

Assessment of OXIS Contact Areas in Primary Molars Using Intraoral Camerain West Godavari District, India (2025): A Cross-Sectional Study

Zia-Ul-Haque Mohamed^{1*}, Ahalya Penmetsa¹, Cheeli Spandana¹, Ravigna Peddi¹, Mettapalli Sai Phanikumar¹, Akula Srilakshmi¹

¹Department of Pedodontics and Preventive Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India

*Corresponding Author: Zia-Ul-Haque Mohamed, Email: haque.kik@gmail.com

Abstract

Background: Evaluation of proximal contacts in primary teeth is crucial, as variations in contact morphology influence caries susceptibility and the maintenance of arch integrity. The present study aimed to assess the prevalence of OXIS contact areas between primary molars using intraoral photographic records among 5–8-year-old schoolchildren in Bhimavaram, Andhra Pradesh. The OXIS classification provides a systematic approach for evaluating interproximal morphology in primary dentition and can be considered an important caries risk factor in primary molars.

Methods: Two schools were selected using convenience sampling. After obtaining informed consent, intraoral camera images of caries-free proximal contacts in all quadrants were obtained. Two calibrated examiners independently assessed contact types based on the OXIS classification. Data were analyzed to determine the prevalence and distribution of contact types with respect to age, gender, and dental arch.

Results: A total of 399 proximal contact areas in 156 children were examined. The overall distribution of OXIS contacts was: I-type (46.1%), S-type (29.8%), X-type (22.3%), and O-type (1.7%). Significant differences in contact type distribution were observed between maxillary and mandibular arches and across age groups. A decreasing trend in O-type contacts and increasing frequencies of I- and X-type contacts were observed with advancing age, particularly between 6 and 7 years.

Conclusion: I-type contact was the most prevalent, followed by S-type, X-type, and O-type. The age-related shift in contact morphology highlights the importance of monitoring proximal contacts during mixed dentition, as they have implications for caries risk, space maintenance, and occlusal development. These findings provide valuable epidemiological evidence to guide preventive strategies and pediatric dental care.

Keywords: Dental proximal contact, Dental classification systems, Epidemiology, Pediatric dentistry, Prevalence

Citation: Mohamed Z, Penmetsa A, Spandana C, Peddi R, Phanikumar MS, Srilakshmi A. Assessment of OXIS contact areas in primary molars using intraoral camerain west Godavari district, India (2025): a cross-sectional study. J Oral Health Oral Epidemiol 2026;15:2508.1777. doi:10.34172/johoe.2508.1777

Received: August 16, 2025, **Revised:** February 16, 2026, **Accepted:** April 18, 2026, **ePublished:** May 18, 2026

Introduction

“Contact areas” are the proximal heights of a tooth’s mesial and distal surfaces, indicating the type (closed/open) and morphological configuration (convex/concave/combination) between adjacent teeth. They are influenced by the shape and size of teeth as well as the dental arch. These areas are essential for the harmonious functioning of the masticatory system. Contact areas in primary teeth are wider, flatter, and more gingivally positioned than those in permanent teeth (1,2).

The literature suggests that approximal contacts can serve as potential predictors of caries. Extensive contact areas have higher caries susceptibility due to compromised self-cleansing action, resulting in greater plaque accumulation(3). World Health Organization statistics demonstrate a higher prevalence of caries in

Latin America and Asia among 5- to 8-year-old children, approximately 10.53% and 80%, respectively, indicating that this age group is more susceptible to caries. Hence, this age group was selected for the study.

A study by Kirthiga M. et al. in 2018 introduced a new classification system for contact areas of primary molars, identifying four distinct types—open (O), point (X), straight (I), and curved (S). Therefore, understanding the frequency of specific contact types within a population is crucial for determining caries risk(4,5).

Various techniques are available for evaluating interproximal contact types, including the flossing method, study models, clinical photography, and cone-beam computed tomography (CBCT). Muthu MS et al. (2021) reported almost perfect agreement between CBCT images and clinical photographs(6). Among these,



CBCT provides the most accurate assessment with a three-dimensional view of the contact area; however, it is associated with increased cost, time, and ionizing radiation exposure of about 20% compared to conventional IOPA (intraoral periapical radiograph). Capturing high-quality clinical photographs can be challenging, requiring technical skill and being affected by factors such as limited patient cooperation, fogging of mirrors, and equipment disinfection. Therefore, the use of an intraoral camera can be considered a practical substitute for conventional clinical photography(7).

Hence, this study aims to assess the prevalence of OXIS contact areas between primary molars using clinical photographs obtained through an intraoral camera in 5–8-year-old children in Bhimavaram, West Godavari, Andhra Pradesh. A simple, portable, and user-friendly intraoral camera can serve as a viable adjunct for assessing approximal contacts in children at caries risk during field trials.

Methods

This was an observational study reviewed and approved by an Institutional Review Board and Ethics Committee (IECVDC/24/PG01/PPD/IVV/50). The research employed a convenience sampling technique to select children from schools in *****, **** district, ****, ****. After obtaining informed consent from parents or guardians, children were enrolled in the study based on predetermined criteria.

The inclusion criteria were children aged between 5 to 8 years of dental age who could cooperate for intraoral camera imaging, with adequate mouth opening (>20 mm) to record caries-free contact areas between primary molars. The exclusion criteria included children with special healthcare needs, those with developmental anomalies in tooth shape and size, and those with a severe gag reflex.

The sample size was calculated based on the study results of Tarun Wali et al. (2021), using G*Power 3.1 software for power analysis. The calculated sample size, with 99% power and a 95% confidence interval, was 399 contact areas.

The armamentarium used in the study included an intraoral camera with a 5-megapixel CMOS ¼ sensor (BO7WFBG2J1, Waldent Innovations, India) and software for the intraoral camera (Dental USB, Waldent Innovations, India).

Standardized intraoral imaging was achieved (Figure 1) by maintaining uniform light exposure using the inbuilt LED illumination, while a consistent distance of 10 mm from the contact area was ensured. This standardization was facilitated by a customized square loop with an extension designed to accommodate a rectangular, cube-shaped silicone putty base with a height of 10 mm. The loop was fabricated from 19-gauge stainless steel wire and positioned at a distance of 10 mm from the tip of the camera head (Figure 2).





Contact type	Description	Clinical image
O (open contact)	when there is no contact between the primary molars.	
X (point contact)	when there is a point contact of ≤1.5mm between the primary molars	
I (straight contact)	when there is a straight contact of ≥1.5mm between the primary molars	
S (curved contact)	when there is a curved contact of >1.5mm between the primary molars	

Figure 1. Evaluation of Contact Areas Based On OXIS Criteria

Results

The study included a total of 156 children with a mean age of 6.2±0.9 years, comprising 79 (50.6%) males and 77 (49.4%) females. A total of 624 contact areas were screened, of which 399 met the inclusion criteria and were included in the study.

The type of contact varied significantly between dental arches (P=0.04*) and across age groups (P=0.027*), while no significant variation was observed with respect to gender (P=0.19). On overall evaluation, I-type contacts (184; 46.1%) were the most prevalent, followed by S-type (119; 29.8%) and X-type (89; 22.3%), with O-type contacts being the least common (7; 1.7%) (Table 1).

Considering arch-wise variation, a total of 212 (53.1%) contacts were observed in the maxillary arch and 187 (46.9%) in the mandibular arch. Notably, O-type (maxilla: 2.4%; mandible: 1.0%) and S-type (maxilla: 35.4%; mandible: 23.6%) contacts were more prevalent in the maxilla compared to the mandible. Conversely, X-type (maxilla: 20.2%; mandible: 24.6%) and I-type (maxilla: 41.9%; mandible: 50.8%) contacts were more prevalent in the mandible.

There was a statistically significant difference in the distribution of contact types between the arches (χ² = 8.12; P=0.04*) (Table 1).

Among the 5–8-year age groups evaluated in the study, participants were further stratified into deciduous and mixed dentition stages. In the primary dentition group, O-type and S-type contacts showed a higher prevalence at 6 years compared to 5 years. Conversely, X-type and

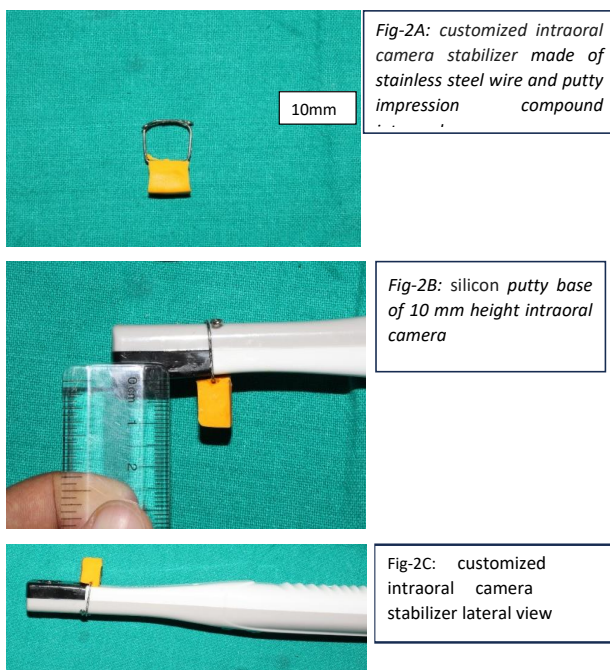


Figure 2. Standardized intraoral imaging of contact areas

I-type contacts were more prevalent at 5 years. In mixed dentition, O-type and X-type contacts showed higher prevalence at 7 years, whereas I-type contacts were higher at 8 years, and S-type contacts were equally distributed between both age groups (Table 2).

Discussion

Interproximal contact areas in dentition are significant for maintaining tooth stability and promoting gingival and periodontal health(7,8). They direct food away from the gingiva, aiding in the prevention of periodontal diseases and proximal caries. Early literature states that “deciduous teeth have broad, flattened interproximal contacts, unlike permanent teeth, which have contact points”(9,10).

Various classification systems have been proposed for interproximal contacts in deciduous teeth. Warren et al. (2003) classified interdental areas in primary teeth into four categories based on the amount of space: (a) space greater than 1 mm; (b) space less than 1 mm; (c) no space with teeth in contact; and (d) no space with overlapping teeth(11). Allison et al. (2003) proposed four patterns—convex-convex, convex-concave, concave-convex, and concave-concave—based on the morphology of the distal surfaces of the first primary molars and the mesial surfaces of the second primary molars(12). Kirthiga et al. (2018) introduced a novel classification system based on contact shape (O-type, X-type, I-type, and S-type), considering these contacts as potential indicators of caries risk. They observed that contact areas are primarily located at the occlusal level and that simple clinical examination is adequate(4).

Methods for evaluating interproximal contact areas between primary molars include clinical examination using floss, fabrication of study models, and cone-beam computed tomography (CBCT), each with its own

advantages and limitations. Muthu MS et al. (2021) reported almost perfect agreement between clinical photographs and CBCT(13). Chiu ST et al. (2023) suggested that intraoral cameras can assist in clinical examination and diagnosis(13). Accordingly, the present study utilized an intraoral camera to obtain clinical photographs for evaluating OXIS contact areas.

In the present study, the age distribution ranged from 5 to 8 years, with a mean age of 6.5 ± 0.98 years. While most previous studies focused on children aged 2–6 years, some included participants up to 10 years, which aligns with the current research(1–12). A total of 624 contact areas were examined, of which 399 were included in the study.

The prevalence of O, X, I, and S contacts was 1.7%, 22.3%, 46.1%, and 29.8%, respectively. I-type contacts were the most prevalent ($n=184$, 46.1%), with a higher prevalence in the mandible. S-type ($n=119$, 29.8%) and X-type ($n=89$, 22.3%) contacts were nearly equally distributed between the maxilla and mandible. This differs from findings by Muthu et al. (2020) and Kirthiga et al. (2018), who reported a higher prevalence of X-type contacts compared to S-type contacts. Open-type contacts had a lower prevalence (1.7%), with a higher distribution in the maxilla (2.4%) compared to the mandible (1.0%), consistent with findings by Muthu MS et al.(1), Walia T et al.(2), and Kirthiga et al.(4).

The discrepancy in the distribution of contact types (particularly S-type versus X-type) may be attributed to variations in the ethnicity of the study population(1,4). Walia et al. (2022) observed contrasting prevalence patterns in two distinct populations. Samples from Ajman, UAE, exhibited a higher prevalence of X-type contacts (22.5%) compared to S-type contacts (5.5%), whereas samples from Pondicherry, India, showed the opposite trend (1.5% X-type and 17% S-type). These findings highlight the potential influence of ethnicity on the distribution of contact types(2).

The age-wise distribution of contact areas in this study showed the highest prevalence of O-type contacts (4.42%) in the 6-year age group, followed by the 7-year age group (1.42%). No O-type contacts were observed in the 5-year and 8-year age groups. Conversely, the 6-year age group demonstrated the lowest prevalence of X-type (17.7%) and I-type contacts (37.17%) compared to other age groups, followed by the 7-year age group. A trend of decreasing O-type contacts and increasing I-type and X-type contacts was observed between 6 and 7 years, which may be attributed to the eruption of the first permanent molars.

Subramaniam et al. (2012) identified an inverse relationship between dental caries and interdental spacing in primary dentition, supporting the notion that the absence of interdental spaces increases caries risk(14). Allison and Schwartz (2003) reported that “in the posterior primary dentition of children at high risk for caries, interproximal sites with closed contact points are at greater risk for caries than those with open contact points”(12). Muthu MS et al. (2023) studied 3812 contacts

Table 1. Prevalence of OXIS Contacts by Gender and Arch

Gender	Male 193 (48.3%)				Female 206 (51.7%)				overall Total	overall%
	Maxilla	Mandible	Total	%	Maxilla	Mandible	Total	%		
Type of contacts	99	94			113	93			399	
O	5	2	7	3.6	0	0	0	0.0	7	1.7
X	21	23	44	22.8	22	23	45	21.8	89	22.3
I	36	44	80	41.5	53	51	104	50.5	184	46.1
S	37	25	62	32.1	38	19	57	27.7	119	29.8
Arch	Maxilla 212 (53.1%)				Mandible 187 (46.9%)					

Gender vs. Arch - Fisher's test; $P=0.54$ (Non-significant as $P>0.05$)

Gender vs. Contact type - Chi-square test; $P=0.19$ (Non-significant as $P>0.05$)

Arch vs contact type- Chi-square test; $P=0.04^*$ (significant as $P<0.05$)

Table 2. Prevalence of OXIS Contacts by Age groups

Age groups (Years)	O-type	X-type	I-type	S-type
5	0%	27.54%	49.28%	23.19%
6	4.42%	17.70%	37.17%	40.71%
7	1.42%	24.11%	48.23%	26.24%
8	0%	21.05%	52.63%	26.32%

Age group vs. Contact type - Chi-square test; $*P=0.027$ (statistically significant as $P<0.05$)

in 953 schoolchildren over 12 months and demonstrated a significant association between contact type and caries prevalence ($P<0.05$). The risk ratios for approximal caries were 2.4 (0.3–17.2; $P=0.38$) for X-type, 4.9 (1.2–19.9; $P=0.027$) for I-type, and 8.2 (1.9–34.2; $P=0.004$) for S-type contacts compared with O-type contacts(14,15). O-type contacts are considered more favorable in primary molars, as they are relatively caries-free due to improved salivary flow and self-cleansing ability(12,14–17).

These findings emphasize the importance of evaluating contact areas in primary dentition as indicators of caries risk. Given the high caries prevalence of 63% and reported tooth mortality of 15.2% in the South Indian population(18,19), understanding the distribution of OXIS contacts provides valuable insights for caries risk assessment and the development of preventive strategies, such as at-home fluoride varnish application, which has demonstrated high effectiveness and parental acceptance(20).

Beyond caries risk, contact type also influences cavity preparation in primary molars. X-type or O-type contacts require minimal preparation, whereas I-type or S-type contacts present greater challenges(15). Restorations should aim to re-establish the original contact type for optimal function. Future research should explore the impact of stainless-steel crowns on contact morphology in primary teeth.

This study has several strengths. It represents the first evaluation of OXIS contacts in the Bhimavaram, Andhra Pradesh population. It also utilized a simple and efficient method for obtaining intraoral clinical images using an intraoral camera. Additionally, the involvement of multiple trained and calibrated OXIS examiners enhanced

data reliability. However, the study has limitations, including its cross-sectional design, which restricts assessment to a single time point. As permanent molars erupt over time, contact patterns are likely to change. Therefore, longitudinal studies are needed to evaluate transitions from primary to mixed dentition.

Conclusion

This study observed a distinct distribution of dental contact types among 5- to 8-year-old schoolchildren in Bhimavaram, Andhra Pradesh, India. The prevalence of O, X, I, and S contacts was 1.7%, 22.3%, 46.1%, and 29.8%, respectively, with significant differences in S- and X-type contacts compared to other populations. Furthermore, a trend of decreasing O-type contacts and increasing I- and X-type contacts was observed between 6 and 7 years of age, possibly due to the eruption of the first permanent molars.

Clinical Significance

Populations at risk for caries can be identified, allowing for the customization of preventive strategies at the community level to reduce caries burden. A simple and practical tool, such as an intraoral camera, can serve as a valuable adjunct for identifying such populations during field trials.

Acknowledgments

Department of Pedodontics and Preventive Dentistry, Vishnu dental college, Bhimavaram, Andhra Pradesh, India

Authors' Contribution

Conceptualization: Zia-UI-Haque Mohamed, Ahalya Penmetsa
 Data Curation: Zia-UI-Haque Mohamed, Ahalya Penmetsa, Cheeli Spandana, Ravigna Peddi,
 Investigation: Zia-UI-Haque Mohamed, Ahalya Penmetsa, Cheeli Spandana
 Formal Analysis: Zia-UI-Haque Mohamed, Ahalya Penmetsa, Cheeli Spandana, Ravigna Peddi
 Methodology: Zia-UI-Haque Mohamed, Ahalya Penmetsa
 Project Administration: Zia-UI-Haque Mohamed, Ahalya Penmetsa
 Supervision: Ahalya Penmetsa, Ravigna Peddi
 Software: Zia-UI-Haque Mohamed
 Resource: Zia-UI-Haque Mohamed, Ahalya Penmetsa, Cheeli Spandana, Ravigna Peddi, Phanikumar MS, Akula Srilakshmi
 Validation: Ahalya Penmetsa, Cheeli Spandana, Ravigna Peddi,

Phanikumar MS, Akula Srilakshmi

Visualization: Zia-UI-Haque Mohamed, Ahalya Penmetsa, Cheeli Spandana, Ravigna Peddi, Phanikumar MS, Akula Srilakshmi

Writing- Original Draft: Zia-UI-Haque Mohamed, Ahalya Penmetsa, Cheeli Spandana,

Writing- Review & Editing: Zia-UI-Haque Mohamed, Ahalya Penmetsa

Competing Interests

The authors declare no competing interests.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Approval

This study was approved by the Institutional Ethics Committee "INSTITUTIONAL ETHICS COMMITTEE, VISHNU DENTAL COLLEGE, BHIMAVARAM", with approval number IECVDC/24/PG01/PPD/IVV/50. Written informed consent was obtained from all participants (or their guardians, where applicable).

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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