

# Resin Infiltration in Proximal Lesions of Primary Teeth: Do We Have Enough Evidence For Its Recommendation?

Dr Neeraj Gugnani  
Email: drgugnani@gmail.com

Contributor:

<sup>1</sup>Professor  
Department of Pedodontics and PCD  
DAV (C)Dental college  
Yamuna Nagar 135001  
Haryana  
INDIA

## Introduction:

The term Early Childhood Caries (ECC) was introduced in 1990s in an attempt to focus attention on multiple factors that contribute to caries rather than ascribing sole causation to inappropriate feeding methods.<sup>1</sup> It is defined as the presence of one or more decayed (non cavitated to cavitated lesions), missing (due to caries), or filled tooth surfaces in primary tooth in a child under the age of 6 while presence of any smooth surface caries in children younger than three years constitutes Severe-ECC.<sup>2</sup>

ECC is prevalent in both developed and developing countries and its prevalence has been reported to be as high as 85% in disadvantaged groups in developing countries.<sup>3,4</sup> In India the prevalence of ECC has been reported to be high and one of the recently published papers reported ECC prevalence in South India to be 28%.<sup>5</sup>

Globally the prevalence of ECC can only be brought down if we focus on curbing the disease process and not simply by surgically restoring the

cavities. In general, the management of Early Childhood Caries should always be based on a risk assessment approach and should include formulating an individualized care plan – including intervention for both non-cavitated and cavitated lesions.<sup>6</sup> Although there is no consensus as to which formal risk assessment tool should be used, the guidelines suggest using an age based risk assessment tool that should involve evaluation of biological factors, defensive/offensive factors and clinical findings including components of Key's triad, saliva, socio-economic and behavioural factors.<sup>7,8</sup> A risk category thus established guides the treatment plan - which should aim at remineralization of the early lesions, arresting of the non-cavitated lesions, surgical management of cavitated lesions in a minimal invasive manner and last, but not the least, framing a customized preventive strategy to change the oral ecology thus ensuring the avoidance of new lesions formation.<sup>8</sup>

Further, it is relatively always easy for a dentist to make treatment plans for the lesions which are visible on naked eye examination. However, proximal surface lesions in primary posterior



teeth are both, difficult to determine and difficult to manage.<sup>9</sup> Though only visual examination is the most common method used to detect proximal lesions but it's highly recommended to use bitewing radiographs so as to record the lesions in its earliest stages.<sup>10,11</sup>

Proximal lesions in primary teeth progress twice as fast compared to permanent teeth<sup>12</sup>, hence once detected, the progression of such lesions should be arrested by the use of non-operative measures (e.g. dietary control, topical fluoridation etc.) or the lesions will become cavitated, leaving the dentist with no choice than to manage them invasively.

Thus the conventional therapy for proximal lesions varies from non-invasive to invasive approaches. Recently caries infiltration, a novel micro-invasive treatment option for non-cavitated lesions has been introduced which serves to bridge the 'gap' between non-operative and operative options.<sup>13</sup> The concept of caries infiltration was first developed at the Charité Berlin and the University of Kiel as a micro-invasive approach for the management of smooth surface and proximal non-cavitated caries lesions.<sup>14</sup>

The present paper elaborates on the indications, clinical use and evidence on the efficacy of micro-invasive resin infiltration in primary molars.

### **Indications and clinical procedure**

Early caries makes the enamel surface porous in nature. The principle of resin infiltration (also called as caries infiltration) is to fill up this porous enamel with a low-viscosity resin (infiltrant). This seals the early carious lesions thereby blocking the diffusion pathways for cariogenic

acids that have been shown to stop the progression of caries.<sup>13,15</sup>

The clinical indication of resin infiltration in primary dentition is non-cavitated proximal lesions in molars which are detected on routine bitewing or IOPA X-rays. For the purpose of understanding we need to classify the lesions as per the radiographic appearance of the lesion;  
E1: Lesion restricted to outer half of enamel  
E2: Lesion extending to inner half of enamel  
D1: Lesion extending to outer half of dentin  
D2: Lesion extending to inner half of dentin  
Studies have demonstrated that when radiolucency is extending to E1 depth, the lesion is rarely cavitated and require non-invasive method for reversal of the lesion while when the lesion is extending to D2 or deeper levels it is usually cavitated and require some kind of restoration.<sup>16</sup>

The lesions at E2 or D1 level are frequently treated in invasive manner by the dentists however such lesions should not be treated invasively without determining their 'cavitation status.' Literature shows most of these lesions showing radiographic extension up to D1 levels are not cavitated (Figure. 1{i}).<sup>17</sup> For these non-cavitated lesions, conventionally non-operative measures including dietary control, topical fluoridation, oral hygiene maintenance, use of antimicrobials and other remineralizing agents, flossing etc. are indicated to arrest the progression of lesions however, all such treatments require both compliant patients, involved and motivated parents who persistently following the dentist's commands.<sup>18</sup> It is sometimes difficult for children to follow the enhanced care instructions and such lesions tend to progress and become cavitated and dentist has no choice than to manage them invasively.



Figure 1{ii} shows an IOPA radiograph with E2 and D1 lesions which should be checked for their cavitation status and if non-cavitated should be treated with resin infiltration. For all such non-cavitated E2 and D1 lesions resin infiltration procedure is indicated as it stops the caries progression in a painless single sitting procedure.<sup>13, 15</sup>

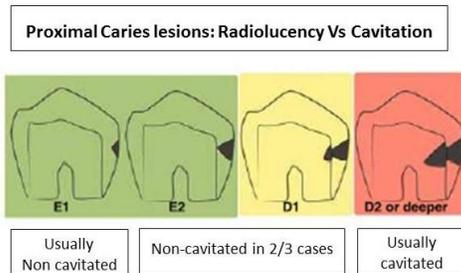


Fig. 1{i}



Fig. 1{ii}

The commercially available resin infiltration kit, ICON, (DMG, Germany) contains 3 syringes, that is acid gel (ICON Etch), drying agent (ICON Dry), and resin infiltrant (ICON Infiltrant) (Figure 2).



Fig. 2

The etching gel is composed of 15% HCl, water, silica and additives, the drying agent is ethanol, and the resin infiltrant is composed of tetra ethylene glycol dimethacrylates, additives, and initiators.<sup>19</sup> Though two different kits are available to be either used for proximal lesions or for vestibular lesions but the main constituents in both the kits are same. The only difference is in their applicator tips. (Figure 3)

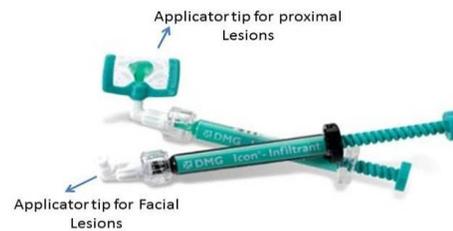


Fig. 3

The procedure as given by the manufacturer is fairly simple and involves three steps; the proximal surface of the teeth with non-cavitated proximal lesion is initially etched with 15% hydrochloric acid for 120 seconds (Icon Proximal Mini Kit, DMG). For the purpose of application of etchant or infiltrant, on a proximal caries, the special applicator tip supplied with the ICON kit, having pores on one side is used. The side with pores should face towards the lesion surface ensuring the flow of material only on the side of the lesion. After 2 minutes of contact with the etchant, the tooth surface is rinsed with water and air dried followed by application of ICON Dry (Ethanol). The surface is dehydrated by evaporation of superficially applied 95% ethanol (Icon Proximal Mini Kit, DMG) and air dried for 30 seconds.

Lastly, Infiltrant resin (Icon Proximal Mini Kit, DMG) is applied to the lesion and allowed to be in contact with the surface for 3 minutes (Figure 4 a-d). Excess material is removed with dental floss and light curing is done for 40 seconds. This

is followed by an additional application of infiltrant for 1 minute followed by light curing.<sup>19,20</sup>

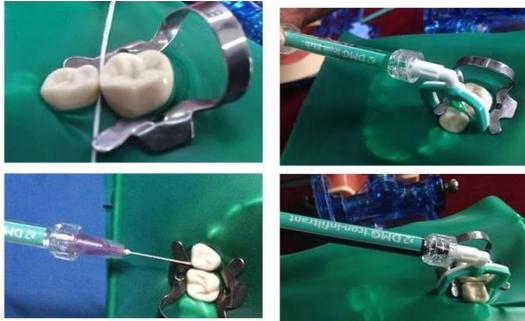


Figure 4a. Application of Rubber dam, 4b. Application of Icon Etchant. 4c. Application of Icon Drying agent  
4d. Application of Icon Infiltrant

Fig. 4

### **Evidence and Recommendations for its use in Primary teeth**

To recommend any new procedure we need to answer following questions, on the basis of which a product is accepted by the dentists and can be used as a routine clinical procedure;

Q. Is it working? Do we have sufficient evidence that it's working?

Q. Is it acceptable to the dentist? Are patients comfortable with the procedure?

Q. Is it safe? Are there any adverse effects reported

Q. Do we have Systematic review proving the evidence?

Coming to these specific questions we need to answer them looking back in to the scientific literature;

#### **Q. Is it working? Do we have any evidence of its working?**

It was found that all the published clinical trials exhibited a favourable evidence to support the use of resin infiltration in stopping the progression of non-cavitated proximal lesions. RUAS

One of the pioneer RCTs conducted to evaluate the efficacy of R.I for proximal lesions in permanent molars compared to non-operative measures, which followed the patients for 18 months, showed lesion progression in only 7% patients in the 'Infiltration group' as compared to 37% of patients exhibiting lesion progression in 'control group' (P.021).<sup>13</sup>

In another 3-year long RCT conducted to evaluate the efficacy of resin infiltration as compared with placebo treatment to arrest progression of proximal non-cavitated caries lesions reported a significant difference in the number of lesions that progressed in control group as compared to the infiltrated group {caries progression in 1/26 test lesions (4%) and 11/26 control lesions (42%) (p = 0.002, McNemar)}.<sup>21</sup>

Another recently published pragmatic randomized split-mouth, placebo-controlled clinical trial done to assess the efficacy of the resin infiltration of proximal caries lesions being performed by several dentists in private practices, in combination with individualized oral hygiene plus non-invasive measures as compared to these non-invasive methods alone again concluded R.I to be more efficacious in reducing lesion progression compared with individualized non-invasive manner over a period of 18 months. This study included 87 children and young adults (with 238 pairs of proximal caries lesions) and after 18 months lesion progression was recorded in only 10/ 186 test lesions while in 58/186 control lesions (31%) (P< 0.001).<sup>15</sup> From these clinical trials we may conclude Resin Infiltration to be an effective procedure in stopping the caries progression as compared to conventional non-invasive strategies in use.

Further, the argument is that, if this technique is working well for permanent dentition, can we



simply translate the results to primary dentition? For this it is important to explore if the primary teeth can be infiltrated in a same manner as permanent teeth. Literature search resulted in various in-vitro studies conducted to evaluate if the 'early carious' lesions in primary teeth behave in same manner as in permanent teeth and whether these can be etched and infiltrated using the 'same' etchant and infiltrant.<sup>22-25</sup>

Firstly, regarding the surface conditioning of natural enamel carious lesion (etching) an in-vitro study concluded effective erosion of surface layer of natural enamel caries in deciduous teeth by etching with same 15% HCl for 90-120 sec as being advocated for permanent teeth.<sup>22</sup>

Another in-vitro study evaluated the penetration coefficient and influence of and ethanol addition on penetration depth of infiltrants into proximal carious lesions in primary molars and concluded that the infiltrants were able to infiltrate proximal carious surface in primary molars too.<sup>23</sup>

Another study that evaluated the penetration depth of proximal caries lesions in primary molars after different applications times concluded that natural non-cavitated lesions in primary molars can be deeply infiltrated with 1-minute application, however recommended a 3-minute application for better and consistent results. The results were further confirmed by another ex-vivo study.<sup>24, 25</sup>

In addition to this in an in-vitro study penetration ability of R.I into proximal lesions in primary molars and permanent molars was compared and no significant differences for overall penetration capability in permanent and primary teeth rather a little better penetration results in primary teeth was observed in the lesions which were limited to enamel only (E2 lesions).<sup>26,27</sup>

From all these in-vitro studies it can be concluded that primary molars can be infiltrated using the same ICON kit and following the manufacturer's instruction. The infiltration of non-cavitated proximal lesions will inhibit the progression of the lesions and stop the advancement of disease process.

A further literature search was carried out to explore if any clinical trials has been conducted with infiltration as one of the intervention for non-cavitated lesions which resulted in two interesting studies.

One split-mouth study that included 50 children with early lesions on primary molars and lasted for 1 year, aimed to assess the efficacy of resin-infiltrated lesions covered by fluoride varnish (FV) versus FV only of proximal lesions on deciduous molar teeth observed the clinical progression in the lesion (ICDAS scores) of 31% of the test lesions and 67% of the control lesions ( $p < 0.01$ ) while radiographically, 23% of the test lesions and 62% of the control lesions had progressed ( $p < 0.01$ ).<sup>28</sup>

Another study aimed to assess the progression of non cavitated initial proximal carious lesions in primary teeth, infiltrated with low viscosity resins, both with and without an overlying layer of chlorhexidine varnish included 45 children, with at least two white spot lesions on the proximal surfaces of primary molars. Participants were recalled after nine months and observed statistically significant positive histogram changes in the test group (RI + CHX varnish). The interesting thing about these two clinical trials is that caries progression stops by RI, but additional non-operative measures do have an supra-additive effects.<sup>29</sup>



**Q. Is it acceptable by dentist? Are patient comfortable by procedure?**

‘Acceptability’ means that dentists are happy to include the procedure in their routine clinical usage depending on the efficacy of the treatment, time and ease of the procedure and cost-effectiveness. The increasing number of papers being published worldwide reflects the increasing acceptability of infiltration concept.

**Q. Is it working? Do we have any evidence?**

However in addition to this simple generalizability, one study evaluated the acceptability of resin infiltration procedure when used for proximal carious teeth in both permanent and primary dentition.

This study involved performing proximal caries infiltration in 50 children (adolescents and young adults) in whom 10 dentists applied the infiltration material, ICON, on noncavitated proximal lesions in permanent and primary teeth. The acceptability was evaluated by assessing the patient comfort, complexity, time, and difficulties of the application in comparison to a filling. The results showed good patient satisfaction with the procedure. The mean time for infiltration ( $24.3 \pm 7.4$  minutes), which included rubber dam application ( $7.7 \pm 4$  minutes) and the effort were perceived to be comparable to or even easier than a composite filling by clinicians. Thus good clinical applicability for clinicians and very high acceptance by patients was concluded while using Resin infiltration for initial non-cavitated proximal lesion in primary and permanent molars.<sup>30</sup>

**Q. Is it safe? Are there any adverse effects reported**

‘Safety’ of a product means that it has no short time or long term local or systemic effects on human contact. In this regard one study is published which was done to assess the safety and quality, as well as the therapeutic effect of resin infiltration on proximal lesions; in which 47 children, adolescents and young adults were treated with RI and assessed for clinical safety and quality of resin infiltration at 1 week, 6 months and 12 months. No relevant changes in clinical status, plaque accumulation or gingival status ( $p > 0.05$ ) were seen with RI treated teeth. A high quality of infiltration was found for the marginal adaptation with only 2 lesions using lesion progression. The study concluded that Resin infiltration is a safe and effective treatment to reduce progression of initial proximal caries.<sup>31</sup>

**Q. Do we have Systematic review proving the evidence?**

A published Cochrane systematic review which included eight trials of which six studies were of permanent dentition and two of primary dentition showed the meta-analysis of the data to be in favour of resin infiltration therapy as compared to non-invasive treatment (e.g. F Varnish) or oral hygiene advice (e.g. to floss) (OR=0.24, 95% CI = 0.14 to 0.41).<sup>32</sup>

Another SR published that also evaluated the in-vivo scientific evidence of the ability of resin infiltration (RI) to arrest non-cavitated caries lesions included 4 articles reported on proximal caries lesions and observed significant differences in caries progression between test and control/placebo groups and concluded RI to be an effective method to arrest the progression of non-cavitated caries lesions.<sup>33</sup>

However both the SRs emphasized a need towards conducting additional, pragmatic long-



term clinical trials with less risk of bias and broader external validity.

### Clinical Decision Tree

A decision tree can be formulated to explain how to detect lesions that can be treated with RI technique and to proceed with the same (Figure5).

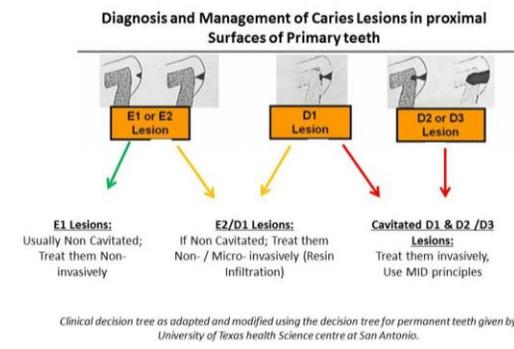


Fig. 5

**Conclusively**, we do have evidence favouring micro-invasive Resin Infiltration procedure in the management of Non-cavitated proximal lesions in primary molars. More studies and clinical acceptance is required by the dentists to adopt the technique as a routine day to day clinical procedure. Routine Bitewing X-rays may help us to detect such lesions in early stages which can then be either managed non-invasively or infiltrated in a single-sitting procedure, and thus collectively may help us to stop the progression of disease.

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