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Recommandations de 2024 pour le prétraitement du collage sur les troubles de l'émail et de la dentine : une revue systématique

2024 guidelines for pretreatment to bonding on enamel and dentin disorders: a systematic review

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C'est un très grand honneur pour moi de vous compter dans ce jury aujourd'hui, et je vous en remercie. J'ai beaucoup de considération pour votre bienveillance, votre investissement dans vos enseignements, et votre implication pour les étudiants.

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Tables des abréviations

Abréviations	Définitions	
	English	*Français*
AI	*Amelogenesis imperfecta*	Amélogénèse imparfaite
CVI, GIC	*Glass ionomer cement*	Ciment verre ionomère
D	*Dentin*	Dentine
DD	*Deciduous dentition*	Denture temporaire
DI	*Dentinogenesis imperfecta*	Dentinogénèse imparfaite
E	*Enamel*	Email
F	*Fluorosis*	Fluorose
GIC, CVI	*Glass ionomer cement*	Ciment verre ionomère
MIH	*Molar-incisor hypomineralization*	Hypominéralisation molaire incisive
NaOCl	*Sodium hypochlorite*	Hypochlorite de sodium
OI	*Osteogenesis imperfecta*	Ostéogénèse imparfaite
PD	*Permanent dentition*	Denture permanente
SBS	*Shear bond strength*	Résistance au collage
SR	*Survival rate*	Taux de survie
XLH	*X-linked hypophosphatemia*	Hypophosphatémie liée à l'X

Abstract

Objectives: *This systematic review focuses on structural anomalies of enamel and dentin such as fluorosis (F), molar-incisor hypomineralization (MIH), amelogenesis imperfecta (AI), dentinogenesis imperfecta (DI), osteogenesis imperfecta (OI), and X-linked hypophosphatemia (XLH). These pathologies affect up to 31% of the population, posing challenges in the adhesion of direct restorations. The primary objective of this analysis is to examine the survival rate and/or bonding resistance of direct restorations on tissues affected by enamel and dentin disorders in humans. We aim to provide precise clinical recommendations for dentists to choose the appropriate bonding pretreatment for various enamel and dentin disorders.*

Data sources: *We systematically searched the medical literature to identify abstracts of interest indexed between 1993 and February, 2024, from 4 databases (Cochrane Library, PubMed, PMC-PubMed, and Web of Science). The results are reported following the PRISMA statement. The GRADE approach was used to assess the risk of bias.*

Conclusion: *The two authors included 24 studies out of the 502 identified. The data extracted from these studies are highly heterogeneous, and the mentioned bonding protocols are all different. 15 articles pertain to F, 4 to MIH, 5 to AI, and none focus on dentin disorders and XLH. We formulated 12 recommendations (7 for F, 2 for MIH, and 3 for AI), including 3 strong recommendations. Additional studies are necessary to confirm the effectiveness of certain pretreatments. In developmental enamel defects, the main recommendations we collected are: (i) bonding on enamel with an etch-and-rinse technique, (ii) deproteinization step with 5% NaOCl.*

Résumé

Objectifs *: Cette revue systématique se concentre sur les anomalies structurelles de l'émail et de la dentine telles que la fluorose (F), l'hypominéralisation molaire incisive (MIH), l'amélogénèse imparfaite (AI), la dentinogénèse imparfaite (DI), l'ostéogénèse imparfaite (OI) et l'hypophosphatémie liée à l'X (XLH). Ces pathologies touchent jusqu'à 31% de la population, posant des défis dans l'adhésion des restaurations directes. L'objectif principal de cette analyse est d'examiner le taux de survie et/ou la résistance au collage des restaurations directes sur les tissus affectés par des troubles de l'émail et de la dentine chez les humains. Nous visons à fournir des recommandations cliniques précises pour aider les dentistes à choisir le prétraitement de collage approprié pour divers troubles de l'émail et de la dentine.*

Sources des données *: Nous avons effectué une recherche systématique dans la littérature médicale pour identifier les articles d'intérêt indexés entre 1993 et février 2024, à partir de 4 bases de données (Cochrane Library, PubMed, PMC-PubMed ,et Web of Science). Les résultats sont présentés conformément à l'énoncé PRISMA. L'approche GRADE a été utilisée pour évaluer le risque de biais.*

Conclusion *: Les deux auteurs ont inclus 24 études parmi les 502 identifiées. Les données extraites de ces études sont très hétérogènes, et les protocoles de collage mentionnés sont tous différents. 15 articles concernent la fluorose, 4 la MIH, 5 l'AI, et aucun ne se concentre sur les troubles de la dentine et le XLH. Nous avons formulé 12 recommandations (7 pour la F, 2 pour la MIH et 3 pour l'AI), dont 3 recommandations fortes. Des études supplémentaires sont nécessaires pour confirmer l'efficacité de certains prétraitements. Pour les défauts affectant l'émail, les principales recommandations que nous avons recueillies sont : (i) le collage sur l'émail avec une technique « etch-and-rinse » ; (ii) une étape de déprotéinisation avec du NaOCl à 5%.*

I. Introduction

A. But de ces recommandations et objectifs spécifiques

Plusieurs auteurs ont mené des investigations concernant la modification de l'étape de prétraitement pour les tissus affectés afin d'optimiser le collage. Les paramètres étudiés varient d'une étude à l'autre, tout comme les conditions spécifiques prises en compte, comme résumé dans certaines revues systématiques. Cependant, aucune de ces revues ne propose des recommandations pratiques englobant l'ensemble des pathologies affectant la structure des tissus dentaires.

L'objectif de ces recommandations cliniques est d'offrir aux chirurgiens-dentistes des prétraitements adaptés aux troubles de l'émail et de la dentine ; incluant la fluorose (F), l'hypominéralisation molaire incisive (MIH), l'amélogénèse imparfaite (AI), la dentinogénèse imparfaite (DI), l'ostéogénèse imparfaite (OI) et l'hypophosphatémie liée à l'X (XLH) afin d'améliorer la résistance au collage (SBS) et d'augmenter le taux de survie (SR) des restaurations directes.

B. Description du problème de santé

Diverses maladies affectent les tissus minéralisés de la dent, telles que la fluorose, la MIH, l'AI, la DI, l'OI et l'XLH. Les caractéristiques de ces anomalies structurelles de l'émail et/ou de la dentine sont résumées dans la **Table 1**, incluant les dents et les tissus affectés, les aspects cliniques et la prévalence de chaque condition. Leur étiologie n'est pas entièrement comprise, mais elles ont principalement une origine génétique, impliquant la défaillance de certains gènes pour l'AI, la DI ou l'OI (1–3), ou sont d'origine environnementale (par une exposition excessive et répétitive de fluor pour la fluorose) (4). Cette altération de la structure des tissus dentaires réduit la résistance au collage et le taux de survie des restaurations directes.

Table 1 : Caractéristiques des principaux troubles de l'émail et de la dentine

***AI :** Amélogénèse imparfaite ; **D** : Dentine ; **DI** : Dentinogénèse imparfaite ; **DP** : Denture Permanente ; **DT** : Denture Temporaire ; **E** : Email ; **F** : Fluorose ; **MIH** : Hypominéralisation Incisive Molaire ; **OI** : Ostéogénèse imparfaite ; **PMP** : Première Molaire Permanente ; **PEB** : Dégradation post-éruptive de l'émail ; **XLH** : Hypophosphatémie liée à l'X.*

Trouble	Denture	Tissu	Aspect clinique	Prévalence
F (5–7)	Les deux	E	**Thylstrup & Fejerskov Index** (TFI de 0 à 9): de la plus légère à la plus sévère, opacités, dyschromies (jaunâtre / marron foncé) **TFI 0 :** Translucidité normale	31/100 à 80/100
MIH (8–11)	PMP et incisives permanentes	E	Email d'épaisseur normale, dyschromies (blanc, jaune, marron) **Légère :** Opacités sans dégradation post-éruptive de l'émail **Modérée :** Opacités avec PEB limitée à l'émail **Sévère :** PEB avec dentine impliquée	2,5/100 à 40/100
AI (1,12,13)	Les deux	E	**Hypoplastique :** Email fin **Hypomature / Hypocalcifiée :** Email mou, dyschromies (jaune/marron à rouge/marron) **Hypominéralisée :** Email mou	1/14000 à 1/700
DI (14–16)	DT ou les deux	D	**Légère :** Couronne normale, oblitération partielle des chambres pulpaires **Modérée :** Dyschromies, oblitération totale des chambres pulpaires, couronnes de forme globuleuse **Sévère :** Dyschromies, chambres pulpaires élargies, dents avec apparence de coquillage	1/8000 à 1/6000
OI (17,18)	DT ou les deux	D	Couronne normale, oblitération partielle des chambres pulpaires **Type I** : OI légère avec fragilité osseuse et sclérotique bleue, pas de DI **Type II** : Mort périnatale, sclérotiques sombres **Type III** : Déformation progressive, sclérotiques grises, DI **Type IV** : Sclérotiques normales et déformation légère, DI	1/20000 à 1/30000
XLH (19,20)	DP	D & E	Abcès, retard d'éruption de la denture permanente, chambres pulpaires élargies, dentine hypominéralisée	5/100000

En fonction du type de trouble, la denture permanente (DP) et/ou la denture temporaire (DT) peuvent être affectées, nécessitant une prise en charge du patient afin de restaurer les fonctions masticatoires et esthétiques. De nombreux rapports de cas ont souligné l'efficacité des restaurations directes sur ces tissus affectés, notamment en dentition mixte (21–23). Cela offre une thérapeutique transitionnelle avant la pose de restaurations indirectes à l'âge adulte, tout en restant une technique de préservation tissulaire (24). Les restaurations directes impliquent l'application d'une résine composite en contact avec l'émail et la dentine par le biais du collage. Le collage consiste en une interface double entre l'adhésif et le tissu dentaire (émail ou dentine) et entre l'adhésif et le matériau de restauration composite. Il existe deux principaux systèmes adhésifs : l'adhésif "*etch-and-rinse*" et le système "*self-etch*" (25).

Plusieurs études démontrent que la performance du collage est compromise dans les cas de troubles de l'émail et de la dentine, en particulier dans des rapports de cas de patients ayant des exigences esthétiques (26–28). Dans l'étude de Yaman *et al.* (2014), la SBS des restaurations directes sur l'émail affecté par l'AI en denture permanente est 40% plus faible par rapport à celle de l'émail sain (29). Dans l'étude de Waidyasekera *et al*. (2007) sur le collage en fluorose, la SBS est réduite de 40% sur la dentine affectée (30). Dans l'étude de Sönmez *et al.* (2017), le taux de survie des restaurations sur l'émail sain après 24 mois est de 100%, tandis qu'il n'atteint que 80,7% dans le groupe affecté par le MIH (31).

II. Data sources

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA Statement) checklist for reporting was followed. The selection and quality assessment of the studies were carried out by authors with no prior publications on the topic of this systematic review. The research strategy was registered on the Prospero platform (CRD42023447502).

Four databases were used or the search, from January, 1993 to February, 2024: PubMed, PMC-PubMed, Web of Science, and the Cochrane Library (the search strategies are available in **Table 2**). The inclusion criteria were evaluation of SR or/and SBS of resin bonding on the tooth affected by F, MIH, AI, DI, OI, or XLH. A manual search through the reference lists of the selected studies was conducted. Duplicate studies found in multiple databases were eliminated. Two reviewers screened the titles and abstracts of the identified studies to determine their eligibility. Not English language articles; no SR or SBS test; documents that were not in article format; non-human studies and full-text unavailable were excluded from the analysis.

Table 2 : Search strategies used on Cochrane Library, PubMed, PMC-PubMed and Web of Science

Cochrane Library From 1993 to 2024	(“amelogenesis imperfecta” OR “dentinogenesis imperfecta” OR “osteogenesis imperfecta” OR hypophosphatemia OR "dentin dysplasia" OR hypomineralization) AND ("dental bonding" OR bond* OR etch*) AND (dental OR tooth)
PubMed From 1993 to 2024	(Developmental Defects of Enamel[MeSH Terms] OR dentin dysplasia[MeSH Terms] OR Dentinogenesis imperfecta[MeSH Terms] OR Hypophosphatemia, X Linked[MeSH Terms] OR dentin disorder) AND (Dental bonding[MeSH Terms] OR bond* OR etch*)
PMC-PubMed From 1993 to 2024	(Developmental Defects of Enamel[MeSH Terms] OR dentin dysplasia[MeSH Terms] OR Dentinogenesis imperfecta[MeSH Terms] OR Hypophosphatemia, X Linked[MeSH Terms] OR "dentin disorder") AND (Dental bonding[MeSH Terms] OR bond* OR etch*)
Web of Science From 1993 to 2024 *Filter 1.49* *« Dentistry & Oral Medicine »*	(“amelogenesis imperfecta” OR “dentinogenesis imperfecta” OR “osteogenesis imperfecta” OR hypophosphatemia OR "dentin dysplasia" OR hypomineralization) AND ("dental bonding" OR bond* OR etch*)

III. Resources selection

Two reviewers conducted the data extraction using Zotero, a personal research assistant tool. Any discrepancies were resolved through discussion, and a consensus was reached. The extracted information from each eligible study included diagnosis, type of tissue (E/D), teeth (PD/DD), sample size, type of test (SBS/SR), used materials, bonding protocol and numerical values of SBS and SR.

The GRADE (Grading of Recommendations Assessment, Development and Evaluation) system was used to grade the certainty of evidence of each outcome (32). Certainty of evidence consists in confidence in the effect estimates of studies. 4 levels are used to characterize certainty of evidence: high, moderate, low and very low (summarized in **Table 3**). Randomized controlled trials start at “high” and observational studies at “low”. We then lowered the certainty of evidence based on 5 factors: risk of bias, indirectness (PICO – population, intervention, comparison, outcome – is detailed), imprecision (sample size), inconsistency, and publication bias. Finally, then raised it with size of effect (based on SR or SBS) if it is very large or large. When multiple disease stages or multiple adhesives were involved, we employed an average to calculate an SBS value specific to the article's pretreatment. We opted for a rate for the SBS and an absolute value for the SR. Strength of recommendations reflects the confidence that the authors have that the desirable effects of a management strategy outweigh the undesirable effects.

The certainty of evidence was then interpreted as two grades of recommendations: “strong” and “weak”.

Table 3 : GRADE levels and strength of recommendation *(32)*

Certainty of evidence	*High*	Further research is very unlikely to change our confidence in the estimate of effect.
	Moderate	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
	Low	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
	Very Low	Any estimate of effect is very uncertain.
Strength of recommendation	*Strong*	Benefits clearly outweigh harms; most patients would want receive this type of intervention.
	Weak (Conditional)	Some uncertainty about the balance of benefits and harms, clinicians would only refer the intervention under specific conditions.

IV. Review

Among the 502 articles obtained after removing duplicates, 99 were considered for a full review after evaluating the title and abstract. As depicted in the flowchart (Fig. 1), studies written in another language than English (n=2), those not fully available (n=15), published in a form other than a scientific article (n=5), those not involving human subjects (n=2) or not related to the selected pathologies in this study (n=1) were excluded. Ultimately, 24 articles were selected and included.

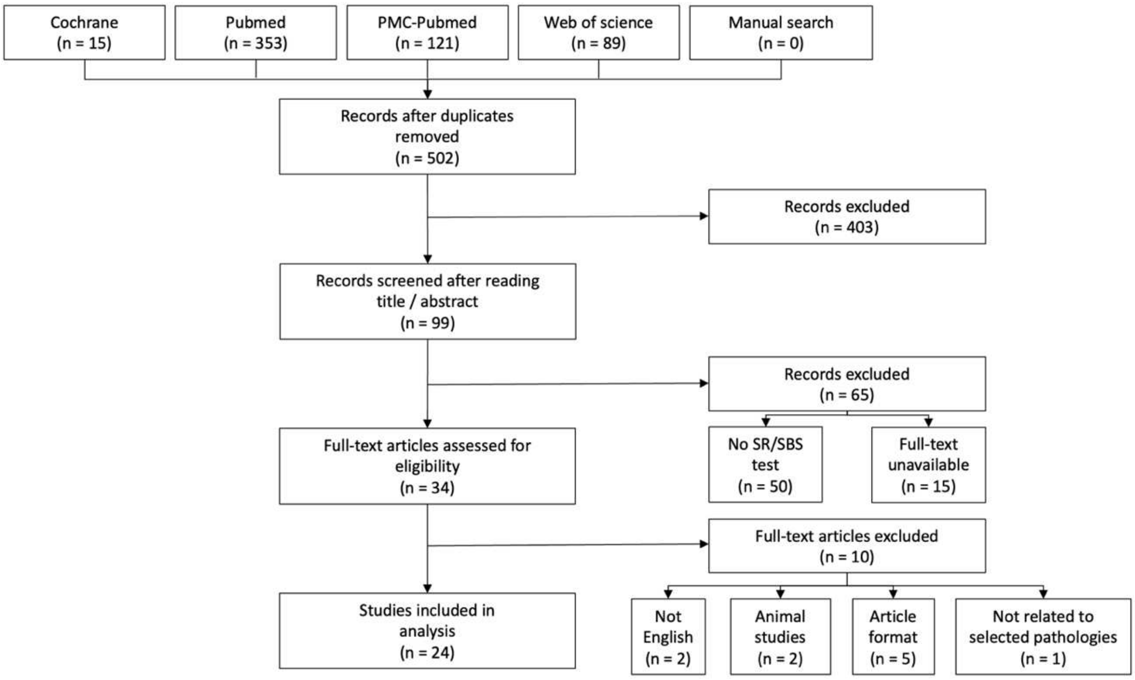

Figure 1: Flowchart of studies selection according to PRISMA statement

SBS: Shear Bond Strength; SR: Survival rate.

The distribution of different types of articles is provided in **Table 4.** The results exhibit significant heterogeneity. 15 articles address fluorosis: 1 is an *in vivo* study (enamel & PD), and 14 articles are *in vitro* studies (12 on enamel & PD, and 2 on dentin & PD). 4 articles focus on MIH: 3 are *in vivo* studies (3 articles on enamel & PD), and 1 article is an *in vitro* study on enamel and dentin & PD. 5 studies pertain to AI: all are *in vitro* (1 article on enamel and dentin & DD, 1 article on dentin & DD, 1 article on enamel & PD, 1 article on enamel and dentin & PD, and 1 article on dentin & PD). No selected article targets DI, OI, or XLH.

The characteristics and results of the 24 articles included in this study have been summarized in **Table 5** in order of diagnosis and publication date. The collected data are highly heterogeneous depending on the conditions considered, with no identical protocol found more than once.

Table 4 : Studies repartition.

***AI**: Amelogenesis imperfecta; **D**: Dentin; **DD**: Deciduous Dentition; **DI**: Dentinogenesis imperfecta; **E:** Enamel; **F**: Fluorosis; **OI**: Osteogenesis imperfecta; **PD**: Permanent Dentition; **XLH**: X-linked hypophosphatemia.*

F	*In vivo*: n=1	E (PD): n=1
	In vitro: n=14	E (PD): n=12 D (PD): n=2
MIH	*In vivo*: n=3	E (PD): n=3
	In vitro: n=1	E & D (PD): n=1
AI	*In vivo*: n=0	
	In vitro: n=5	E & D (DD): n=1 D (DD): n=1 E (PD): n=1 E & D (PD): n=1 D (PD): n=1
DI, OI, XLH	n=0	

The characteristics and results of the 24 articles included in this study have been summarized in **Table 5** in order of diagnosis and publication date. The collected data are highly heterogeneous depending on the conditions considered, with no identical protocol found more than once.

Table 5 : 24 included studies

***AF:** Adhesive Fracture; **Aff:** Affected; **AI:** Amelogenesis Imperfecta; **CF:** Cohesive Fracture; **D**: Dentin; **DD**: Deciduous Dentition; **Diag:** Diagnostic; **E:** Enamel; **ER:** Etch-and-rinse; **F:** Fluorosis; **GIC**: Glass Ionomer Cement ; **m:** Month; **MA**: Micro-abrasion; **MIH:** Molar-Incisor Hypomineralization; **Mod:** Moderate; **NaOCl:** Sodium Hypochlorite; **PD:** Permanent Dentition; **PhA**: Phosphoric Acid; **P&B**: Prime and Bond; **SE**: Self-etch; **SBS**: Shear Bond Strength (including µTBS) ; **So**: Sound; **SR**: Survival Rate; **Sev**: Severe; **µTBS**: Microtensile Bond Strength; **%**: Concentration.*

Reference	Diag • Tissue ¤ Tooth (Aff / So)	Study (Test)	Materials: • adhesive (SE/ER), others	Bonding protocol	SBS (Mpa) / SR of affected tooth
Weerasinghe 2005 (33)	F (Mild, Moderate & Severe) • E ¤ PD (60/20)	*In vitro* (SBS)	• Clearfil SE Bond (SE) Primer: Clearfil SE-Bond Primer PhA: K-Etchant	**1:** Etching & Primer & SE **2:** Primer & SE	**↗: Etching before SE** Mild: 32 / 26 Moderate: 35 / 30 Severe: 30 / 25 *↗ CF for etching before SE*
Ermis 2007 (34)	F (Severe) • E ¤ PD (10/11)	*In vitro* (SBS)	• OptiBond FL (ER) • Clearfil Protect Bond (SE) PhA: *unknown*	**1:** ER **2:** SE *Grinding/no grinding of E*	**= SE and ER** Ground E: 42 / 45 Unground E: 27 / 16
Waidyasekera 2007 (30)	F (Mild & Moderate) • D ¤ PD (32/16)	*In vitro* (SBS)	• Clearfil Tri S Bond (ER) • Single Bond (SE1) • Clearfil SE Bond (SE2)	**1:** ER **2:** SE1 **3:** SE2	**↗: SE** Mild: 20 / 29 / 41 Moderate: 17 / 24 / 27 *No AF for SE2*
Noble 2008 (35)	F (Severe) • E ¤ PD (52/0)	*In vivo* (SR)	PhA: 37% Primer: Scotchbond Multipurpose Primer Pre-coated brackets: 3M Unitek Victory	**1:** MA & Etching & Primer **2:** Etching & Primer	**= MA/no MA before bonding** SR at 9m: 98% / 100%
Ertuğrul 2009 (36)	F (Moderate) • E ¤ PD (36/36)	*In vitro* (SBS)	• Peak LC Bond (SE1) • Xeno V (SE2) PhA: UltraEtch Primer: Peak SE Primer	**1:** Etching 15s & SE1 **2:** SE1 **3:** SE2	**↗: ER** 17 / 13 / 11 *↗ CF for ER*
Isci 2010 (37)	F (Mild) • E ¤ PD (40/40)	*In vitro* (SBS)	• Transbond XT (SE) PhA: 37% Primer: Transbond Plus Self Etching Primer	**1:** Etching & SE **2:** Primer & SE	**↗: Etching before SE** 15 / 9
Torres-Gallegos 2012 (38)	F (Mild, Moderate & Severe) • E ¤ PD (90/30)	*In vitro* (SBS)	• Excite (ER) • Adper Prompt L-Pop (SE1) • AdheSE One (SE2) PhA: 37%	**1:** ER **2:** SE1 **3:** SE2	**↗: SE1** Mild: 13 / 12 / 7 Moderate: 11 / 14 / 6 Severe: 9 / 13 / 7
Silva-Benítez 2012 (39)	F (Moderate & Severe) • E ¤ PD (120/20)	*In vitro* (SBS)	• Transbond XT (ER) PhA: Total Etch	**1:** ER (etching 15s) **2:** ER (etching 150s) **3:** MA & ER (etching 15s)	Moderate F: **↗: Longer etching** 16 / 19 / 13 Severe F: **↗: MA before ER** 11 / 10 / 13

Reference	Diag • Tissue ¤ Tooth (Aff / So)	Study (Test)	Materials: • adhesive (SE/ER), <u>others</u>	Bonding protocol	SBS (Mpa) / SR of affected tooth
Shafiei 2014 (40)	F (Moderate) • E ¤ PD (70/0)	*In vitro* (SBS)	• Adper Single Bond (ER) • Clearfil SE Bond (SE) <u>Laser:</u> Er,Cr:YSGG <u>PhA:</u> 37%	**1:** ER (etching 20s) **2:** ER (etching 40s) **3:** SE **4:** Etching 30s & SE *Laser-etching/bur-grinding before* *2. not done with bur-grinding*	**No superiority of laser** Laser: 26 / 29 / 17 / 19 Bur: 40 / – / 32 / 36
Bakhadher 2015 (41)	F (Moderate & Severe) • E ¤ PD (45/45)	*In vitro* (SBS)	• Transbond XT (ER) <u>PhA:</u> Total Etch	**1:** MA & ER **2:** Etching 30s & ER **3:** MA & Etching 30s & ER	**↗: MA & Etching before ER** 4 / 8 / 9
Nalcaci 2017 (42)	F (Moderate) • E ¤ PD (34/34)	*In vitro* (SBS)	• Transbond XT (ER) <u>PhA:</u> ScotchBond <u>Laser:</u> Er: YAG	**1:** Etching 30s & ER **2:** Laser-etching & ER	**↘: Laser-etching before ER** 15 /12 *↗ CF with Etching*
Gu 2018 (28)	F (Mild, Moderate & Severe) • E ¤ PD (90/30)	*In vitro* (SBS)	• Adper Single Bond 2 (ER) <u>PhA:</u> 35/40/45%	**1:** 35% PhA **2:** 40% PhA **3:** 45% PhA *Etching 30s before bonding.*	**↗: 40% PhA** Mild: 13 / 15 / 9 Moderate: 10 /13 / 8 Severe: 6 / 10 / 6
Tan 2018 (43)	F (Mild, Moderate & Severe) • D ¤ PD (132/44)	*In vitro* (SBS)	• Prime and Bond NT (ER) • RelyX U200 SE (SE) • RelyX Luting SE (GIC)	**1:** SE **2:** ER & SE **3:** GIC **4:** ER & GIC *Etching 15s for ER.*	**↗: ER & SE** Mild: 4 / 6 / 2 / 3 Moderate: 4 / 6 / 1 / 1 Severe: 3 / 5 / 1 / 1 *↗CF with ER*
Cardenas 2019 (44)	F (Moderate) • E ¤ PD (49/49)	*In vitro* (SBS)	• Clearfil Universal Bond (SE1) • Futurabond U (SE2) • iBond Universal (SE3) • Scotchbond universal (SE4)	*Each adhesive was applied by 3 ways:* **1:** Etching & SE **2:** Active SE (20s) **3:** Passive SE (20s) *"Active" meaning manual pressure*	**↗: Etching before SE** SE1: 16 / 13 **/** 10 SE2: 14 / 13 / 9 SE3: 12 / 11 / 9 SE4: 15 / 15 / 12
Zhengfan 2021 (45)	F (Mild & Moderate) • E ¤ PD (48/0)	*In vitro* (SBS)	• Single Bond Universal (SE) <u>NaOCl</u>: 5,25% <u>PhA:</u> 35%	**1:** Etching & SE **2:** NaOCl (60s) & Etching & SE **3:** NaOCl (120s) & Etching & SE **4:** NaOCl (180s) & Etching & SE	**↗: 60/120s NaOCl before etching** Mild: 26 / 28 / 29 / 23 Moderate: 25 / 28 / 31 / 25 *↗ CF with NaOCl time*
Sönmez 2017 (31)	MIH • E ¤ PD (95/31)	*In vivo* (SR)	• Futurabond NR (SE) <u>PhA:</u> Etch-37	**1:** Aff E removed **2:** Aff E ground **3:** Aff E ground & NaOCl (60s) after etching **4:** control	**↗: NaOCl after etching** <u>SR at 24m:</u> 81% / 58% / 78% / 87%
Krämer 2018 (46)	MIH • E/D ¤ PD (53/41)	*In vitro* (SBS)	• OptiBond FL (ER) • Clearfil SE Bond (SE1) • Scotchbond Universal (SE2) <u>NaOCl:</u> 5% <u>Infiltrant:</u> Icon	**1:** ER **2:** NaOCl (60s) & ER **3:** NaOCl (60s) & Icon & ER **4:** SE1 **5:** SE2 *2., 3. & 5. were only on E*	<u>Enamel:</u> **↗: NaOCl & Icon before ER** 21 / 24 / 25 / 11 / 17 <u>Dentin:</u> **↗: ER** 57 / – / – / 43 / –

Reference	Diag • Tissue ¤ Tooth (Aff / So)	Study (Test)	Materials: • adhesive (SE/ER), <u>others</u>	Bonding protocol	SBS (Mpa) / SR of affected tooth
Rolim 2020 (47)	MIH • E ¤ PD (64/0)	*In vivo* (SR)	• Ambar Universal (SE) <u>PhA:</u> Ultra-etch	**1:** Etching & SE **2:** SE *Etching: 30s E, 15s D.*	**↗: Etching before SE** <u>SR at 12m:</u> 81% / 62%
Özgür 2022 (48)	MIH • E ¤ PD (100/0)	*In vivo* (SR)	• Conceal F (ER) • Beautisealant (SE) <u>PhA:</u> i-GEL N <u>Primer:</u> Beautisealant Primer	**1:** ER **2:** Primer & SE	**↗: ER** <u>SR at 12m:</u> 68% / 8%
Saroğlu 2006 (49)	AI (Hypocal.) • E/D ¤ DD (7/7)	*In vitro* (SBS)	• Gluma One Bond (ER) <u>PhA:</u> 20% <u>NaOCl:</u> 5%	**1:** Etching (20s) & ER **2:** Etching (20s) & NaOCl (60s) & ER	<u>Enamel:</u> **↗: NaOCl after etching** 14 / 27 <u>Dentin:</u> **= NaOCl/no NaOCl** 10 / 9
Hiraishi 2008 (50)	AI • D ¤ DD (6/6)	*In vitro* (SBS)	• Prime and Bond NT (ER) <u>PhA:</u> Caulk Tooth Conditionner Gel (34%)	*Etching before P&B* **1:** 15s **2:** 30s	**= 15/30s etching time** 20 / 21
Faria-e-Silva 2011 (51)	AI (Hypocal.) • E/D ¤ PD (5/5)	*In vitro* (SBS)	• Single Bond 2 (ER) <u>NaOCl:</u> 5%	**1:** NaOCl (60s) & ER **2:** ER	<u>Both Enamel & Dentin:</u> **= NaOCl/no NaOCl** Data not shared
Yaman 2014 (29)	AI (Hypopla.) • E ¤ PD (18/14)	*In vitro* (SBS)	• Adper single Bond 2 (ER) • Clearfil SE Bond (SE) <u>PhA:</u> 35%	**1:** ER **2:** SE	**= both ER & SE** 20 / 18
Epasinghe 2017 (52)	AI (Hypocal.) • D ¤ PD (4/4)	*In vitro* (SBS)	• Clearfil SE Bond <u>PhA:</u> Caulk Tooth Conditionner Gel (34%)	**1:** Etching (15s) & SE **2:** SE	**↗: Etching before SE** 25 / 19

This resulted in 12 clinical recommendations for practitioners: 7 for fluorosis, 2 for MIH and 3 for AI. These include 3 strong recommendations and 9 weak recommendations. As there was no study collected on dentinogenesis imperfecta, osteogenesis imperfecta and X-linked hypophosphatemia, there is no recommendation for dentin disorders.

A. Recommendations for bonding in fluorosis

1. *Recommendation 1: Bonding on fluorosis enamel should be performed after a deproteinization step with 5% NaOCl, before etching (weak recommendation; low level of evidence).*

Sodium hypochlorite is a solution commonly used in endodontics to remove entangled dentin debris from the canals during root canal treatment. It neutralizes amino acids in tissues, resulting in the formation of water and salt, hence the principle of deproteinization (53). According to the work of Sabandal *et al.* (2016), hypomineralized tissues have a higher amount of proteins on their surface, which poses challenges for the durability of bonding (54). Pretreatment with 5% NaOCl – a concentration higher than that typically used in endodontics – could potentially reduce the protein load on their surfaces, thereby optimizing the SBS.

There is very low-level evidence that the addition of 5% NaOCl in fluorosis moderately improves the SBS (+18%) (45). The *in vitro* study on permanent enamel (n=48) by Zhengfan *et al.* (2021) shows that the application of 5.25% NaOCl for 60 and 120 seconds before etching improves bond strength. The incidence of cohesive fractures rises with longer application times. However, the study notes that excessive deproteinization time (180 seconds) significantly decreases the surface protein quantity, adversely affecting bonding. For clarity in recommendations, we use a 5% NaOCl concentration, even though Zhengfan's study specifies 5.25%. Commercially, the concentration varies between 5 and 6%, and to date, no optimal concentration for tissue deproteinization has yet been established.

2. Recommendation 2: Bonding on fluorosis enamel should be performed using an etch-and-rinse technique (strong recommendation; very high level of evidence).

In the literature, the ER technique entails using a conditioner to remove dentin debris (most commonly 37% phosphoric acid), followed by a primer and finally the adhesive resin (55). Self-etch adhesives are made of functional acidic monomers that create a chemical bond between with dental substrates (56). They directly interact with the dental surface through dentin debris (25,57). In this study, we define the "etch-and-rinse technique" as the application of acid etching before the adhesive is applied (either standard or self-etch), regardless of whether the manufacturer's instructions are followed.

There is a very high level of evidence that using an etch-and-rinse technique significantly improves the SBS (+10% to +69%) (33,34,36,37,40,44), as underscored by 6 high-quality *in vitro* studies (n=72+80+98+80+70+21).

Ertuğrul *et al.* (2009) compare two SE adhesives in moderate fluorosis (after etching with 35% phosphoric acid for 15 seconds, or not), finding both the SBS results and the number of cohesive fractures to be higher in the ER technique group. The work of Isci *et al.* (2010) involve applying phosphoric acid etching for 30 seconds before the SE, compared to a primer, with etching yielding superior results in moderate fluorosis. Cardenas *et al.* (2017) assess four different SE adhesives, applying them by three ways in moderate fluorosis (with an etching before, with an active application, or with a passive application), showing the ER technique to be more effective for three adhesives. However, an active application of the SE – applying a 35g pressure with microbrush – resulted in better bonding than a passive application. by Weerasinghe *et al.* (2005) compares the ER technique with the SE technique using a SE adhesive joined to a primer, noting that the ER technique produced higher SBS and cohesive fractures for each fluorosis severity. Shafiei *et al.* (2014) tested the effectiveness of laser to optimize bonding in moderate fluorosis (see recommendation 5), finding that the ER technique exhibits superior SBS, regardless of the enamel preparation type (laser or bur). In their investigation of severe fluorosis, Ermis *et al.* (2007) observe no significant difference between the techniques, though numerical values lean towards the ER technique. Nonetheless, they highlight the necessity of grinding fluorotic enamel before bonding.

Two *in vitro* studies (n=120+48) report a decrease in SBS (–15% to –39%) (30,38), presenting a contrasting viewpoint. Among these, the study by Waidyasekera *et al.* (2007), which carries low certainty, mainly concludes that the Clearfil SE Bond adhesive outperforms Single Bond (SE) and Clearfil Tri S Bond (ER) in mild to moderate fluorosis. The second study, by Torres-Gallegos *et al.* (2012), also comparing three adhesives (2 SE, 1 ER), finds primarily that the SE Adper Prompt L-Pop is superior to the other two. However, these studies alone do not undermine the strength of the recommendation, particularly since they focus on comparing different adhesives rather than directly contrasting the two techniques.

The greater volume of studies related to fluorosis can be attributed to its higher prevalence (see **Table 1**). Nonetheless, there is a notable shortage of *in vivo* studies to supplement these findings.

3. Recommendation 3: Bonding on fluorosis enamel should be performed after a longer etching time (weak recommendation; low level of evidence).

Some authors, such as Barkmeier *et al.* (2009), have examined the effectiveness of increasing etching time on bonding and have indicated that it does not have a significant impact on the SBS on healthy enamel (58). Surface geometry is not substantially altered. However, since surface properties vary on hypomineralized tissues, investigations have been conducted in fluorosis to test this pretreatment.

There is a very low level of evidence that extending the etching time enhances SBS (+7%) (39). The *in vitro* study (n=140) by Silva-Benitez *et al.* (2012) finds that bonding improves when the etching duration with 37% phosphoric acid is extended to 150 seconds instead of 15 seconds in moderate fluorosis. They propose that the acid achieve deeper penetration and generates a surface roughness similar to that of healthy enamel etched for 15 seconds. However, the findings indicate that a prolonged etching duration does not yield better results in severe fluorosis. Torres-Gallegos *et al.* support this observation by noting that lengthening the etching time in severe fluorosis might decrease surface roughness, resulting in a completely intact surface, which could negatively affect retention (59).

The *in vitro* studies by Zavala-Alonso (2011) and Al-Sugair (1999) were excluded from our analysis as they did not assess SBS (60,61). Nonetheless, they show that the microstructural depth incrases by up to 5µm in moderate fluorosis after extending the etching time. This could potentially enlarge the available bonding surface, thereby enhancing the SBS.

4. Recommendation 4: Bonding on fluorosis enamel should be performed using a 40% phosphoric acid etching (weak recommendation; high level of evidence).

Some authors hypothesize that increasing the concentration of phosphoric acid would allow better penetration of the acid into tissues, thus leading to improved SBS. However, the most commonly encountered concentration in protocols is 37% phosphoric acid.

There is a high level of evidence that the use of 40% phosphoric acid markedly enhances SBS (+31%)(28), drawing from a high-quality *in vitro* study (n=120). In their research, Gu *et al.* (2018) showed that employing 40% phosphoric acid (instead of 35% and 45%) for 30 seconds improves SBS on enamel for all severities of fluorosis. The authors attribute this improvement to the observation of a resin-penetrated matrix under the microscope during the bonding interface formation with the 40% etching. Despite the high level of evidence, the study lacked a comparison group for 37% phosphoric acid, the concentration most frequently mentioned in the selected articles. Assuming that 37% closely approximates 40% significantly dilutes the recommendation’s robustness.
Additional research is needed to expand upon these results.

5. Recommendation 5: Bonding on fluorosis enamel should not be performed after a laser etching (strong recommendation; high level of evidence).

The laser was described during the 1990s by Pick & Colvard (1993) as a tool for soft tissue surgeries, and it is also used for water evaporation in hard tissues (62). Concurrently, numerous studies have indicated that optimal bonding is achieved on dry surfaces, highlighting the potential utility of lasers in attaining this condition. Additionally, some authors have suggested that lasers could serve as a substitute for etching or be utilized for grinding.

There is a high level of evidence that using laser results in a moderate decrease in SBS (–20% to –41%) (40,42) , based on two *in vitro* studies presenting a low evidence level. Nalcaci *et al.* (2017) found that laser etching with Erbium: YAG for 30 seconds before applying an ER adhesive yielded inferior outcomes compared to 30 seconds of acid-etching. Similarly, Shafiei *et al.* (2014) identified the highest performance in groups that underwent conventional grinding with a diamond bur, concluding that laser does not offer any superiority.
This recommendation may be formulated because laser etching induces excessive dryness, that which hinders the achievement of effective bonding.

6. Recommendation 6: Bonding on fluorosis enamel can be performed after a micro-abrasion (weak recommendation; very low level of evidence).

Micro-abrasion, introduced by Croll in the 1990s, entails the superficial removal of discolorations resulting from demineralization on teeth (63). It is highly recommended for improving bonding to sound tissues (64).

There is a very low level of evidence indicating that micro-abrasion marginally improves the SBS in fluorosis (+13%) (41), based on a low-quality *in vitro* study (n=90) by

Bakhader *et al.* (2015). The authors demonstrate that combining microabrasion with etching provides better outcomes than etching alone. However, the values are significantly lower when microabrasion is used instead of etching, underscoring its importance.

Two other low-quality studies (n=52+140) indicate that micro-abrasion has minimal impact on the SR at 9 months (–2%) and the SBS (–4%) (35,39). In the *in vivo* study by Noble *et al.* (2008), the lack of clear explanation for randomization diminishes its quality. The authors report that SR outcomes are nearly the same at 9 months for groups with and without microabrasion, with only one restoration in the microabrasion group detaching after 4 days. Given the poor quality of this study, it carries little weight in this recommendation. The study by Silva-Benitez *et al.* (2013) finds that microabrasion slightly reduces the SBS in moderate fluorosis but enhances it in severe fluorosis.

These results, while not highly significant, should not discourage practitioners from incorporating microabrasion into their bonding procedures for fluorosis. This is due to its proven effectiveness on bonding to healthy enamel and the low quality of the studies underpinning this recommendation.

7. Recommendation 7: Bonding on fluorosis dentin can be performed with a succession of etch-and-rinse adhesive and a self-etch adhesive (weak recommendation; low level of evidence).

The ER and SE techniques do not have the same effect on tissues (see recommendation 2). Some authors have mentioned that a combination of these two techniques could enhance the benefits of each in the same protocol.

There is low-level evidence that the succession of ER adhesive and SE adhesive significantly increases SBS (+55%) (43), according to a the low-quality *in vitro* study of Tan et al. (2018) on permanent teeth (n=176). The authors found that implementing the technique before applying a SE or glass-ionomer cement (GIC) enhances the SBS. The incidence of cohesive fractures rises with the inclusion of the ER technique. However, the study's lack of clear randomization significantly diminishes its quality and, by extension, the reliability of this recommendation.

This aligns with Recommendation 2 and, through deduction, further supports the preference for an ER technique over an SE technique.

B. Recommendations for bonding on MIH

1. *Recommendation 8: Bonding on MIH enamel should be performed after a deproteinization step with 5% NaOCl (weak recommendation; moderate level of evidence).*

This recommendation is based on the same thinking as the Recommendation 1.

There is a moderate level of evidence that deproteinization of enamel with NaOCl marginally enhances the SR and the SBS. This recommendation draws from two high-quality studies. An *in vivo* study by Sönmez *et al.* (2017) shows that the addition of 5% NaOCl for 60 seconds after etching on MIH-affected teeth increases the SR after 24 months (+20%) (31). An *in vitro* study by Krämer *et al.* (2018) highlights the effectiveness of enamel bonding when 5% NaOCl is applied for 60 seconds before etching (+14%) (46). Moreover, the SBS can be increased when this step is followed by an ICON infiltration. Outcomes for these parameters are not provided for dentin.

This recommendation is consistent with the systematic review of Lagarde *et al.* (2020). They note that bonding is not significantly different based on the type of adhesive technique (SE or ER), but is improved by deproteinization (5% NaOCl for 60 seconds) after etching in MIH (65). However, the recommendation’s strength is considered weak due to the limited research available to corroborate the findings.

2. *Recommendation 9: Bonding on MIH enamel should be performed using an etch-and-rinse technique (strong recommendation; high level of evidence).*

This recommendation is based on the same thinking as the Recommendation 2.

There is a moderate level of evidence that using an ER technique significantly improves the SBS (+50%) (46) and the SR (+19% to +60%) (47,48). This recommendation is supported by three studies on PD (n=94+100+64), comprising two high-quality studies and a lower-quality one.

The *in vitro* study by Krämer *et al.* (2018) was performed on previously extracted human permanent teeth. The authors first compared ER and SE technique, using 3 different adhesives. In a subsequent phase, they assess the SBS with or without the addition of NaOCl with or without an ICON infiltration (30 seconds) as it is mentioned in Recommendation 1. The results suggest the superiority of a meticulously performed ER technique on enamel, and that the addition of NaOCl and ICON further enhances bonding. Concurrently, the authors determine that the ER technique also yields better results on dentin. The *in vivo* study by Rolim *et al.* (2020) investigates the SR over 12 months with a SE adhesive, assessing the impact of acid etching applied for 30 seconds on the enamel. This approach is shown to be significantly more effective than applying the SE adhesive alone. The study by Ozgür *et al.* (2022) evaluate a 'giomer' adhesive, which failed to demonstrate strong bonding efficacy. The SR is significantly higher for the group that received the ER technique, although the results must be considered with caution due to the ineffectiveness of the selected SE.

In MIH, increased fragility of hypomineralized tissues requires a higher amount of material to be removed before bonding (54). The SE adhesive's action might not be as effective as phosphoric acid in the ER technique, despite simplifying the procedure for the practitioner. Given that the selected studies primarily focus on enamel, this recommendation mainly pertains to enamel. Further reasearch is needed to extend it to dentin. This recommendation is supported by the work of Alvarez *et al.* (2023), which finds the SBS on MIH to be superior with an ER technique compared to a SE (66). However, the systematic review by Lagarde *et al.* (2020) indicates that there is no significant difference in bonding in MIH between the two systems (65).

C. Recommendations for amelogenesis imperfecta

1. Recommendation 10: Bonding on AI enamel should be performed after a deproteinization step with 5% NaOCl (weak recommendation; very low level of evidence).

This recommendation is based on the same thinking as the Recommendation 1.

There is a very low level of evidence that the adding 5% NaOCl significantly increases SBS (+93%) on enamel affected by AI, based on two very low-quality *in vitro* studies (n=14+10) (49,51). Saroğlu *et al.*'s (2006) study on primary teeth illustrates that applying 5% NaOCl (60 sec) after etching with phosphoric acid for 20 sec significantly increases the SBS for enamel, a result not mirrored in dentin, where SBS with or without NaOCl does not differ significantly. Faria-e-Silva *et al.*'s (2011) study on permanent teeth indicates that deproteinization with 5% NaOCl for 60 sec before etching does not significantly affect SBS for either enamel or dentin, though the absence of disclosed numerical SBS values calls for a nuanced interpretation. This is further explored by Ahmed *et al.*'s (2019) study on the enamel of primary teeth (n=10), which adds NaOCl before etching (67), focusing not on SBS but on the depth of etching penetration after 15 sec of application, finding an increase for the NaOCl group compared to controls.

The *in vitro* studies by Pugach *et al.* (2011 and 2014) were not included in this analysis as they were not conducted on human subjects (68,69). These studies were carried out on permanent teeth extracted from mice with AI. The 2014 study examined the effects of deproteinization with 5% NaOCl before applying a SE technique. The authors found no significant difference in SBS between the control group and the test group for both affected enamel and dentin.

Further research involving SBS and SR tests is essential to reinforce this recommendation. The findings from these articles provide limited insights on dentin, preventing a definitive recommendation concerning its treatment.

2. Recommendation 11: Bonding on AI enamel and dentin should be performed using an etch-and-rinse technique (weak recommendation; low level of evidence).

This recommendation is based on the same thinking as the Recommendation 2.

There is a low level of evidence that using an ER technique increases SBS (+11 to +32%) (29,52), supported by two low-quality *in vitro* studies (n=8+32).

The study by Epasinghe *et al.* (2017) demonstrates that etching for 15 seconds before applying SE increases SBS in hypocalcified AI-affected dentin. Yaman *et al.* (2014) indicate that the SBS for groups undergoing etching with 35% phosphoric acid (30 sec) followed by a two-layer adhesive application differs slightly from groups using a SE technique. Although the increase in SBS between the two test groups is minimal, it still leans in favor of the ER technique, thus supporting this recommendation. As noted in recommendation 10, the 2011 study by Pugach *et al.* on animal subjects showed a greater incidence of cohesive fractures in enamel of teeth treated with a SE technique compared to an ER technique, which is consistent with this recommendation.

The results involved in this recommendation are not sufficient to strengthen it; further investigations on humans are needed.

3. Recommendation 12: Bonding on AI dentin can be performed after a longer etching time (weak recommendation; very low level of evidence).

This recommendation is based on the same thinking as the Recommendation 3.

There is weak evidence that increasing the etching time marginally increases SBS (+6%) (50), stemming from an *in vitro* study on primary teeth (n=12) by Hiraishi *et al.* (2008). The authors found that increasing the etching duration from 15 to 30 seconds on affected dentin results in a slight improvement in SBS, whereas bonding decreases on healthy dentin with the 30 seconds etching. A 34% phosphoric acid etch was used, followed by the application of a two-step adhesive and prime & bond.

This recommendation is specific to dentin; and additional investigations are required to extend its application to enamel.

V. Discussion

De nombreux patients souffrent de maladies systémiques qui affectent négativement l'intégrité structurelle de leurs tissus dentaires, posant des défis pour le collage des restaurations directes. Cette revue montre que des techniques spécifiques de prétraitement des tissus peuvent significativement améliorer la résistance au collage ou le taux de survie des restaurations.

Les résultats de cette étude varient en fonction du type de maladie ; la majorité des recherches sélectionnées ont été réalisées *in vitro*, après l'extraction de dents humaines. Des études supplémentaires *in vivo* sont donc nécessaires pour confirmer ces conclusions.

Dans cette étude, nous avons supposé que les tissus des dents temporaires et permanentes partagent des caractéristiques identiques. Par conséquent, les recommandations ne font pas de distinction entre le type de dents concerné. Nous pensons que ces recommandations ne sont pas limitées à une gravité spécifique de la maladie, car les résultats n'ont pas varié de manière significative en fonction de la gravité de la maladie étudiée. De plus, la recherche sélectionnée pour cette analyse aborde principalement l'amélogénèse imparfaite hypocalcifiée. Il est clair qu'il est nécessaire de réaliser des études supplémentaires pour étendre ces recommandations à tous les types d'amélogénèse imparfaite.

Aucun article axé sur des troubles spécifiques de la dentine, tels que la dentinogénèse imparfaite, l'ostéogenèse imparfaite ou l'hypophosphatémie liée à l'X, n'a été intégré à cette étude. Cela contraste avec l'étude de Massé *et al.* (15), qui se concentre uniquement sur le collage sur les troubles de la dentine. Cette disparité peut émaner du fait que cette étude de 2021 repose principalement sur une analyse des propriétés chimiques, minérales et microstructurales des tissus pour la sélection des articles. En conséquence, il est recommandé que les futures recherches abordent spécifiquement les maladies de la dentine, y compris le XLH.

Cette étude se concentre sur le collage mais pourrait également s'étendre au scellement de restaurations prothétiques dans les cas de troubles de l'émail et de la dentine. Dans leur revue systématique, Strauch et Hahnel (2018) proposent que les restaurations indirectes soient préférées chaque fois que possible pour la prise en charge des patients présentant de telles conditions (70).

VI. Conclusion

Cette étude permet de recommander aux praticiens de prioriser :

(i) Dans le cas de la fluorose, un collage sur l'émail avec la technique « *etch-and-rinse* » (recommandation forte, niveau de preuve très élevé) ; une étape de déprotéinisation avec du NaOCl à 5% (recommandation faible, niveau de preuve faible) ; et avec un temps de mordançage plus long (recommandation faible, niveau de preuve faible) ;

(ii) Dans le cas du MIH, un collage sur l'émail avec la technique « *etch-and-rinse* » (recommandation forte, niveau de preuve élevé) ; et une étape de déprotéinisation avec du NaOCl à 5% (recommandation faible, niveau de preuve modéré) ;

(iii) Dans le cas de l'AI, un collage sur l'émail avec la technique « *etch-and-rinse* » (recommandation faible, niveau de preuve faible) ; une étape de déprotéinisation avec du NaOCl à 5% (recommandation faible, niveau de preuve très faible) ; et un collage sur la dentine avec un temps de mordançage plus long (recommandation faible, niveau de preuve faible).

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Annexes

A. Recommendations in fluorosis

FLUOROSIS	#1	#2								#3
Tissue	E	E	E	E	E	E	E	E	D	E
Source	(45)	(36)	(39)	(34)	(37)	(44)	(33)	(38)	(30)	(40)
1.Non-randomization	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2.Non-indication of severity	1	0	0	0	0	0	0	0	0	0
3.No control group	0	0	0	0	0	0	0	0	0	0
4.*In vitro* study	1	1	1	1	1	1	1	1	1	1
5.Protocol not clearly described	0	0	0	0	0	0	0	0	0	0
Risk of bias (interpretation)	+	+	+	+	+	+	+	+	+	+
PICO detailed	+	+	+	+	+	+	+	+	+	+
Precision (sample size)	-	+	+	-	+	+	+	+	-	+
No publication bias	-	+								-
Inconsistency of results	NA	+								NA
Certainty	**VERY LOW**	**HIGH**								**LOW**
Type of value	SBS	SBS	SBS	SBS	SBS	SBS	SBS	SBS	SBS	SBS
Numerical value	↗18%	↗30%	↗7%	↗69%	↗67%	↗10%	↗20%	↘15%	↘39%	↗19%
Size of effect	S	VL	VS	VL	VL	S	L	S	VL	S
GRADE of evidence quality	**LOW**	**VERY HIGH**								**LOW**
Strength of recommendation	**WEAK**	**STRONG**								**WEAK**

FLUOROSIS	**#4**	**#5**		**#6**			**#7**
Tissue	E	E	E	E	E	E	D
Source	(28)	(42)	(40)	(41)	(35)	(39)	(43)
1. Non-randomization	**0**	**0**	**0**	**1**	**1**	**0**	**1**
2. Non-indication of severity	0	0	0	0	0	0	0
3. No control group	0	0	0	0	0	0	0
4. *In vitro* study	1	1	1	1	0	1	1
5.Protocol not clearly described	0	0	0	0	0	0	0
Risk of bias (interpretation)	+	+	+	+	+	+	+
PICO detailed	+	+	+	+	+	+	+
Precision (sample size)	+	+	+	+	+	+	+
No publication bias	-	-		-			-
Inconsistency of results	NA	+		-			NA
Certainty	**LOW**	**LOW**		**VERY LOW**			**VERY LOW**
Type of value	SBS	SBS	SBS	SBS	SR (9m)	SBS	SBS
Numerical value	↗31%	↘20%	↘41%	↗13%	−2%	↘4%	↗55%
Size of effect	VL	L	VL	S	VS	VS	VL
GRADE of evidence quality	**HIGH**	**HIGH**		**VERY LOW**			**LOW**
Strength of recommendation	**WEAK**	**STRONG**		**WEAK**			**WEAK**

OUTCOMES	Participants (*Number of studies*)	GRADE	Strength of recommendations
1. Added NaOCl increases bonding	N = 48 *(1 study)*	LOW	WEAK
2. Better to use ER technique than SE	N = 72+21+80+98+80+120+48+70 *(8 studies)*	VERY HIGH	STRONG
3. Longer etching time increases bonding	N =140 *(1 study)*	LOW	WEAK
4. Using a 40% etching increases bonding	N = 120 *(1 study)*	HIGH	WEAK
5. Laser preparation doesn't increase bonding	N = 68+70 *(2 studies)*	HIGH	STRONG
6. MA increases bonding	N = 90+52+140 *(3 studies)*	VERY LOW	WEAK
7. Using ER before SE increases bonding	N = 176 *(1 study)*	LOW	WEAK

Size of effect	Very Large (VL): > 30% Large (L): [20%;30%] Small (S): [10%;20% [Very Small (VS): < 10%

B. Recommendations in MIH

MIH	#8		#9		
Tissue	E	E	E/D	E	E
Source	(31)	(46)	(46)	(48)	(47)
1.Non-randomization	**0**	**0**	**0**	**0**	**0**
2.Non-indication of severity	1	1	1	1	1
3.No control group	0	0	0	0	0
4.*In vitro* study	0	1	1	0	0
5.Protocol not clearly described	0	0	0	0	0
Risk of bias (interpretation)	+	+	+	+	+
PICO detailed	+	+	+	+	+
Precision (sample size)	+	+	+	+	+
No publication bias	-		+		
Inconsistency of results	+		+		
Certainty	**MODERATE**		**HIGH**		
Type of value	SR (24m)	SBS	SBS	SR (12m)	SR (12m)
Numerical value	+20%	↗14%	↗50%	+60%	+19%
Size of effect	**L**	**S**	**VL**	**VL**	**S**
GRADE of evidence quality	**MODERATE**		**HIGH**		
Strength of recommendation	**WEAK**		**STRONG**		

OUTCOMES	Participants (*Number of studies*)	GRADE	Strength of recommendations
8. Added NaOCl step increases bonding	N =126 + 94 *(2 studies)*	MODERATE	WEAK
9. Better to use ER technique than SE	N =94 + 100 + 64 *(3 studies)*	HIGH	STRONG

Size of effect	Very Large (VL): > 30% Large (L): [20%;30%] Small (S): [10%;20% [Very Small (VS): < 10%

C. Recommendations in AI

AI	#10		#11		#12
Tissue	E	E	D	E	D
Source	(49)	(51)	(52)	(29)	(50)
1.**Non-randomization**	**0**	**0**	**1**	**0**	**0**
2.Non-indication of severity	1	1	1	1	0
3.No control group	0	0	0	0	0
4.*In vitro* study	1	1	1	1	1
5.Protocol not clearly described	0	0	0	0	0
Risk of bias (interpretation)	+	+	-	+	+
PICO detailed	+	+	+	+	+
Precision (sample size)	-	-	-	+	-
No publication bias	-		-		-
Inconsistency of results	-		+		NA
Certainty	**VERY LOW**		**LOW**		**VERY LOW**
Type of value	SBS	SBS	SBS	SBS	SBS
Numerical value	↗93%	NA	↗32%	↗11%	↗5%
Size of effect	S	VS	VL	S	VS
GRADE of evidence quality	**VERY LOW**		**LOW**		**VERY LOW**
Strength of recommendation	**WEAK**		**WEAK**		**WEAK**

OUTCOMES	Participants (*Number of studies*)	GRADE	Strength of recommendations
10. Added NaOCl increases bonding for enamel	N = 14+10 *(2 studies)*	VERY LOW	WEAK
11. Better to use ER technique than SE	N = 8+140 *(2 studies)*	LOW	WEAK
12. Longer etching time increases bonding for dentin	N = 12 *(1 study)*	VERY LOW	WEAK

Size of effect	Very Large (VL): > 30% Large (L): [20%;30%] Small (S): [10%;20% [Very Small (VS): < 10%

Thèse d'exercice : Chir. Dent. : Lille : Année 2024 – N° :

Recommandations de 2024 pour le prétraitement du collage sur les troubles de l'émail et de la dentine : une revue systématique

(2024 guidelines for pretreatment to bonding on enamel and dentin disorders: a systematic review) / **Jeanne VOINOT**– *p. (51); ill. (6); réf. (70).*

Domaines : Dentisterie Restauratrice Endodontie ; Odontologie pédiatrique ; Biologie Orale.

Mots clés libres : Anomalies de structure, Collage, Déprotéinisation, Etching, Troubles de l'émail, Troubles de la dentine.

Résumé de la thèse

Cette revue systématique se concentre sur les anomalies structurelles de l'émail et de la dentine telles que la fluorose, l'hypominéralisation molaire-incisive, l'amélogénèse imparfaite, la dentinogénèse imparfaite, l'ostéogenèse imparfaite et l'hypophosphatémie liée à l'X. Ces pathologies posent des défis dans l'adhésion des restaurations directes.

L'objectif principal de cette analyse est d'examiner le taux de survie et/ou la résistance au collage des restaurations directes sur les tissus affectés par des troubles de l'émail et de la dentine chez les humains. L'étude vise à fournir des recommandations cliniques précises afin d'aider les dentistes à choisir le prétraitement de collage approprié pour divers troubles de l'émail et de la dentine.

JURY :

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