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НОВЫЙ ДЕНЬ В МЕДИЦИНЕ
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MULTIMODAL PREVENTION AND MINIMALLY INVASIVE MANAGEMENT OF EARLY DENTAL FLUOROSIS IN CHILDREN *(literature review)*

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✓ ***Resume***

Early dental fluorosis is a developmental enamel condition that requires management at three interconnected levels: control of excessive fluoride exposure, preservation of mineral balance and plaque control, and conservative correction of patient-relevant aesthetic defects. This narrative review integrates public-health prevention, salivary and behavioural risk modification, remineralization, microabrasion and resin infiltration for children with non-pitted early lesions. Evidence from randomized and prospective clinical studies indicates that resin infiltration generally provides stronger immediate masking than remineralization or microabrasion, while microabrasion remains useful for superficial stained defects. A fluorescence-guided, severity-based pathway is proposed for children aged 6–15 years with TF 1–3 lesions, together with a 24-month monitoring framework.

Keywords: children, dental fluorosis, multimodal prevention, remineralization, resin infiltration, microabrasion, fluorescence monitoring, oral health-related quality of life.

МУЛЬТИМОДАЛЬНАЯ ПРОФИЛАКТИКА И МИНИМАЛЬНО ИНВАЗИВНОЕ ЛЕЧЕНИЕ РАННИХ ФОРМ ФЛЮОРОЗА ЗУБОВ У ДЕТЕЙ *(обзор литературы)*

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✓ ***Резюме***

Ранний флюороз зубов у детей требует вмешательства на трех взаимосвязанных уровнях: ограничение избыточной фторидной экспозиции, поддержание минерального равновесия и контроля биопленки, а также консервативная коррекция эстетически значимых поражений. В обзоре сопоставлены реминерализация, микроабразия и инфильтрация смолой при неповрежденной поверхности эмали. Предложен дифференцированный алгоритм для детей 6–15 лет с TF 1–3 и система наблюдения до 24 месяцев.

Ключевые слова: дети, зубной флюороз, мультимодальная профилактика, реминерализация, инфильтрация смолой, микроабразия, качество жизни.

БОЛАЛАРДА ТИШ ФЛЮОРОЗИНИНГ ЭРТА ШАКЛЛАРИНИ МУЛЬТИМОДАЛ ПРОФИЛАКТИКА ҚИЛИШ ВА МИНИМАЛ ИНВАЗИВ ДАВОЛАШ *(адабиётлар шарҳи)*

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✓ ***Резюме***

Болаларда тиш флюорозининг эрта босқичларини бошқариш ортиқча фтор таъсирини камайтириш, эмал ва сўлакнинг минерал мувозанатини қўллаб-қувватлаш, биоплёнкани назорат қилиш ҳамда эстетик аҳамиятли доғларни минимал инвазив усулда бартараф этишни бирлаштириши керак. Мақолада реминерализация, микроабразия ва резин-инфильтрация усуллари қиёсланиб, 6–15 ёшли TF 1–3 бўлган болалар учун табақалаштирилган алгоритм таклиф қилинган.

Калит сўзлар: болалар, тиш флюорози, мультимодал профилактика, реминерализация, резин-инфильтрация, микроабразия.

Relevance

Dental fluorosis is established during enamel formation, but its clinical consequences are managed after eruption. This temporal separation explains why a single topical product cannot be considered a complete treatment. Removing the original source of excessive fluoride prevents additional developing teeth from being affected, yet it does not reverse the porosity already incorporated into an erupted crown. Conversely, an aesthetic procedure may improve a visible opacity without correcting ongoing exposure, plaque retention, dietary imbalance or the child's perception of the defect.

Children aged 6–15 years with early lesions (TF 1–3) are especially suitable for digital fluorescence assessment and a multimodal local-plus-systemic prevention strategy. Severity, surface integrity, staining, caries activity and the child's own concern should determine the least invasive effective option.

Review approach

A focused narrative review was conducted using PubMed, PubMed Central, Cochrane reviews and World Health Organization documents. Priority was given to systematic reviews, randomized trials, prospective paediatric studies and clinically relevant follow-up reports on fluorosis prevention, microabrasion, remineralization, bleaching and resin infiltration. Evidence was organized by the clinical function of an intervention rather than by product name: exposure control, biological stabilization, optical masking and structural restoration.

Biological rationale for multimodal care

Fluorosed enamel has a relatively mineralized surface over a porous subsurface zone. In TF 1–3 lesions the surface is usually intact, so aggressive preparation is biologically disproportionate. Management should first establish whether the defect is stable and developmental or complicated by active caries. Plaque control, diet and salivary conditions influence post-eruptive mineral exchange and caries risk even though they did not cause the developmental defect itself. This distinction prevents the inaccurate claim that remineralization "cures" fluorosis while still recognizing its value in stabilizing enamel and reducing sensitivity.

Level one prevention: control of excessive fluoride exposure

The first level is environmental and family-based. Drinking water should be tested where endemic exposure is suspected, and the result interpreted with climate, daily water consumption and fluoride from tea, food processing, supplements and swallowed dentifrice. WHO retains a guideline value of 1.5 mg/L, but the risk of dental fluorosis may occur at lower water concentrations when total intake or water consumption is high. For children younger than eight years, caregivers should supervise brushing, use an age-appropriate amount of toothpaste and teach spitting rather than swallowing.

Exposure control must be balanced with caries prevention. The 2024 Cochrane review on topical fluoride and fluorosis stresses uncertainty in parts of the evidence and does not support abandoning effective fluoride toothpaste indiscriminately. In endemic settings, the safer principle is source accounting: quantify the major routes, avoid unnecessary duplication and tailor the preventive plan to both fluorosis and caries risk.

Level two prevention: oral hygiene, diet and mineral support

At the child level, plaque control reduces the chance that a stable fluorotic opacity becomes superimposed by active caries. OHI-S or a comparable hygiene index provides a practical baseline. Dietary assessment should identify frequent fermentable carbohydrate exposure and inadequate sources of calcium and phosphate. Salivary flow, pH, buffering capacity, calcium and phosphate are useful research outcomes and may help characterize high-risk children, but systemic supplementation should

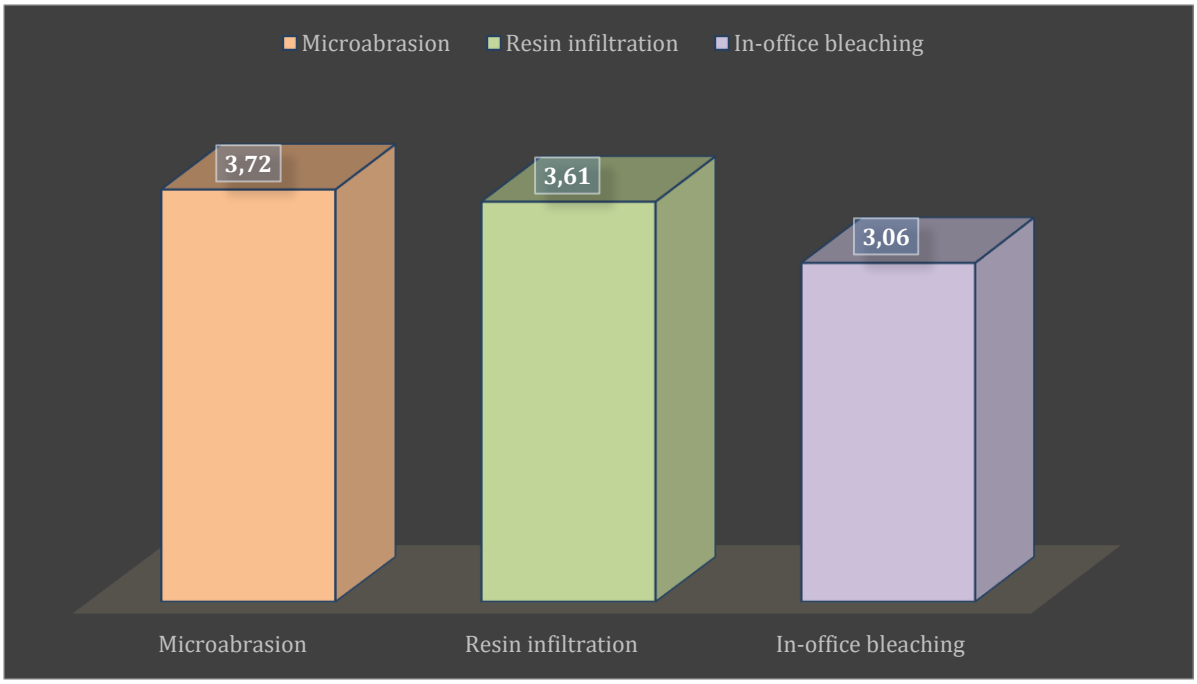
only follow nutritional or medical assessment; indiscriminate calcium-magnesium supplementation is not an evidence-based substitute for exposure control.

Remineralizing products can increase mineral availability at the enamel surface and are particularly reasonable when early lesions coexist with caries susceptibility, roughness or sensitivity. Their main role is biological stabilization. A QLF-based randomized trial by Singhania and colleagues found improvement after both resin infiltration and remineralization protocols, but resin infiltration produced greater fluorescence gain and colour masking for unstained grade III fluorosis. Thus, optical improvement and mineral support should be treated as related but distinct outcomes.

Table 1. Components of a multimodal programme

Level	Target	Core actions	Measurable endpoints	Main safeguard
Community / family	excess fluoride intake	water testing, source substitution where indicated, toothpaste supervision	water fluoride, exposure history, new-tooth phenotype	avoid loss of caries protection
Biological	plaque and mineral balance	hygiene coaching, diet review, targeted remineralization	OHI-S, caries activity, saliva pH/buffer, QLF trend	do not claim reversal of developmental defect
Aesthetic microintervention	patient-relevant non-pitted opacity	microabrasion or resin infiltration after diagnosis	standard photographs, ΔE, lesion area, satisfaction	preserve intact enamel
Restorative	pitting or structural loss	additive composite; indirect restoration only when essential	integrity, sensitivity, maintenance burden	delay the restorative cycle

Figure 1. Immediate mean aesthetic-improvement scores after minimally invasive interventions



Source: Garg et al., 2022. Scale: 1–7; higher values indicate greater aesthetic improvement. The diagram is built as an editable Word table.

Choosing among remineralization, microabrasion and resin infiltration

Remineralization is the least invasive option and is appropriate when the child has no aesthetic concern, when the diagnosis is uncertain, or when biological stabilization is the priority. Microabrasion removes a controlled superficial layer with an acid-abrasive slurry and is most logical for shallow, stained or surface-confined changes. Its limitations are irreversible enamel removal and reduced effectiveness for deeper diffuse opacities. Resin infiltration uses hydrochloric acid conditioning, ethanol drying and a low-viscosity resin to replace air and water within accessible pores, bringing the refractive index closer to that of sound enamel. This mechanism produces immediate masking without conventional preparation, but it requires excellent isolation and careful consent.

Discussions

Randomized studies do not support a single procedure for every phenotype. Gugnani et al. reported better aesthetic change with resin infiltration than bleaching in non-pitted fluorosis. Gencer and Kirzioglu found stronger colour masking with infiltration than microabrasion across developmental defects. Narayanamurthy et al. observed a postoperative colour difference between lesion and adjacent enamel of approximately 1.47 after infiltration versus 3.34 after microabrasion, with stability during short follow-up. These findings favour infiltration for diffuse, deeper white opacities, while microabrasion remains useful when surface staining is dominant.

Table 2. Evidence-informed selection of minimally invasive methods

Clinical phenotype	First-line option	Expected benefit	Limitation / caution	Monitoring
TF 1–2, no complaint, smooth surface	observation ± remineralization	biological support without tissue removal	limited immediate masking	photo, TF, QLF at 6–12 months
superficial stain, shallow opacity	microabrasion ± remineralization	surface stain reduction and smoothing	irreversible enamel removal; sensitivity possible	photograph, sensitivity, colour
diffuse non-pitted white opacity, aesthetic concern	resin infiltration	strong immediate optical masking	isolation, etching; response varies with depth	ΔE/QLF, photos at 1, 6, 12 months
mixed white and brown non-pitted lesions	staged microabrasion then infiltration	surface stain removal plus subsurface masking	avoid cumulative over-treatment	stepwise reassessment
pitting or structural loss	additive composite restoration	restores contour and protects weak areas	maintenance and restorative cycle	integrity at each recall

Bleaching in children

Bleaching changes the colour of surrounding tooth structure and can camouflage mild fluorosis, but it does not infiltrate porous enamel. In minors, concentration, consent and local regulation require particular caution. The clinical trials reviewed generally place bleaching below resin infiltration for persistent non-pitted opacities, although patient satisfaction may still improve. Bleaching should therefore be an age-appropriate, clinician-supervised option rather than an automatic first step.

Fluorescence-guided decision making

Digital fluorescence is most useful when it changes a decision. Baseline autofluorescence or QLF mapping can document lesion boundaries and provide a numerical reference. A dry-and-wet photographic protocol, TF score and caries-activity assessment remain essential because fluorescence is affected by plaque, stains and device settings. After intervention, the same acquisition geometry should be repeated. Improvement in fluorescence does not necessarily equal complete mineral restoration, and aesthetic success should be confirmed with standardized colour measurements and the child's own report.

Patient-reported outcomes and proportionality

Very mild fluorosis is often clinically harmless, and treatment should not create disease out of variation. The child and caregiver should be shown standardized photographs and given a neutral explanation of options, including no active aesthetic treatment. Oral-health-related quality of life instruments such as CPQ or age-appropriate alternatives capture whether the opacity actually affects smiling, school interaction or self-confidence. A randomized trial reported that treating fluorosis can improve OHRQoL, but benefit depends on the baseline burden and should be weighed against procedural costs and future maintenance.

Proposed monitoring framework

Table 3. Core follow-up dataset for children with early fluorosis

Time point	Clinical	Digital / optical	Biological	Patient-reported
Baseline	Dean, TF, surface integrity, caries activity, OHI-S	standard photographs, lesion area, ΔE, QLF/AF or calibrated laser fluorescence	saliva flow, pH/buffer; Ca/P in research settings	aesthetic concern, CPQ/ECOHIS by age
1 month	healing, sensitivity, plaque	early colour and fluorescence response	only if clinically indicated	satisfaction and adverse effects
3–6 months	stability, new caries, OHI-S	repeat identical photo and optical map	pH/buffer in high-risk protocol	satisfaction, adherence
12 months	surface integrity and treatment durability	ΔE/QLF trend	risk-based reassessment	CPQ and retreatment preference
24 months	newly erupted teeth, complications	long-term optical stability	exposure and diet review	sustained quality-of-life effect

Methodological framework for endemic paediatric populations

Clinical evaluation should predefine separate outcomes for diagnosis, biological stabilization and aesthetics. Assessment of 6-, 12- and 15-year-old sentinel groups combines water-fluoride mapping with calibrated TF scoring and blinded analysis of digital images. Treatment comparisons are stratified by staining and lesion depth, because pooled analysis of unlike phenotypes obscures clinically relevant differences. Follow-up to 24 months distinguishes immediate camouflage from durable benefit.

Conclusion

Multimodal care for early dental fluorosis begins with correct diagnosis and control of excessive exposure, not with an aesthetic procedure. Hygiene, diet and mineral support protect the post-eruptive environment; standardized fluorescence and photography provide objective monitoring; and microabrasion or resin infiltration is selected according to lesion depth, staining, surface integrity and patient concern. For TF 1–3 lesions, a conservative escalation pathway preserves enamel and aligns treatment intensity with measurable need.

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