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Prosthetic appliance use in the patients with premature shedding of deciduous teeth and its impact on orthodontic treatment: A retrospective study

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Abstract: Premature loss of deciduous teeth is a prevalent concern in pediatric dentistry and can disrupt normal occlusal development, often increasing the need for complex orthodontic and prosthodontic interventions. This retrospective observational study assessed the association between early primary tooth loss, malocclusion patterns, and subsequent treatment requirements among children attending dental clinics in Riyadh, Saudi Arabia. Records of 467 patients aged 6–18 years were analyzed. Early loss of deciduous teeth was observed in 39% of patients, most commonly due to dental caries and frequently involving primary molars. Children with premature tooth loss exhibited significantly higher rates of crowding, midline deviation, crossbite, and altered overjet or overbite. These occlusal disturbances often necessitated space management using fixed or removable space maintainers, pediatric partial dentures, or functional appliances to preserve arch length and guide the eruption of permanent successors. Patients with early tooth loss demonstrated a greater need for orthodontic treatment, increased treatment complexity, and prolonged treatment duration. Multivariable analyses identified early deciduous tooth loss as an independent predictor of severe treatment complexity, while timely space maintenance and prosthodontic rehabilitation showed a mitigating effect. These findings emphasize the importance of preserving primary teeth and integrating preventive, orthodontic, and prosthodontic strategies to optimize occlusal development and reduce long-term treatment burden in children.

Keywords: *Deciduous teeth, Orthodontic treatment, Premature shedding, Prosthetic appliance.*

1. Introduction

The premature loss of deciduous teeth is a significant concern in pediatric dentistry, frequently contributing to the development of malocclusion and increasing the complexity and duration of subsequent orthodontic and adjunctive prosthodontic interventions [1]. The integrity of primary teeth is crucial for the normal development of occlusal relationships and overall dentofacial structures, making their preservation until natural exfoliation a primary goal in pediatric dentistry and pediatric prosthodontic care [2]. When deciduous teeth are lost prematurely, the adjacent and opposing teeth can drift, leading to space loss, crowding, and various other forms of malocclusion that necessitate complex orthodontic treatments often supported by prosthodontic space replacement or maintenance strategies [1]. This phenomenon is particularly pronounced when primary molars are lost prematurely, often due to caries or failed pulp therapy, potentially leading to migration of adjacent teeth and impaction of

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permanent successors with functional and aesthetic consequences requiring interim prosthetic management [3]. Such early loss can have detrimental effects on occlusion, often necessitating space maintainers or removable prosthodontic appliances to mitigate problems like crowding [4].

Acquired etiologies, such as caries and early primary tooth loss, are prevalent issues that often necessitate interceptive orthodontic treatment in children alongside prosthodontic space management approaches [5]. The timing and type of deciduous tooth loss, particularly first molars, have been shown to influence space loss, with some studies indicating significant mesial drift of maxillary deciduous second molars [4]. This highlights the critical need for a deeper understanding of the precise impact of early deciduous tooth loss on the subsequent orthodontic needs of children and the role of prosthodontic intervention in maintaining arch integrity during growth. This retrospective study aims to quantify these impacts within the Riyadh population, offering insights into local prevalence rates and associated clinical sequelae. Specifically, this research will delve into the relationships between premature primary tooth loss and outcomes such as midline deviation and asymmetric molar relationships, which have been observed in other populations [1]. Moreover, it will assess how these early dental issues affect the subsequent need for, timing of, and complexity of orthodontic interventions and supportive prosthodontic rehabilitation [6]. Understanding these correlations is vital for developing effective preventive strategies and optimizing treatment protocols to minimize the long-term impact on oral health and reduce the burden of extensive orthodontic care and prosthodontic replacement therapy [7]. Furthermore, this study will investigate the influence of parental factors and socioeconomic status on the prevalence of early deciduous tooth loss and its subsequent impact on orthodontic treatment outcomes [8]. This comprehensive approach will provide a holistic view of the contributing factors and consequences, enabling the formulation of targeted public health strategies and clinical guidelines to improve pediatric oral health outcomes in Riyadh. The subsequent sections will elaborate on the methodological framework, delineate the data collection and analytical procedures, and present the findings to address the study's stated aims and objectives, including the prevalence of early deciduous tooth loss and its association with specific malocclusions.

The mixed dentition stage is particularly susceptible to disruptions from premature primary tooth loss, which can significantly alter arch length and permanent tooth positioning [9]. The early extraction of primary molars, for instance, can result in mesial migration of the permanent first molar, subsequently reducing space for erupting premolars and canines [10]. Premature loss of primary anterior teeth, although often debated, can also lead to issues such as impaction or eruption disturbances of permanent successors, inclination of adjacent teeth, and midline deviations [11]. The absence of primary teeth can also lead to infraocclusion, potentially affecting the eruption path and position of succeeding permanent teeth [7]. This intricate interplay underscores the importance of an interdisciplinary team approach to assess and address dental issues arising from premature deciduous tooth loss, integrating orthodontic, preventive, and prosthodontic interventions such as space maintainers or pediatric removable prostheses, tailored to the severity and specific needs of each patient [7]. Such interdisciplinary approaches are crucial given that the etiology of malocclusion often involves complex interactions between skeletal, dental, and soft tissue development [5]. Furthermore, the early identification of risk factors, such as dental caries, which frequently leads to premature primary tooth loss, is critical for implementing preventive measures and targeted interventions [12]. Proximal cavities and the absence of primary molars due to caries can significantly reduce space in the dental arches, directly impacting the alignment of erupting permanent teeth [13]. The prevalence of malocclusions in the primary dentition, including open bite, crossbite, and infraocclusion, highlights the necessity for early assessment and prosthetic intervention aimed at space preservation and functional rehabilitation to mitigate future orthodontic complications [14].

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2. Materials and Methods

2.1. Study Design and Setting

This retrospective observational study was conducted using dental and orthodontic records retrieved from multiple public and private dental clinics in Riyadh, Saudi Arabia. Records covering a 5–10 year period were screened and included if they met the study criteria. The study was approved by the institutional review board, and all data were anonymized before analysis.

2.2. Study Population and Eligibility Criteria

Records were eligible for inclusion if the patient was between 6 and 18 years of age at the time of documentation and had complete dental and orthodontic information available. Patients were included irrespective of nationality or sex. Records were excluded if the patient had syndromic conditions, systemic diseases known to influence tooth eruption, a history of craniofacial trauma or surgery, or incomplete documentation of dental history, occlusal findings, or orthodontic treatment.
A total of 467 patient records met the inclusion criteria and were included in the final analysis.

2.3. Exposure Definition: Early Shedding of Deciduous Teeth

Early exfoliation was defined as the loss or extraction of a primary tooth earlier than the accepted chronological exfoliation age for that tooth, based on standard eruption charts. The causes of early loss (caries, extraction, trauma, or natural/accelerated exfoliation) and the type of primary tooth lost (molars, incisors, canines, or multiple teeth) were recorded. When applicable, the use of a space maintainer and the time interval between early loss and the eruption of the permanent successor were documented.

2.4. Outcome Measures

2.4.1. Malocclusion Assessment

Occlusal findings were recorded from clinical notes, photographs, study models, and radiographs. The following parameters were evaluated as binary variables (present/absent), as shown in Figure 1.

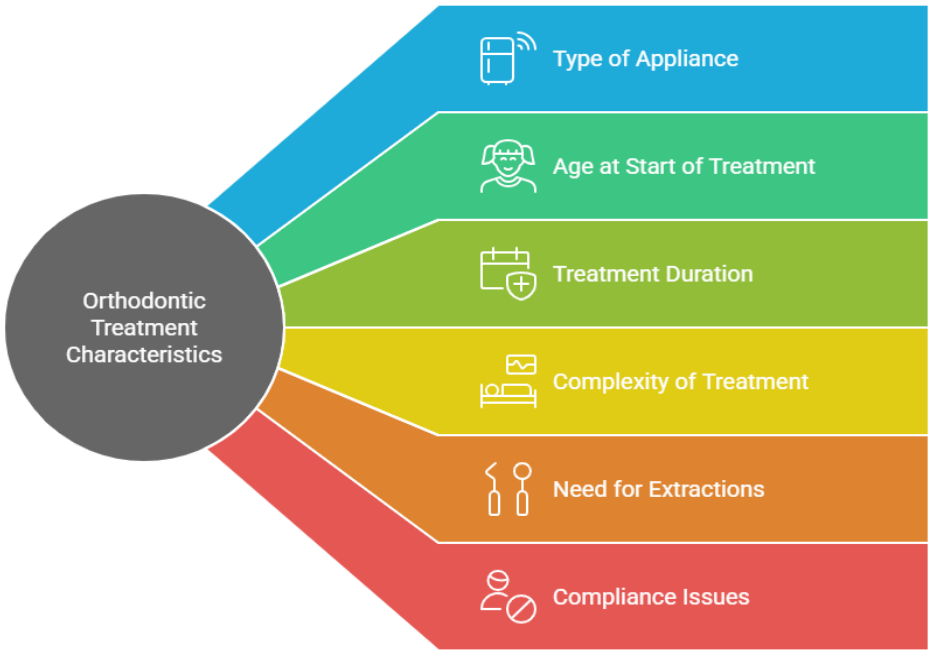

Figure 1.
Orthodontic treatment variables.

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Complexity was recorded as documented in clinical charts and verified against criteria consistent with the Index of Complexity, Outcome, and Need (ICON).

2.5. Data Collection Procedures

A standardized data extraction sheet was used to ensure consistency across clinics. Two calibrated examiners reviewed all records, and discrepancies were resolved by consensus. Missing data were assessed, and where necessary, multiple imputation techniques were used; sensitivity analyses confirmed the robustness of findings.

2.6. Sample Size Considerations

Although this was a retrospective study, a minimum sample of 200 records was targeted to ensure adequate statistical power. The final dataset of 467 records exceeded this requirement and provided sufficient cases for subgroup and multivariable analyses.

2.7. Statistical Analysis

Descriptive statistics (means, standard deviations, frequencies, and percentages) were computed for demographic and clinical variables. Differences between patients with and without early deciduous tooth loss were assessed using chi-square tests for categorical variables and t-tests for continuous variables.

2.8. Two Multivariable Models Were Performed

Logistic regression was used to evaluate predictors of severe orthodontic complexity, adjusting for age, sex, cause of early loss, and use of space maintainers. Linear regression assessed the independent effect of early loss on treatment duration, controlling for the same covariates. Statistical significance was defined as $p < 0.05$. All analyses were performed using standard statistical software.

3. Result

A total of 467 patient records met the inclusion criteria. The mean age of the sample was 9.8 ± 2.7 years (range: 5–18 years), and 51.8% were male. Early premature shedding of deciduous teeth was documented in 182 patients (39.0%). Table 1 summarizes the demographic and clinical characteristics of the study population.

Table 1.
Demographic and Clinical Characteristics of the Study Population (N = 467).

Variable	Total (N=467)	Early Loss (n=182)	No Early Loss (n=285)	p-value
Age (years), mean ± SD	9.8 ± 2.7	9.6 ± 2.5	9.9 ± 2.8	0.18
Male sex, n (%) Female sex,	242 (51.8%) (48.2%)	98 (53.8%)	144 (50.5%)	0.48
Nationality, n (%)				0.31
– Saudi	336 (72.0%)	128 (70.3%)	208 (73.0%)	
– Other	131 (28.0%)	54 (29.7%)	77 (27.0%)	
Cause of early loss, n (%)	—		—	—
– Caries	—	113 (62.1%)	—	—
– Traumatic	—	22 (12.1%)	—	—
– Therapeutic extraction	—	33 (18.1%)	—	—
– Natural/accelerated	—	14 (7.7%)	—	—
Type of teeth lost early, n (%)	—		—	—
– Molars	—	100 (55.0%)	—	—
– Incisors	—	45 (25.0%)	—	—
– Canines	—	18 (10.0%)	—	—
– Multiple	—	19 (10.0%)	—	—
Space maintainer used, n (%)	65 (13.9%)	51 (28.0%)	14 (4.9%)	<0.001
Time to permanent successor (months)	13.8 ± 6.4	14.6 ± 5.9	—	—

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3.1. Malocclusion Patterns

Children with early premature shedding exhibited a significantly higher prevalence of several malocclusion traits compared with those without early loss. Crowding, midline deviation, and crossbite were especially common among the early-loss group. These differences are summarized in Table 2.

Table 2.
Prevalence of Malocclusion Features by Early Loss Status.

Malocclusion Feature	Early Loss (n=182)	No Early Loss (n=285)	χ^2 (df=1)	p-value
Crowding	109 (59.9%)	97 (34.0%)	31.2	<0.001
Spacing	61 (33.5%)	80 (28.1%)	1.52	0.22
Midline Shift	66 (36.3%)	36 (12.6%)	38.9	<0.001
Crossbite	34 (18.7%)	22 (7.7%)	12.3	<0.001
Overjet/Overbite Issues	59 (32.4%)	62 (21.8%)	6.02	0.014

3.2. Orthodontic Treatment Characteristics

A significantly greater proportion of children with early tooth loss required orthodontic treatment (78.0%) compared with those without early loss (40.7%; $p < 0.001$). Furthermore, early loss was associated with more severe treatment needs and longer treatment durations. Table 3 summarizes these findings.

Table 3.
Orthodontic Treatment Characteristics by Early Loss Status.

Variable	Early Loss (n=182)	No Early Loss (n=285)	Test	p-value
Required orthodontic treatment	142 (78.0%)	116 (40.7%)	$\chi^2(1)=72.4$	<0.001
Treatment complexity			$\chi^2(2)=20.1$	<0.001
– Mild	42 (29.6%)	56 (48.3%)		
– Moderate	66 (46.5%)	50 (43.1%)		
– Severe	34 (23.9%)	10 (8.6%)		
Treatment duration (months), mean ± SD	28.4 ± 9.6	21.3 ± 7.8	$t(256)=7.16$	<0.001
Appliance type			$\chi^2=8.4$	0.015
– Fixed	98 (69.0%)	70 (60.3%)		
– Removable	34 (24.0%)	38 (32.8%)		
– Interceptive/Functional	10 (7.0%)	8 (6.9%)		
Extraction required	41 (28.9%)	23 (19.8%)	$\chi^2=3.7$	0.054
Compliance issues	38 (26.8%)	22 (19.0%)	$\chi^2=2.74$	0.098

3.3. Multivariable Regression Analysis

Two regression models were used to evaluate the independent effects of early primary tooth loss.

3.4. Severe Orthodontic Complexity (Logistic Regression)

Early loss remained a significant predictor of severe treatment complexity after adjustment for sex, age, cause of tooth loss, and space-maintainer use (Table 4).

Table 4.
Multivariable Logistic Regression Predicting Severe Orthodontic Complexity Predictor.

Predictor	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Early loss (Yes vs No)	2.62	1.61 – 4.24	<0.001
Age (per year)	1.05	0.97 – 1.14	0.22
Sex (Male)	0.97	0.62 – 1.52	0.88
Space maintainer used	0.60	0.37 – 0.97	0.036
Cause = Caries	1.38	0.92 – 2.08	0.11

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3.5. Treatment Duration (Linear Regression)

Early tooth loss was independently associated with longer orthodontic treatment duration (Table 5).

Table 5.
Linear Regression Predicting Orthodontic Treatment Duration.

Predictor	β Coefficient (Months)	95% CI	p-value
Early loss (Yes vs No)	+6.1	4.2 – 8.0	<0.001
Age (per year)	+0.6	0.1 – 1.1	0.02
Sex (Male)	–0.3	–1.5 – 0.9	0.61
Space maintainer used	–2.8	–4.9 – –0.7	0.009
Cause = Caries	+1.7	0.1 – 3.3	0.036
Model R^2	0.29	—	—

4. Discussion

The present study rigorously investigated the profound implications of early deciduous tooth loss on subsequent malocclusion development and the trajectory of orthodontic treatment within a specific demographic in Riyadh, offering a comprehensive understanding of this critical pediatric dental issue. Our findings corroborate previous research indicating a significant correlation between premature primary tooth exfoliation and an increased incidence of various malocclusions, emphasizing the importance of timely intervention [15, 16]. Specifically, the elevated prevalence of crowding, midline deviations, and crossbites observed in our cohort underscores the disruptive effect of early deciduous tooth loss on normal occlusal development, necessitating proactive management strategies [17]. This aligns with the expert consensus emphasizing early orthodontic treatment for malocclusions in childhood due to its significant practical and social importance [18]. Furthermore, the need for, and complexity of, orthodontic intervention, as well as treatment duration, were significantly higher in patients who experienced early primary tooth loss, which aligns with findings from other retrospective analyses [19]. The increased requirement for orthodontic intervention in these cases highlights the importance of effective space management, such as the strategic placement of space maintainers, to mitigate subsequent dental complications [20].

Our multivariate analysis further reinforced that early loss of primary teeth serves as a potent independent predictor for both increased orthodontic treatment complexity and extended treatment duration [21]. This suggests that the consequences of premature primary tooth loss extend beyond immediate space loss, influencing the overall physiological and biomechanical environment of the developing dentition. This complex interplay often results in greater demand for advanced orthodontic techniques and a prolonged period of active treatment.

Such findings underscore the critical importance of early interceptive orthodontic measures, initiated during the deciduous or early mixed dentition phases, to mitigate the severity of malocclusion and potentially reduce the need for extensive future interventions [18, 22]. These interventions, which may include space maintainers or other early orthodontic therapies, can substantially decrease the incidence and severity of malocclusion, thereby enhancing overall oral health and potentially reducing the economic and social burden associated with more complex and prolonged treatments [18]. The efficacy of early orthodontic intervention for malocclusion is well-documented, with studies demonstrating its effectiveness in achieving harmonious and aesthetically pleasing dental-maxillofacial structures [18]. Beyond structural improvements, early treatment offers additional benefits, such as improved patient compliance and enhanced stability of long-term outcomes [23].

5. Conclusion

The findings emphasize that preventing premature deciduous tooth loss, particularly through effective caries management and oral health promotion, can significantly contribute to better long-term orthodontic outcomes and overall oral health in children. Therefore, targeted public health campaigns

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aimed at educating parents and caregivers about the importance of primary tooth retention and early dental care are crucial for reducing the prevalence of early deciduous tooth loss and its associated orthodontic sequelae.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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