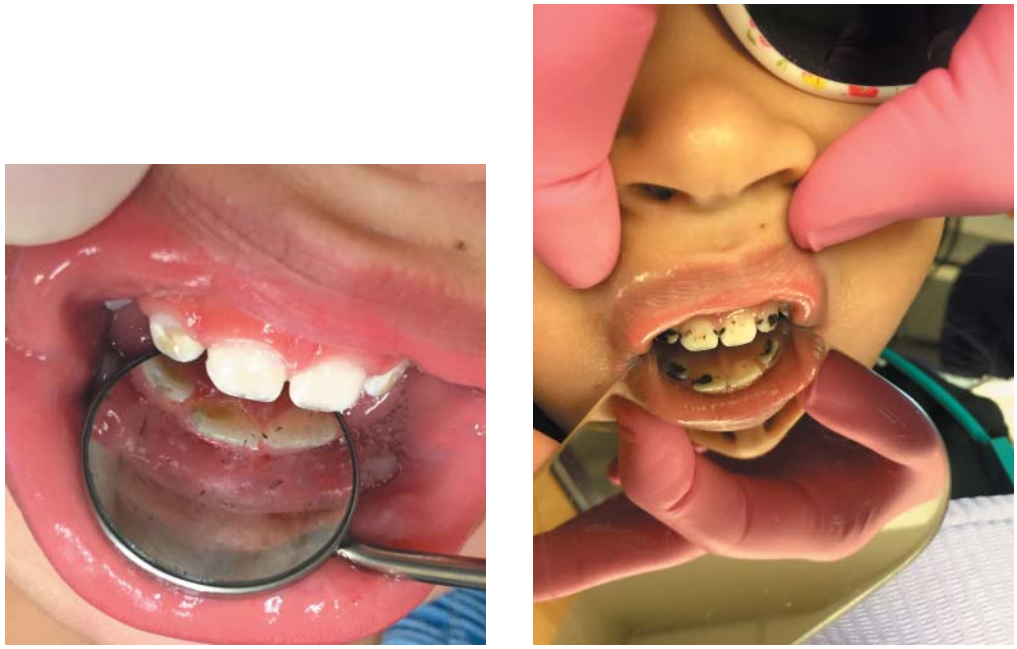
- High caries risk.
- Patients who cannot tolerate surgical restorations due to age (pediatric, geriatric), behavior, special needs, medical condition, dental phobia, anxiety, or psychologic condition.
- Need to delay or avoid the use of sedation or anesthesia.
- More lesions than can be treated in one appointment.
- Financial barriers.
- Poor access to care.
- Salivary dysfunction (xerostomia, polypharmacy, salivary dysfunction).
- Difficult-to-treat lesions (root caries, furcations, molar incisor hypomineralization).
- Recurrent caries at a restoration margin.
- Carious primary teeth that will soon exfoliate.
- Carious lesions that are either asymptomatic or have reversible pulpitis.
- Hypersensitivity.

Contraindications for SDF treatment:

- Silver allergy (rare).
- Irreversible pulpitis.
- Carious lesions extending to the pulp.
- Mouth sores, ulcerative gingivitis (or coat soft tissue lesion(s) with petroleum jelly).

Procedure

- Protective eyewear and a plastic-lined bib are placed on the patient.
- Petroleum jelly is applied to the lips and peri-oral area to prevent inadvertently staining the lips or face with SDF.



(a) (b)

Figure 1.1 (a) Carious lesions on maxillary primary incisors. (b) Maxillary primary incisors post application of silver diamine fluoride.

- The tooth should be clean and free from food or debris. No caries removal is necessary.
- Isolate with Dri-Aids™ (Microbrush International, Grafton, WI, USA) and/or cotton rolls.
- Thoroughly dry the tooth with compressed air or, if air is not tolerated, gauze.
- Place one drop of SDF on a plastic dappen dish or open a unit-dose vial.
- Dip a microbrush into the SDF and then apply to the tooth for 1–3 minutes. Fully saturate the lesion and then allow the SDF to absorb via capillary action. Carefully apply only to the desired tooth surface(s) to minimize risk of accidental staining of unintended surfaces.
- For proximal lesions, place woven floss into the contact, and apply SDF to the lingual, buccal, and occlusal aspect of the contact, saturating the floss, using caution to not allow the floss to contact the patient's lips (Figure 1.2) (Hammersmith *et al.*, 2020).
- Do not light-cure, rinse, or blow compressed air onto the SDF while it is absorbing.
- After it has absorbed via capillary action for at least 1–3 minutes, you may blot the excess SDF with gauze and/or coat the treated site(s) with fluoride varnish. Varnish is optional; however, it helps improve the patient experience by masking the poor taste and preventing SDF from staining other teeth.
- No eating or drinking restrictions.

Topical Fluoride

Fluoride's role in the protection from dental caries is well recognized, and it is considered the first line of defense for caries prevention. More recently, evidence suggests that

Figure 1.2 Application of silver diamine fluoride to woven floss for interproximal caries.

fluoride can also be used for the treatment of incipient or noncavitated carious lesions. In 2018, the ADA published evidence-based recommendations for nonrestorative treatments for dental caries (Slayton *et al.* 2018). Those recommendations include the use of sealants plus 5% sodium fluoride (NaF) varnish (application every 3–6 months) for noncavitated occlusal caries in both primary and permanent teeth. The research suggests that this application is more effective than sealants or varnish alone (Honkala *et al.* 2015). Application every 3–6 months of 1.23% acidulated phosphate fluoride (APF) gel on noncavitated carious occlusal surfaces of both primary and permanent teeth was also recommended (Agrawal & Pushpanjali, 2011). Additionally, the use of a once-a-week, 0.2% NaF mouth rinse for incipient carious lesions in permanent teeth has been recommended (Florio *et al.*, 2001). For facial or lingual noncavitated lesions on primary and permanent teeth, the ADA recommends 1.23% APF gel (application every 3–6 months) or 5% NaF varnish with application every 3–6 months (Autio-Gold & Courts, 2001) (Figure 1.3).

Casein Phosphopeptide and Amorphous Calcium Phosphate

CPP-ACP is a topical cream for tooth remineralization and desensitization. Recaldent™ (CPP-ACP) is derived from milk protein and releases bioavailable calcium and phosphate, commercially available as MI Paste® and MI Paste Plus (with 900 ppm fluoride; GC Corporation, Tokyo, Japan) (Reynolds *et al.*, 2008). It is contraindicated in individuals with a true casein allergy, but is tolerated by those with lactose sensitivity. There is limited evidence that CPP-ACP can reverse active white spot lesions (Fernández-Ferrer *et al.*, 2018). After brushing and flossing, the paste can be applied 1–2 times a day, directly or in custom trays.

Concentrated fluoride agents, such as 5000 ppm fluoride toothpaste, can help prevent and arrest demineralization. However, the surface hypermineralization by fluoride can block diffusion pathways, preventing the subsequent natural remineralization by salivary calcium and phosphate. Arrested lesions may stay the same size, but can also become unsightly and stained by organic debris. One method of reversing this is to acid-etch the fluoride-treated lesions to facilitate remineralization of the lesion by CPP-ACP (Lopatiene *et al.*, 2016). This is known as the Etch and MI Paste Technique. Total treatment time is 15 minutes, in 4–6 sessions, 10–14 days apart, with MI Paste applied daily at home. The technique can also be effective in certain congenital enamel defects (Figures 1.4–1.6, and 1.7).

Procedure

- Clean teeth with plain pumice.
- Protect soft tissue with cotton isolation.
- Apply 37% phosphoric acid-etch for 2 minutes.
- Rinse.
- Apply/burnish MI Paste for 5 minutes.

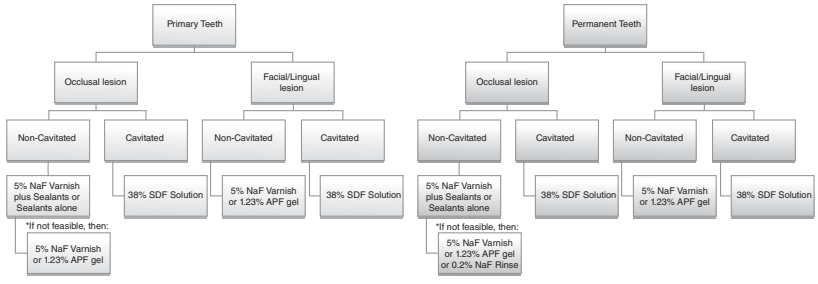


Figure 1.3 Clinical pathway for the nonrestorative treatment with fluoride of noncavitated and cavitated carious lesions on primary and permanent teeth. Source: Adapted from Slayton, R.L., Urquhart, O., Araujo, M.W.B., *et al.* (2018) Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions: A report from the American Dental Association. *Journal of the American Dental Association*, **149** (10), 845–846.

Figure 1.4 Maxillary permanent incisors with congenital enamel defects.

Figure 1.5 Maxillary permanent incisors with 37% phosphoric acid applied for 2 minutes.

- For stubborn lesions, use a rubber cup to apply pumice and MI Paste.
- Rinse.
- Patient applies paste 1–2 times daily at home.

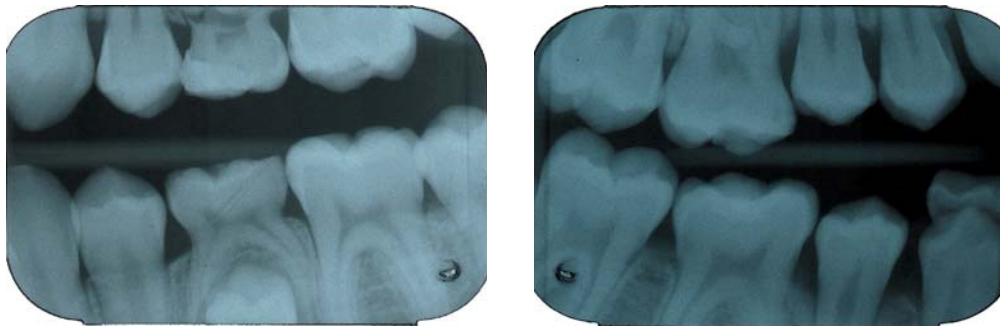
Resin Infiltration

Resin infiltration is a noninvasive method to reduce or arrest the progression of non-cavitated interproximal caries limited to the inner half of enamel or outer third of dentin (Figures 1.8a, b and 1.9a, b). Resin infiltration may be also used to treat white spot lesions; however, this method is not discussed in this chapter. A low-viscosity resin penetrates the

Figure 1.6 CPP-ACP paste applied/burnished to maxillary permanent incisors for 5 minutes.

Figure 1.7 6-month follow-up of maxillary permanent incisors post treatment with 5 rounds of etch and MI Paste technique.

porous enamel lesion body, creating a diffusion barrier, blocking pathways for cariogenic acids (AAPD, 2019–2020c; Meyer-Lueckel *et al.*, 2012). Resin infiltration of noncavitated interproximal carious lesions in primary molars requires less patient/parent or legal guardian cooperation than flossing and has been shown to be more efficacious than flossing or use of fluoride toothpaste alone (Ammari *et al.*, 2018). The difference between topical application of fluoride and resin infiltration is that the diffusion barrier is created inside the lesion and not on the surface. This intervention bridges



(a) (b)

Figure 1.8 (a) Bitewing radiograph showing caries limited to outer half of enamel in maxillary left first permanent molar. (b) Bitewing radiograph showing lesion in outer third of dentin in maxillary right first permanent molar.

(a) (b)

Figure 1.9 (a) Clinical photograph of noncavitated carious lesion mesial of maxillary left first permanent molar. (b) Clinical photograph of noncavitated carious lesion mesial of mandibular right first permanent molar.

the gap between nonoperative and operative treatment choices, as well as postpones the first restoration placement (Soxman, 2010). Additionally, this concept supports a conviction that caries can be controlled and arrested prior to cavitation (Kabakchieva *et al.*, 2014). Operator adherence to the protocol is essential. Cost may also be a factor for use, although the procedure maybe covered by some insurance plans.

The ADA clinical practice guideline reported low to very low certainty for efficacy of arresting noncavitated interproximal carious lesions in primary and permanent dentitions with resin infiltration (Slayton *et al.*, 2018). More recent studies reported that the available evidence provided high confidence that interproximal carious lesion progression may be slowed or arrested with resin infiltration when compared to other noninvasive or preventive modalities (Elrashid *et al.*, 2019; Jorge *et al.*, 2019; Sarti *et al.*, 2020).

Infiltrant resin (triethylene-glycol-dimethacrylate-based resin) is manufactured by DMG (Hamburg, Germany) as the Icon system. Icon is not radiopaque. Filler materials necessary to make the resin radiopaque would negatively affect the infiltrant's flow properties and ability to penetrate the lesion. The kit contains a wedge, 15% hydrochloric acid, 95% ethanol, and the resin infiltrant in applicator syringes.

Figure 1.10 Wedge to open interproximal area.

Figure 1.11 Icon applicator.

Figure 1.12 Hydrochloric acid gel placed with application aid.

Total treatment time per lesion is about 15 minutes (Figures 1.10–1.15).

Procedure

- Clean proximal surface with floss.
- Local anesthesia may be administered if deemed necessary, but typically not needed.

Figure 1.13 Icon-Dry applied.

Figure 1.14 Icon infiltrant resin applied.

Figure 1.15 Light curing infiltrant.

- Rubber dam is applied.
- The dental wedge is inserted to open the proximal area (an orthodontic separator may be placed a week prior to the treatment to open the contact).
- 15% hydrochloric acid (HCL) gel to erode the lesion and open the pores is applied for

120 seconds with applicator perforations toward the lesion.
- The surface is rinsed and dried for 30 seconds.
- The pore system is dehydrated with Icon-Dry, 95% ethanol, and air-dried for 30 seconds.
- Chair light may be turned off.
- Lesion body is flooded with Icon infiltrant resin, penetrating the lesion pores, for 180 seconds and dispersed with oil-free air.
- Excess resin is removed with floss and the area is light-cured for 40 seconds.
- Icon infiltrant is applied again for 60 seconds with the same protocol as the initial application.
- The area is light-cured for 40 seconds.
- The wedge is removed and the area is rinsed with water before removing the rubber dam.

Interim Therapeutic Restoration

ITR may be the procedure of choice for restoration in uncooperative children, young children, or children with special needs when definitive restorative treatment cannot be performed. ITR avoids the use of sedation or general anesthesia until a child is old enough to cooperate, or curtails caries progression and/or emergency care while awaiting for the availability of sedation or general anesthesia services (Kateeb *et al*., 2013; AAPD, 2019–2020b, c).

Indication

Alterative/atraumatic restorative technique (ART) is performed with similar indications and techniques as ITR; however, ART restorations have been traditionally placed where people have limited ability to obtain dental treatment and without a plan for future replacement. ART is endorsed by the World Health Organization and the International Association of Dental Research (AAPD, 2019–2020b, c). ART was first introduced 26 years ago in Tanzania and has developed into an accepted protocol for caries management to improve quality and access to dental treatment over the world (Frencken *et al*., 2012). Mahoney *et al*. (2008) state that ART should be used only when the restoration can be periodically evaluated to insure the integrity of the restoration.

ITR is minimally invasive and includes only asymptomatic primary incisors or molars with lesions confined to dentin with sound enamel margins, along with a plan for future follow-up and final restoration (Amini & Casamassimo, 2012). ITR with glass ionomer is preferable to SDF for cavitated lesions. Food particles impacted in a cavitation could decrease the efficacy of SDF. Superficial carious lesions are removed and form and function are more closely achieved compared to SDF. This method of restoration is more successful in children with moderate caries experience compared to those with high caries experience, and is considered to have a good prognosis in young children (da Silva *et al*., 2020). Two surfaces may be treated, but the use of a matrix and rubber dam increases the complexity of the procedure, and the longevity of a multisurface glass ionomer restoration is reduced compared to a one-surface restoration. Survival rates over the first 2 years of 93% for single-surface and 62% for multiple-surface primary molar restorations are reported (de Amorim *et al*., 2012). Tedesco *et al*. (2017) recommended cementing an orthodontic or space maintainer band to hold the glass ionomer. They found no statistical difference in success between two surface composite and glass ionomer restorations over 2–3 years (Tedesco *et al*., 2017). Carious lesions ideal for ITR are mesial caries on maxillary incisors, facial caries, cervical caries, and occlusal caries in the primary dentition (Figures 1.16–1.19).

Stepwise excavation of open carious lesions is another indication for ITR (AAPD, 2019b-2020b, c). Partial removal of carious dentin avoids pulpotomy. Microbial counts of bacteria are reduced under the restoration with or without complete removal of the carious dentin

Figure 1.16 Mesial caries maxillary primary central incisors.

Figure 1.17 Facial caries maxillary primary central incisors.

Figure 1.18 Cervical caries primary canines and first primary molars.

(Lula *et al*., 2009). Varying levels of biodegradation may occur on resin-based restorative materials by esterase activity of *Streptococcus mutans*. A study by Gautam *et al*. (2017) showed restoration with a resin-modified glass ionomer (RMGI) was more resistant to degradation.

Figure 1.19 Occlusal caries mandibular right second primary molar.

Procedure

The procedure can be performed in 5 minutes or less without the use of local anesthesia or a rubber dam. The nonpainful carious dentin is removed with a large round bur in a slow-speed rotary instrument or with a SmartBur® II (SS White Dental, Lakewood, NJ, USA) (Figure 1.20a, b). The single-use SmartBur is used for caries removal to avoid pulp exposure and permit a more comfortable procedure without the use of local anesthesia. This bur cannot cut healthy dentin or enamel, and is an ideal bur for ITR. Using the same size bur as the cavitation will simultaneously remove the peripheral carious dentin during excavation of the infected carious dentin on the base of the preparation. A spoon excavator may also be used, but cautiously, due to the risk of unroofing the pulp chamber with a large mass of carious dentin (Figure 1.21a, b). A Dri-Angle or Dri-Aid is used to cover Stensen's duct and provide cheek retraction for a posterior restoration. When restoring a mandibular primary molar, a second Dri-Angle/Dri-Aid may be placed on the lingual to retract the tongue, while placing the glass ionomer restoration (Figure 1.22). A NeoDry on the buccal and 2 × 2 gauze placed under the Dri-Angle on the lingual improve comfort (Figure 1.23).

(a) (b)

Figure 1.20 (a) Slow speed with round carbide bur to remover superficial nonpainful carious dentin. (b) Smart bur to remove superficial nonpainful carious dentin.

Figure 1.21 Spoon excavator to remove superficial nonpainful carious dentin.

Figure 1.22 Dri-Angles to retract cheek and tongue while placing glass ionomer.

Materials

A high-viscosity glass ionomer or RMGI are the materials of choice for restoration owing to the ease of use and physical properties. Glass ionomer is fluoride releasing, esthetically acceptable, tolerates some moisture contamination, chemically bonds to the tooth, and chemically cures. Recurrent caries are the primary reason for replacement of restorations in primary teeth. Raggio *et al.* (2016) found glass ionomer cements to be significantly associated with a reduction in the incidence of secondary caries. ITR with RMGI instead of the traditional more invasive method and a resin-based restorative material may decrease the need for additional restorative care in children with high caries risk (Gautam *et al.*, 2017). Application with the use of preloaded capsules in a capsule applier or gun significantly reduces working time. After placement in the preparation, finger pressure may be used to compress the material, removing occlusal contacts to increase the longevity of the restoration (Figure 1.24). Finishing is not necessary. Select a glass ionomer with a fast setting time to insure the procedure is completed in the shortest possible chair time. An RMGI will increase working and setting time. Mouth props are available in various sizes for pediatrics and may be used if necessary. A strand of dental floss should be placed to insure easy retrieval should the prop be dislodged, avoiding choking or aspiration (Figure 1.25).