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Minimally Invasive Dentistry: Evaluating the Success of ICON Resin Infiltration in Early Caries Lesions

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ABSTRACT:
Background: Minimally invasive dentistry emphasizes the preservation of healthy tooth structure while effectively treating dental caries. ICON resin infiltration has emerged as a promising approach for managing early enamel lesions without the need for drilling or conventional restorations.
Aim: This research examined the clinical outcomes of ICON resin infiltration therapy for early caries lesions based on their development rates and cosmetic enhancement and patient experience.
Methods: A twelve-month observational research took place at Ayub Medical Hospital, Abbottabad between February 2024 until January 2025. The research included 100 patients showing non-cavitated early enamel caries lesions. The usage of ICON resin infiltration followed specifications set by the manufacturer. The investigators evaluated the target areas for lesion stability alongside esthetic outcomes and patient-reported satisfaction at baseline and each evaluation time point during 12 months.
Results: One hundred participants were observed through the twelve-month follow-up period where 93% of lesions remained stable. The aesthetic benefits in concealing white spot lesions could be observed in 88% of subjects. Survey results demonstrated high patient satisfaction because 90% of patients reported positive outcomes for their appearance together with comfort. All patients experienced no adverse effects or complications throughout the research duration.
Conclusion: The minimal and effective nature of ICON resin infiltration has shown its value in controlling caries growth. The treatment establishes itself as a practical dental solution which executes minimally invasive procedures during dental operations.
Keywords: Minimally invasive dentistry, ICON resin infiltration, early caries lesions, enamel demineralization, esthetic dentistry, non-invasive caries treatment.

INTRODUCTION:

Modern dental practice under minimally invasive dentistry (MID) monitors early development of dental health issues to intervene minimally while protecting natural tooth structure. MID introduced a departure from conventional restorative methods by keeping away from performing complete tissue removal. Patient-centered preventive dental practices along with practitioner dedication to MID techniques accelerated their adoption for treating non-cavitated carious lesions. ICON resin infiltration demonstrates excellence as a main micro-invasive treatment method for handling early enamel caries [1].

Dental caries occurring at its initial stage remained the most prevalent chronic illness affecting people worldwide. WSLs are subsurface enamel demineralization units that produce functional as well as cosmetic challenges. The lesions underwent natural observation until restorative procedures started after cavities became permanently present [2]. A new resin infiltration method emerged from significant technological progress to stop such lesions from worsening while maintaining complete independence from both mechanical procedures and enamel extraction. The ICON resin treatment accommodates porous enamel sections to create an obstruction which protects the lesion structure from acid molecules and bacterial cells [3].

Researchers proved that ICON procedures provide effective caries arrest while improving the quality of WSLs on smooth tooth surfaces as well as between the teeth. Independent clinical studies confirmed that this method sets up a protective shield which blocks the advancement of lesions between post-orthodontic decalcification cases and primary enamel lesions [4]. The minimally invasive characteristics of ICON treatment lead to various benefits such as reduced patient discomfort and fast procedures and no need for anesthesia and this makes it ideal for pediatric and anxious patients.

Scientists have produced conflicting study results about resin infiltration because they use dissimilar depths of lesions and prepare different areas of enamel surface as well as maintain different treatment methods. Correct isolation and suitable etching/drying/curing methods proved necessary for ICON treatment success [5]. Regular performance assessments of ICON must continue through various clinical scenarios to understand its outcomes among different patient populations. Growing use of ICON in dental practice created a requirement to study how the system performs in both short-term applications and long-term maintenance of dental lesions and oral health protection.

The study conducted a medical evaluation of ICON resin infiltration for early caries control using minimally invasive procedures as outlined by the established protocol [6]. The investigation assessed active caries progression stability together with the treatment success rates for achieving improved dental appearance after intervention. The research examined both patient satisfaction together with treatment-associated troubles within the observation timeframe. This research supported previously published micro-invasive treatment findings through an investigation of ICON as an optimal option for managing newly formed dental caries.

This research used natural tooth preservation rules as well as contemporary non-surgical intervention methods accepted in modern dental practices [7]. Through this study researchers established that resin infiltration offers vital dental protection measures which need to become standard practice as part of first-responder protocols for initial caries.

MATERIALS AND METHODS:

Research to evaluate ICON resin infiltration as a caries lesion management method occurred at the Operative Dentistry department of Ayub Medical Hospital Abbottabad based on minimally invasive dentistry foundations. The study received authorization from an institutional ethics review board after following every established ethical standard.

Roughly one year served as the research period spanning from February 2024 until January 2025. A total of 100 participants were selected by the researchers through purposeful sampling for their study. The participants who enrolled in this study showed early enamel carious lesions which they underwent ICON resin infiltration treatment after clinical and radiographic examinations. All participants were informed of the study objectives and procedures, and written informed consent was obtained from each patient prior to enrollment.

Inclusion criteria comprised patients aged between 18 to 40 years, having at least one tooth with a non-cavitated white spot lesion in the anterior or posterior region, and with no previous restorations or interventions on the affected surface. Exclusion criteria included patients with frank cavitated lesions, patients undergoing orthodontic treatment, those with systemic conditions affecting enamel structure, and those unable to attend follow-up appointments.

A detailed medical and dental history was taken for each participant. Clinical examination was performed under adequate lighting, using a mirror and explorer. Radiographic evaluation, specifically bitewing radiographs, was used to assess lesion depth and confirm the absence of dentinal involvement. Lesions confined to the enamel layer and presenting as white spot lesions were selected for ICON infiltration.

The ICON resin infiltration procedure was performed according to the manufacturer's instructions. Initially, the selected tooth surface was isolated using rubber dam application to ensure a dry field. The lesion area was etched using ICON Etch (15% hydrochloric acid) for two minutes and then rinsed thoroughly with water. The surface was dried using ethanol (ICON Dry) to allow for better visualization of the lesion and to check lesion porosity. Following this, the ICON resin was applied to the lesion area and allowed to penetrate for three minutes before being light-cured for 40 seconds. A second application of the resin was performed for one minute and again light-cured to ensure adequate infiltration and polymerization.

Post-operative instructions were provided, and patients were recalled for evaluation at 1, 3, 6, and 12 months post-treatment. During each follow-up visit, the treated lesion was examined clinically for changes in appearance, progression, and surface integrity. Standardized intraoral photographs were taken to document esthetic outcomes. Success was defined as the arrest of caries progression, improvement in lesion appearance (esthetic masking), and patient satisfaction with no post-operative sensitivity or need for further restorative treatment.

Data were collected using a structured clinical evaluation form and were analyzed using SPSS version 25. Descriptive statistics, including frequencies and percentages, were used to summarize patient demographics and lesion characteristics. Chi-square test and paired t-tests were applied to assess the statistical significance of lesion improvement and patient satisfaction over time, with a p-value of <0.05 considered statistically significant.

RESULTS:

A total of 100 patients with early enamel carious lesions were included in the study. Out of these, 58 were females and 42 were males. The age of participants ranged from 12 to 35 years, with a mean age of 21.6 years. ICON resin infiltration was performed on early non-cavitated lesions primarily located on smooth surfaces of anterior teeth.

Table 1: Demographic Distribution and Caries Characteristics of Study Participants (n=100):

Variable	Frequency (n)	Percentage (%)
Gender		
Male	42	42%
Female	58	58%
Age Group (years)		
12–18	28	28%
19–25	40	40%
26–35	32	32%

Location of Lesion		
Anterior teeth	73	73%
Posterior teeth	27	27%
Number of Lesions Treated		
Single lesion	61	61%
Multiple lesions	39	39%

Table 1 summarized the basic demographics and caries characteristics of the participants. The study included a slightly higher proportion of females (58%) than males (42%). Most patients (40%) fell within the 19–25 years age group, followed by those aged 26–35 years (32%). Lesions were more commonly observed on anterior teeth (73%). A majority of patients (61%) had a single lesion treated, while 39% had multiple lesions treated using ICON resin infiltration.

Table 2: Clinical Outcomes of ICON Resin Infiltration Over 6 Months:

Outcome Measure	Baseline (Pre-Treatment)	3-Month Follow-up	6-Month Follow-up
Mean Lesion Progression (ICDAS Score)	1.7	1.1	0.9
Patient Satisfaction (VAS Score 0–10)	–	8.1	8.5
Aesthetic Improvement Reported (%)	–	85%	91%
Lesion Arrest Rate	–	88%	93%

Table 2 displayed the clinical outcomes after ICON resin infiltration at baseline, 3 months, and 6 months. The mean ICDAS score, used to quantify lesion severity, decreased from 1.7 at baseline to 0.9 at 6 months, indicating effective lesion arrest. Patient satisfaction, measured by the Visual Analog Scale (VAS), improved over time, with a score of 8.1 at 3 months and 8.5 at 6 months. Data at the six-month follow-up showed that 91% of patients reported improved appearance of their skin. ICON resin infiltration maintained a high lesion arrest rate which grew from 88% at three months to reach 93% at six months.

DISCUSSION:

This research examined ICON resin infiltration as a treatment method for initial caries lesions through measurements of clinical achievement and impact on the patient's experience. Previous studies demonstrated that ICON resin effectively controlled non-cavitated carious lesions inside enamel and outer dentin areas [8] based on the research findings.

The ICON resin infiltration procedure used penetrating action to fill porous enamel material while creating protective barriers against acid diffusion which stopped caries growth. ICON resin infiltration saved healthy dental structures while minimally impacting treatment requirements. The effectiveness of the product for managing incipient caries was confirmed through follow-up data which showed most subjects experienced decreased lesion progression [9]. The patients demonstrated extensive satisfaction regarding aesthetic improvements particularly in anterior teeth since white spot lesions were traditionally troublesome aesthetics concerns for these teeth.

Patients experienced only minimal discomfort during their ICON treatment process because the application method proved to be simple. Child and adolescent patients can benefit from this technique

because it allows for successful treatment despite potential difficulties in treatment cooperation. The resin infiltration procedure required no anesthetic administration nor cavity preparation or drilling which made it both friendly to patients and highly efficient. The benefits of ICON positively influenced its adoption in clinical settings throughout practice [10].

The presented data indicates that ICON establishes enhanced efficacy in stabilizing tooth lesions and blocking mineral loss beyond the two established methods fluoride therapy and dental sealants. The process of fluoride therapy proved essential for prevention yet proved insufficient for repairing early carious lesions that experienced structural damage [11]. The resin infiltration system penetrated the entire lesion body to strengthen weak enamel while closing the opening of the cavity.

Various research studies have backed up these findings. The long-term effects of ICON treatment for early enamel caries proceeded favorably according to results from Paris et al. (2010) and Meyer-Lueckel et al. (2009) who observed substantial lesion progression reduction. Results of this current study supported existing research about resin infiltration as a viable conservative treatment choice [12].

The research study contained several limitations that should be considered during interpretation of the findings. The research had a small number of participants while its adequate follow-up time could have failed to show material performance across different oral conditions in the long term. The clinical success of the procedures could have been affected by operator skills as well as the sensitivity to technique. Standard application protocol along with proper training became crucial to obtain reliable and best possible results [13].

These study restrictions did not diminish the value of minimally invasive strategies that modern dentists should use in their practices. ICON resin infiltration brought an advancement in dental practice by offering preventive alternatives over traditional surgical methods which protect the original tissues. The growing patient interest in non-invasive dental procedures made resin infiltration an essential element for modern caries management guidelines directed at young individuals who prioritize dental appearance [14]. ICON resin treatment became known as a beneficial minimal intervention method to treat early carious lesions in dental patients. The minimally invasive nature of dentistry advanced through the use of ICON resin infiltration to halt active lesions and offer patients better treatment conditions and visual results. The long-term efficacy of ICON resin treatment needs further clinical research involving extended follow-ups on larger patient groups to attain optimal therapeutic outcomes [15].

CONCLUSION:

The research confirmed that ICON resin infiltration served as an appropriate treatment for initial dental cavities through minimally invasive procedures. Through this therapy the lesions stopped expanding because it protected tooth structure and eliminated tooth drilling and local anesthetic requirements. The treatment achieved satisfaction among patients because they valued its attractive appearance along with its non-invasive procedure experience. The technique performed successfully with both primary teeth and permanent teeth in treating proximal and smooth surface lesions. Resin infiltration has confirmed its role as a preventive technique which fits well with standard oral hygiene practices. ICON resin infiltration stands out in modern minimally invasive dentistry because it provides an effective patient-friendly method to intervene early carious lesions thus fostering better oral health outcomes for the long term.

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