

Effectiveness of Intraoral Camera as a Visual Aid for Communicating Dental Findings in Pediatric Dentistry: A Randomized Controlled Trial

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ABSTRACT

Aim

Effective communication with parents/caregivers is critical for treatment planning. Sole reliance on verbal communication may fail to adequately convey complex dental findings to non-medical caregivers. The Intraoral Camera (IOC) offers an accessible, cost-effective tool providing real-time images to visually bridge this gap. This study aimed to evaluate the

effectiveness of the IOC as a visual aid in parental comprehension of Pediatric dental findings and treatment plans compared to verbal communication in children aged 4-14 years.

Materials and Methods

A Randomized control trial involving 60 participants allocated randomly into two groups (n=30 each): the

Verbal group (Visual Examination + Verbal Explanation) and the IOC group (Visual Examination + Explanation using IOC). Parental comprehension, confidence and satisfaction were assessed using a Structured Questionnaire. Informed consent was obtained prior to the intervention.

Results

The IOC group consistently outperformed the Verbal group reporting higher clarity and confidence. Welch's t-test demonstrated statistically significant mean differences favouring the IOC group for six of the seven metrics. The largest difference was found in ease of visualization [$t(29.00) = 5.04, p < 0.001$]. The difference was also highly significant for the detail of treatment plan [$t(29.00) = 4.71, p < 0.001$] and helpfulness of the method [$t(42.65) = 4.51, p < 0.001$]. The difference in satisfaction with explanation ($p = 0.326$) was not significant.

Conclusion

The Intraoral Camera (IOC) significantly enhanced parental comprehension and confidence in decision-making compared to verbal explanation (VE) alone. Integrating this visual aid was recommended for better patient and parent engagement in Pediatric dental practice.

Clinical Significance

Using an intraoral camera significantly improved parental understanding and confidence in Pediatric dental care. It replaced the uncertainty of verbal-only explanations with clear visual evidence fostering better engagement between the dentist, parent and child. This clarity ultimately led to higher treatment acceptance and better long-term adherence to oral hygiene.

Keywords

Diagnostic Aid, Intraoral Camera, Patient Education, Verbal Communication, Visual Aid.

INTRODUCTION

Effective communication between the dental professional and the parent or caregiver is a cornerstone of ethical and successful Pediatric dental practice. Unlike adult dentistry, pediatric care relies on a tripartite relationship involving the dentist, the child and the parent. Because the parent acts as the primary decision-maker, their complete and accurate understanding of the child's dental issues is an absolute prerequisite for informed consent.^{1,2} When parents truly understand the nature of the dental disease and the necessity of the proposed intervention, they are far more likely to adhere to necessary care and maintain follow-up appointments. However, effectively communicating intraoral pathology presents a significant challenge. Dental findings rely heavily on specialized anatomical knowledge, meaning that a purely verbal explanation (VE) can result in an abstract or ambiguous representation of the disease's severity and location for non-medical caregivers. Previous literature indicates that sole reliance on VE in clinical settings often results in poor comprehension, reduced treatment acceptance and potential dissatisfaction.^{3,4}

If pediatric dental consultations are based on the principles of objective visualization and active reinforcement rather than purely abstract descriptions, it is highly possible that parents will establish a more accurate perception of their child's dental needs. It has been found that a heightened understanding of oral health is strictly necessary for greater compliance. The

vital "need to explain" clinical findings clearly has led to the adoption of technologies such as the Intraoral Camera (IOC). The IOC is an accessible and cost-effective device that captures and displays magnified, high-resolution, real-time images of the patient's oral condition directly onto a monitor.^{5,6} This technology provides objective visual evidence of pathology, transforming abstract verbal concepts into tangible, easily understandable visual realities. By providing direct visualization of findings like carious lesions or restorations, the IOC acts as a powerful educational aid to effectively bridge the gap between the professional's diagnosis and the parent's perception.⁷⁻¹⁰ Hence, if standard verbal explanations are combined with displaying the actual intraoral pathology using an intraoral camera as a visual reinforcement tool, then indeed remarkable improvements in parental comprehension, confidence and treatment acceptance

may be visible.

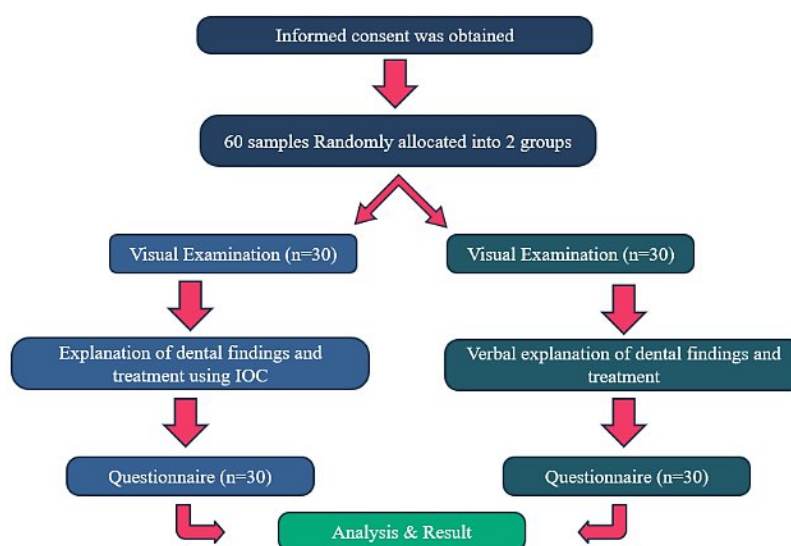
Therefore, the purpose of this study was to rigorously evaluate whether the use of an Intraoral Camera as a visual reinforcement tool can improve parental understanding of dental findings. The primary aim was to compare the impact of the IOC-augmented explanation against a standard VE alone on parental comprehension, confidence in treatment decisions and overall satisfaction regarding Pediatric dental findings and treatment plans in children aged 4–14 years.

MATERIALS & METHODS

STUDY DESIGN

This was a randomized controlled trial designed to evaluate the effectiveness of the IOC as a visual aid in enhancing parental comprehension and satisfaction of diagnosis and treatment plan in Pediatric dentistry (Figure 1).

Fig. 1: Study Design



The study was conducted in May 2025 in the Department of Pediatric and Preventive Dentistry, Ahmedabad dental college and hospital after obtaining ethical clearance from the Institutional Ethical Committee (Approval No: IECADC/0113/2025). The sample size was determined using G*Power software. For a two-tailed independent samples t-test with an estimated effect size (d) of 0.74, an alpha error probability of 0.05 and a target power ($1-\beta$) of 0.80, the required sample size was calculated as 30 participants per group (allocation ratio 1:1) yielding a total sample size of 60.

STUDY POPULATION

A total of 60 parents of Pediatric patients aged between 4–14 years who reported to the department were included in the study. Parents who were willing to provide informed consent and had children requiring dental treatment were considered eligible. Exclusion criteria included parents with professional dental background, those unwilling to participate and cases where language or communication barriers existed.

RANDOMIZATION

The participants were randomly divided into two groups of 30 each:

- Control Group (VE): Parents were given the diagnosis and treatment plan explanation verbally by the operator.
- Study Group (IOC): Parents were shown their child's oral findings using an intraoral camera followed by explanation of the treatment plan.

Randomization was performed using sealed, opaque and concealed pouches containing group allocation slips. This method ensured allocation concealment and minimized selection bias. The pouches were prepared by an independent staff member not involved in the study.

Documentation of Dental Findings

Following the VE, IOC specifically the Waldent Ergo 10 MP Intra Oral Camera (Waldent, New Delhi, India) was utilized exclusively in the study group. The operator systematically captured high-resolution digital images of all diagnosed sites (e.g., carious lesions) by moving quadrant-by-quadrant for documentation and presentation (Figure 2).

Fig. 2: Use of the IOC during Patient Examination



Standardized Explanation Protocol

All parents/guardians received a standardized explanation of dental findings and treatment plans discussed systematically by quadrant. The control group received VE only while the study group received the verbal explanation supplemented by the captured IOC images.

QUESTIONNAIRE

Following the explanation, each parent was asked to complete a structured questionnaire designed to assess comprehension and satisfaction regarding the diagnosis and treatment plan. The questionnaire consisted of dichotomous (Yes/No) questions assessing satisfaction, ease of visualization and confidence in treatment decisions.

Multiple-choice questions with three response options (e.g., “completely clear, somewhat clear, unclear” or “very likely, likely, unlikely”).

The questionnaire was validated by subject experts and pretested on a small sample prior to the main study to ensure clarity and reliability.

DATA COLLECTION

Responses were collected from all 60 parents under supervision to ensure completeness of the forms. The

responses were then coded numerically for statistical analysis (e.g. Yes = 1, No = 0; Completely clear = 3, Somewhat clear = 2, Unclear = 1).

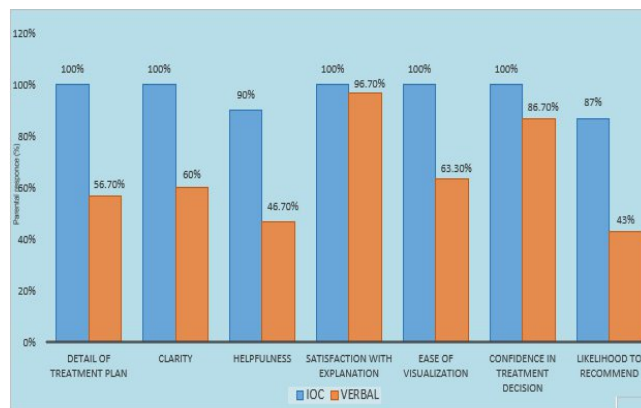
STATISTICAL ANALYSIS

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics software (version 29.0). Descriptive statistics (frequency and percentages) were calculated for each response. Since the analysis involved comparing mean scores of two independent groups with significant heterogeneity of variances, the Welch's independent samples t-test was applied as the primary measure of difference. A Mann-Whitney U test was performed for corroboration given the ordinal nature of some questionnaire items. A p-value of <0.001 indicated a highly statistically significant result and <0.05 was considered as statistically significant result.

RESULTS

This graphical representation served to emphasize the dramatic shift in parental perception achieved by integrating the visual aid. The significant statistical findings regarding comprehension and positive outcome preference were observed (Graph 1).

Graph 1: Comparison of Positive Parental Response Rates Between the IOC and VE Groups



Digital images were captured by Intraoral Camera (Figure 3, 4).

Fig. 3: Eruption of the tooth captured by the IOC



Fig. 4: Dental caries captured by the IOC



The numerical coding of responses allowed the calculation of mean scores ($\pm$ standard deviation) for each outcome metric. The Welch's independent samples t-test was conducted to assess the difference in these mean scores between the two independent groups. Due to a ceiling effect in several variables, the

degrees of freedom (df) were estimated using the Satterthwaite approximation. The t-test demonstrated a statistically significant mean difference in parental perception between the groups for six of the seven evaluated metrics. (Table 1).

Table 1: Comparison of Parental Perception Mean Scores between the IOC Group and the VE Group using Welch's Independent Samples t-Test

Comparison of Parental Perception Mean Scores between the IOC Group and the VE Group using Welch's Independent Samples t-Test						
Variable Assessed by Questionnaire	IOC Group (M ± SD)	VE Group (M ± SD)	t-value	df	P-Value	Significance
Detail of Treatment Plan	3.00±0.00	2.57±0.50	4.7092	29	<0.001	Highly Significant
Clarity of Benefits & Risks	3.00±0.00	2.60±0.50	4.397	29	<0.001	Highly Significant
Helpfulness of Explanation Method	2.93±0.25	2.47±0.50	4.5056	42.647	<0.001	Highly Significant
Satisfaction with Explanation	1.00±0.00	0.97±0.18	1	29	0.3256	Not Significant
Ease of Visualization	1.00±0.00	0.53±0.50	5.0374	29	<0.001	Highly Significant
Confidence in Treatment Decision	1.00±0.00	0.87±0.35	2.1122	29	0.0434	Significant
Likelihood to Recommend	2.87±0.35	2.40±0.56	3.8675	48.138	0.0003	Significant

To confirm the robustness of the findings for the ordinal-scale variables, a rank-based Mann-Whitney

U test was conducted for the four questions showing highly significant differences in the primary analysis (Table 2).

Table 2: Comparison of Ordinal Variable Ranks between the IOC Group and the VE Group using the Mann-Whitney U Test

Comparison of Ordinal Variable Ranks between the IOC Group and the VE Group using the Mann-Whitney U Test			
Variable Assessed by Questionnaire	Z-score	p-value (2-tailed)	Corroboration with t-test
Detail of Treatment Plan	4.877	<0.0001	Highly Significant
Clarity of Benefits & Risks	4.621	<0.0001	Highly Significant
Helpfulness of Explanation Method	4.5905	<0.0001	Highly Significant
Likelihood to Recommend	3.8967	<0.0001	Highly Significant

The use of the Intraoral Camera demonstrated a statistically significant improvement in parental understanding of the detail of treatment plan [$t(29.00) = 4.71, p = 0.0001$] and the clarity of benefits & risks [$t(29.00) = 4.40, p = 0.0001$]. The ease of visualization was rated highly in the IOC group [$t(29.00) = 5.04, p < 0.0001$] leading to significantly higher confidence in treatment decision [$t(29.00) = 2.11, p = 0.0434$] and significant likelihood to recommend the method [$t(48.14) = 3.87, p = 0.0003$]. The overall satisfaction with explanation showed no statistically significant difference between the two groups. The Mann-Whitney U test confirmed that the distributions of ranks were significantly different between the IOC and VE groups for all tested outcomes with the results mirroring the highly significant findings of the Welch's t-test.

DISCUSSION

The novelty of this study lies in evaluating the intraoral camera as a real-time communication tool to bridge the immediate cognitive gap between pediatric dentists and parents. Unlike previous studies that focused on teledentistry or long-term plaque control, this trial provides direct quantitative evidence on how objective visual reinforcement immediately improves a non-medical caregiver's comprehension and confidence in treatment decisions.

This randomized controlled trial demonstrated that the use of an IOC as a visual communication tool significantly improved parental understanding and confidence regarding Pediatric dental diagnosis and treatment plans. The findings clearly highlighted the difference in both clinical and statistical outcomes between verbal and visual modes of communication. Statistically significant improvements were noted in

parameters such as clarity of the treatment plan, understanding of benefits and risks and enhancement of parental confidence. The Welch's t-test results supported by the Mann-Whitney U analysis confirm that visual reinforcement plays a significant role in enhancing communication effectiveness in Pediatric dentistry.

The outcomes of the present study are consistent with recent evidence in the literature. Schulz-Weidner et al. also reported that the use of visual aids including intraoral scans improved parental comprehension in Pediatric dental consultations particularly when complex procedures were discussed.¹¹⁻¹³ In the present study, a significant increase in parental confidence in the decision [$t(29.00) = 2.11, p = 0.043$] further emphasized the role of visual input in enhancing parental assurance and psychological readiness for dental treatment.

Pentapati et al. highlighted the multifaceted utility of intraoral cameras in dental practice underscoring their role in improving communication, facilitating case documentation and promoting treatment acceptance.^{1,2} This aligns with the current study's findings, where IOC use was perceived as a more helpful and transparent communication method [$t(42.65) = 4.51, p < 0.001$].

Although the overall satisfaction with the explanation did not differ significantly between the two groups ($p = 0.326$), this may reflect an inherently high baseline satisfaction with professional verbal communication. A significant tendency among parents to recommend the IOC-based method [$t(48.14) = 3.87, p = 0.0003$] indicated a strong preference for the added visual clarity provided by this tool. This favorable perception was supported by Pate et al. who observed a positive

parental attitude and preference toward intraoral camera use during Pediatric dental visits.¹⁰ Tan WK et al. had also concluded that IOC has clinically appropriate feasibility as a avenue for teledentistry with a high level of caregiver-child acceptance.¹⁴

The superiority of visual evidence over purely verbal instruction is evident in long-term preventive care; Machale et al. found that using an intraoral camera to show patients their plaque retentive sites was a highly effective reinforcement tool that yielded lower plaque scores over a 12-month period.¹⁵

This study's findings are limited by its single-center design and a relatively small sample size of 60 participants which may restrict generalizability. Future large-scale, multicentric studies are necessary to evaluate if these immediate improvements in comprehension translate to sustained treatment compliance and better oral health outcomes.

CONCLUSION

Within the limitations of this study, the intraoral camera proved to be a valuable visual aid that significantly improved parental comprehension and confidence in clinical decision-making compared to

conventional VEs. The findings suggested that incorporating intraoral camera-based communication can enhance the quality of parent-clinician interaction and promote informed consent in Pediatric dental practice. Larger multicentric studies with extended follow-up periods are recommended to evaluate the long-term effects of this enhanced understanding on treatment compliance and overall oral health outcomes.

CLINICAL SIGNIFICANCE

The use of visual communication tools such as the intraoral camera markedly enhances parental understanding and confidence when discussing Pediatric dental findings and treatment options. Incorporating this technology into routine Pediatric practice helps minimize the uncertainty often associated with VE alone thereby promoting clearer communication and greater engagement between the dentist, parent and child. Improved comprehension and transparency through visual reinforcement can lead to higher treatment acceptance rates and foster better adherence to long-term follow-up and oral hygiene practices.

List of Abbreviations

IOC -	Intraoral Camera
VE -	Verbal Explanation
RCT -	Randomized Controlled Trial
SPSS -	Statistical Package for the Social Sciences
M -	Mean Score
SD -	Standard Deviation
df -	Degrees of freedom

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