Original Article

The second molar dilemma in orthodontics: to bond or not to bond?

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ABSTRACT

Objectives: To compare orthodontic treatment (OT) outcome in adolescents undergoing nonextraction fixed OT with or without bonding of second molars using the score of the American Board of Orthodontics Cast Radiograph Evaluation (C-R-Eval).

Materials and Methods: This study included healthy adolescents with skeletal Class I or mild Class II/Class III malocclusion, normal or deep overbite (OB), and mild-to-moderate dental crowding (<5 mm) who underwent nonextraction fixed OT with ("bonded" group) or without ("not-bonded" group) bonding of second molars. Patient treatment records, pre- and posttreatment digital models, lateral cephalograms, and orthopantomograms were assessed. The evaluated outcomes included leveling of the curve of Spee (COS), OB, control of incisor mandibular plane angle (IMPA), number of emergency visits (related to poking wires and/or bracket failure of the terminal molar tubes), treatment duration, and C-R-Eval. Treatment variables were compared across time points and among groups.

Results: The sample included 30 patients (mean age 16.07 $\pm$ 1.80 years) in the bonded group and 32 patients (mean age 15.69 $\pm$ 1.86 years) in the not-bonded group. The mean overall C-R-Eval score was significantly higher ($P < .001$) in the not-bonded group (25.25 $\pm$ 3.98) than in the bonded group (17.70 $\pm$ 2.97). There were no significant differences in mean changes of COS, OB, IMPA, or treatment duration among groups. The mean number of emergency visits was significantly higher in the bonded (3.3 $\pm$ 0.6) than the not-bonded group (1.9 $\pm$ 0.4) ($P < .001$).

Conclusions: Bonding of second molars enhances the outcome of nonextraction fixed OT as demonstrated by the C-R-Eval without increasing treatment duration, irrespective of more emergency visits. (*Angle Orthod*. 2024;94:320–327.)

KEY WORDS: Bonding of second molars; Cast-radiograph evaluation; Fixed orthodontic treatment; Treatment duration; Treatment outcomes

INTRODUCTION

Treatment effectiveness in clinical orthodontics involves the achievement of treatment goals while taking into consideration time efficiency, patient comfort, preferences, and satisfaction.[1–3] The outcome of orthodontic treatment (OT) can be influenced by patient-related factors, including compliance with appointments, appliances, and oral hygiene instructions, as well as case-related factors, such as the type and severity of malocclusion.[1–5]

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Various doctor-related factors, including the treatment approach, appliance selection, and decisions made during treatment, may also influence the OT results obtained.[1–5] Other treatment factors potentially influencing the effectiveness of OT include the bracket slot size, mechanics used in space closure (sliding vs segmental), type of ligation (self-ligation vs conventional), and wire sequence and type.[1,6] Nonetheless, treatment decisions in orthodontics are often influenced by doctor preferences and anecdotal beliefs.[7]

The American Board of Orthodontics (ABO) standards for fixed OT entail bonding both arches from second molar to second molar except for third molars, unless they substitute for missing second molars.[8] However, due to various reasons and constraints, many practitioners tend to skip the second molars when bonding fixed appliances. Al-Jewair et al.[9] argued that second molars are occasionally not bonded during fixed OT because some patients begin OT before the eruption of the second molars, and hence, extending treatment time until they do is not always reasonable. Other reported reasons include occlusal interferences, difficult access to the buccal surfaces of second molars that are commonly attributed to limited mouth opening and the interference of flaccid buccal tissues, and the increased risk of bond failure due to inadequate moisture control.[10,11] Although there is shared anecdotal evidence claiming that bonding of second molars improves the outcome of fixed OT, there is a scarcity of scientific evidence supporting this claim.

This retrospective study aimed to compare the outcome in adolescents undergoing conventional nonextraction fixed OT with or without bonding permanent second molars using the score of the ABO Cast Radiograph Evaluation (C-R-Eval).[12] Other treatment parameters assessed included leveling of the curve of Spee (COS), overbite (OB) reduction, control of the incisor mandibular plane angle (IMPA), number of emergency visits, and treatment duration.

MATERIALS AND METHODS

This retrospective study received Institutional Review Board exemption (STUDY00007663) at the Eastman Institute for Oral Health, University of Rochester, New York.

The sample consisted of patients who started and completed comprehensive fixed OT at the Department of Orthodontics, Eastman Institute for Oral Health, University of Rochester, New York, between January 1, 2017, and January 1, 2023. All patients were treated by assigned orthodontic residents under the supervision of two ABO-certified full-time orthodontic faculty (Dr Rossouw and Dr Michelogiannakis). The following inclusion criteria were applied: (1) healthy adolescents (12–18 years), (2) second molars partially or fully erupted at the start of OT, (3) treated with conventional bracket appliances (0.022-inch slot, Roth prescription), (4) skeletal Class I or mild Class II/Class III ($-2° <$ ANB angle $< 5°$), (5) normal or deep pretreatment OB, (6) mild-to-moderate pretreatment dental crowding (<5 mm), (7) no extractions or orthognathic surgery, and (8) no history of previous comprehensive OT. Patients with systemic diseases and/or craniofacial syndromes, with severe skeletal Class III (ANB $< -2°$) or Class II malocclusion (ANB $>5°$), anterior open bite, impacted/missing teeth, unerupted second molars, and/or with severe crowding requiring OT with extractions and/or orthognathic surgery were excluded. Fixed OT included the use of conventional archwires, bite turbos, and intermaxillary elastics; wire selection/sequence and treatment mechanics were customized based on individual patient needs. The supervising faculty (Dr Rossouw and Dr Michelogiannakis) provided debonding approval prior to the completion of fixed OT (removal of orthodontic appliances); patients who terminated OT early due to lack of compliance were excluded.

Eligible patients possessing pre- (T1) and posttreatment (T2) records of sufficient quality, including diagnostic three-dimensional (3D) digital models, orthopantomograms, and lateral cephalograms, were assigned to one of two groups:

- "Bonded" group: Patients who received comprehensive full-arch fixed OT including bonding of maxillary and mandibular permanent second molars during the first 2 months of OT
- "Not-bonded" group: Similar to bonded group, except that permanent second molars were not bonded during fixed OT

All measurements were conducted by one examiner (Dr Alshuraim) who was precalibrated and blinded to group allocation. The same examiner (Dr Alshuraim) remeasured records from 10 randomly selected patients to assess intraobserver reliability. A second calibrated examiner (Dr Burns) measured records from 10 randomly selected patients to assess interobserver reliability. The outcome variables (Appendix 1) were measured using the following diagnostic records:

- 3D digital models: The COS and OB were measured at T1 and T2 using digital diagnostic models generated through iTero scanners (Align Technology, San Jose, Calif) and analyzed through integrated OrthoCAD software using digital calipers. Several studies have validated the accuracy of digital measurements, and the margin of error was found to be clinically insignificant.[13,14] The C-R-Eval overall score and scores per

Table 1. Baseline Demographic Characteristics between Study Groups[a]

	Bonded Group (n = 30)		Not-Bonded Group (n = 32)			
Variable	N	%	N	%	Statistical Test	*P* Value
Gender						
Male	11	36.7	14	43.8	$\chi^2 = 0.323$	.570
Female	19	63.3	18	56.3		
Race						
Asian	2	6.7	2	6.23	$\chi^2 = 0.926$	MC 0.968
Black	6	20.0	7	21.9		
Caucasian	12	40	15	46.87		
Hispanic	10	33.3	8	25.0		
Age, y	Mean ± SD, Median	Range	Mean ± SD, Median	Range	$t = 0.816$	.418
	16.07 ± 1.80, 16.0	12.0–18.0	15.69 ± 1.86, 16.0	12.0–18.0		

[a] Bonded group indicates bonding of second molars; not-bonded group, not bonding of second molars; N, number; SD, standard deviation; *P*, statistical comparison between study groups, statistical significance when $P < .05$; χ^2: chi-square test; MC, Monte Carlo test; *t*, Student *t*-test.

each individual category were measured at T2 using 3D-printed diagnostic models and orthopantomograms in correspondence with the ABO measurement criteria.

- Lateral cephalograms: Digital lateral cephalograms stored in Dolphin Imaging software (version 11.5, Dolphin Imaging & Management Solutions, Chatsworth, Calif) were digitally traced to measure IMPA at T1 and T2.
- Orthopantomograms: Posttreatment digital orthopantomograms were analyzed in Dolphin to evaluate root parallelism.
- Patient charts: Using Axium dental software (Henry Schein, Inc., Melville, NY), patient charts were reviewed to identify treatment duration and number of emergency visits during treatment. The emergency visits recorded in the present study were related to either poking wires and/or bracket failure of the terminal molar tubes.

Statistical Analysis

A sample size of 30 patients per group was found to achieve 93.07% power to detect a 75% change in COS with a significance level set at $\alpha = .05$. The analysis was based on a power curve for two-sample *t*-test based on findings from a previous study.[11] Intra- and interobserver reliabilities were measured using the concordance correlation coefficient (CCC).[15] The mean, standard deviation (SD), standard error (SE), median, and range were used for description of numerical data. Frequency and percentage were used for description of nonnumerical data. The normality distribution of the data was examined using the Kolmogorov-Smirnov and Shapiro-Wilk tests.

Independent and paired-sample *t*-tests were used to compare normally distributed study variables between groups and across time points, respectively. The Mann-Whitney and Wilcoxon tests were used to compare nonparametric variables among groups and study time points, respectively. The chi-square test was used to examine the relationship between two qualitative variables, and the Monte Carlo test was used to examine the relationship between two qualitative variables when the expected count was less than 5 in more than 20% of cells. Linear regression analyses were performed to evaluate the influence of second molar bonding on the main study outcomes while adjusting for covariates such age, gender, and race. IBM SPSS Statistics for Windows, version 25.0 (2017, IBM Corp, Armonk, NY) was used. A *P* value was considered significant if $< .05$.

RESULTS

The CCC for all study measurements was high (CCC > 0.96; $P < .000$). For data that were not normally distributed, nonparametric tests were used accordingly.

Characteristics of the Study Sample

Thirty patients (19 females, 11 males) with a mean age of 16.07 ± 1.80 years were included in the bonded group. The racial distribution in the bonded group was 40% Caucasian, 20% African American, 33.3% Hispanic, and 6.7% Asian. The not-bonded group included 32 patients (18 females, 14 males) with a mean age of 15.69 ± 1.86 years. The racial distribution in the not-bonded group was 46.87% Caucasian, 21.9% African American, 25% Hispanic, and 6.23% Asian. There were no significant demographic differences between groups (Table 1).

Most patients had skeletal/dental Class I or Class II malocclusion as well as mild maxillary and mandibular dental crowding. There were no significant differences in the distribution of skeletal/dental malocclusion or in the mean amounts of dental crowding among study groups (Table 2).

Comparison of the Main Treatment Variables/ Outcomes Across Time Points and Among Groups

Table 3 summarizes the descriptive values of COS, OB, and IMPA at T1 and T2 for both groups. In the bonded

Table 2. Baseline Malocclusion-Related Characteristics Between Study Groups[a]

	Bonded Group (n = 30)		Not-Bonded Group (n = 32)			
Variable	N	%	N	%	Statistical Test	*P* Value
Skeletal malocclusion						
Class I	15	50.0	20	62.5	$\chi^2 = 1.639$	MC 0.391
Class II	12	40.0	11	34.4		
Class III	3	10.0	1	3.1		
Dental malocclusion						
Class I	9	30.0	17	56.7	$\chi^2 = 4.288$	MC 0.144
Class II	16	53.3	10	33.3		
Class III	5	16.7	3	10.0		
Anterior crowding	Mean ± SE, Median	Range	Mean ± SE, Median,	Range	Statistical Test	*P* Value
Maxillary, mm	2.2 ± 0.1, 2.0	0.0–5.0	2.6 ± 0.2, 2.0	0.0–5.0	*U* = 106.5	.14
Mandibular, mm	2.8 ± 0.1, 3.0	0.0–5.0	3.2 ± 0.2, 3.0	0.0–5.0	*U* = 114.0	.11

[a] Bonded group indictes bonding of second molars; not-bonded group, not bonding of second molars; SE, standard error; *U*, Mann-Whitney *U* test; χ^2: chi-square test; MC: Monte Carlo test; *P*, statistical comparison between study groups, statistical significance when $P < .05$.

group, there was a significant decrease ($P = .004$) in the mean (±SE) COS between T1 and T2 (from 2.49 ± 0.26 mm to 1.72 ± 0.15 mm). In the not-bonded group, there was a significant decrease ($P = .008$) in the mean (±SE) COS between T1 and T2 (from 2.54 ± 0.26 mm to 1.96 ± 0.15 mm). There were no significant differences in the mean COS between groups at T1 and T2. In the bonded and not-bonded groups, there was a significant decrease in mean OB ($P < .001$ and $P = .003$, respectively), and the mean OB did not differ significantly between groups at T1 and T2. In the bonded group, there was a nonsignificant increase in the mean

Table 3. Comparison of the Curve of Spee (COS), Overbite (OB), and Lower Incisor Mandibular Plane Angle (IMPA) Across Time Points and Between Study Groups[a]

Variable		Bonded Group (n = 30)	Not-Bonded Group (n = 32)	Statistical Test	*P* Value
COS, mm					
T1	Mean ± SE	2.49 ± 0.26	2.54 ± 0.26	*U* = 468.0	.865
	Median	2.30	2.25		
	Range	0.10 – 6.10	0.50–7.00		
T2	Mean ± SE	1.72 ± 0.15	1.96 ± 0.15	*U* = 584.0	.141
	Median	1.85	2.00		
	Range	0.00–5.00	0.20–3.70		
Wilcoxon test		2.902	2.655		
P1		.004	.008		
OB, mm					
T1	Mean ± SE	3.21 ± 0.34	2.86 ± 0.25	*U* = 431.5	.494
	Median	3.50	3.05		
	Range	0.30–8.60	0.30–6.90		
T2	Mean ± SE	1.99 ± 0.19	2.08 ± 0.16	*U* = 535.5	.434
	Median	2.00	2.05		
	Range	0.50–5.10	0.20–3.50		
Wilcoxon test		4.260	2.938		
P1		<.001	.003		
IMPA, °					
T1	Mean ± SE	94.11 ± 5.67	92.97 ± 7.40	Student *t*-test = .673	.503
	Median	94.15	92.78		
	Range	83.00–103.10	81.20–115.6		
T2	Mean ± SE	96.61 ± 5.60	98.06 ± 8.0	Student *t*-test =.825	.413
	Median	95.70	96.75		
	Range	86.50–108.9	79.70–115.0		
Paired *t*-test		1.750	3.779		
P1		.091	.001		

[a] Bonded group indicates bonding of second molars; not-bonded group, not bonding of second molars; COS, curve of Spee; OB, overbite; IMPA, incisor mandibular plane angle; SE, standard error; *U*, Mann-Whitney *U* test; T1, before treatment; T2, after treatment; P1, statistical comparison between T1 and T2, statistical significance when *P* value < .05; *P*, statistical comparison between groups, statistical significance when $P < .05$.

Table 4. Comparison of the Main Treatment Variables/Outcomes Between Groups[a]

Variable	Bonded Group (n = 30)	Not-Bonded Group (n = 32)	Statistical Test	*P* Value
Decrease in COS, mm				
Mean ± SE	0.78 ± 0.22	0.58 ± 0.26	*U* = 361.0	.093
Median	1.0	0.35		
Range	−2.0 to 4.0	−2.40 to 5.50		
Decrease in OB, mm				
Mean ± SE	1.22 ± 0.21	0.78 ± 0.26	*U* = 378.5	.152
Median	1.0	0.50		
Range	−0.50 to 3.90	−2.00 to 4.90		
Increase in IMPA, °				
Mean ± SE	2.50 ± 1.43	5.09 ± 1.35	*U* = 597.5	.098
Median	0.85	5.30		
Range	−10.40 to 20.60	−14.00 to 18.70		
Overall orthodontic treatment outcome (ABO C-R-Eval)				
Mean ± SD	17.70 ± 2.97	25.25 ± 3.98	Student *t*-test = 8.424	<.001
Median	17.50	26.0		
Range	13.0–25.0	14.0–30.0		
Number of emergency visits				
Mean ± SE	3.3 ± 0.6	1.9 ± 0.4	Student *t*-test = 3.35	<.001
Median	2.0	1.0		
Range	0–7	0–5		
Total treatmentduration, mo				
Mean ± SE	24.83 ± 2.15	26.78 ± 1.73	*U* = 589.0	.124
Median	22.0	26.0		
Range	13.0–67.0	9.0–48.0		

[a] Bonded group indicates bonding of second molars; not-bonded group, not bonding of second molars; COS, curve of Spee; OB, overbite; IMPA, incisor mandibular plane angle; ABO C-R-Eval, American Board of Orthodontics Cast-Radiograph Evaluation; SE, standard error; SD, standard deviation; *U*, Mann-Whitney *U* test; *P*, statistical comparison among study groups, statistical significance when $P < .05$.

IMPA, and in the not-bonded group, the mean IMPA increased significantly ($P = .001$). The mean IMPA did not differ significantly among groups at T1 and T2.

Table 4 presents the comparison of the main treatment changes/outcomes among groups. The mean (±SE) decrease in the COS did not differ significantly between the bonded group (0.78 ± 0.22 mm) and the not-bonded group (0.58 ± 0.26 mm). The mean (±SE) decrease in OB did not differ significantly between the bonded group (1.22 ± 0.21 mm) and the not-bonded group (0.78 ± 0.26 mm). The increase in the mean IMPA did not differ significantly between the bonded group (2.50° ± 1.43°) and the not-bonded group (5.09° ± 1.35°). The mean (±SD) overall C-R-Eval score was significantly ($P < .001$) lower in the bonded group (17.70 ± 2.97) than in the not-bonded group (25.25 ± 3.98), indicating a superior overall OT outcome in the bonded group. The mean number of emergency visits was significantly higher ($P < .001$) in the bonded group (3.3 ± 0.6) than in the not-bonded group (1.9 ± 0.4), and there was no significant difference in mean treatment duration.

Linear Regression Analyses

Bonding of second molars was associated ($P < .001$) with a decrease in the overall C-R-Eval score. No other significant associations were identified (Table 5).

Comparison of ABO C-R-Eval Scores per Individual Categories Between Groups

The total mean (±SD) scores for buccolingual inclination were significantly lower ($P = .026$) in the bonded (3.37 ± 2.39) than in the nonbonded group (4.69 ± 2.31). Although the total mean scores were lower in the bonded than the nonbonded groups for most of the ABO C-R-Eval categories, no other statistically significant differences were identified. The scores obtained from second molars were significantly lower only in the bonded than the nonbonded groups for all ABO-C-R-Eval categories except for occlusal relationships, for which a significant difference was not found (Table 6).

DISCUSSION

The ABO C-R-Eval was adopted in this study as an indicator of the OT outcome as it has been well-established as a standardized and objective approach to assess OT outcomes, grade clinical case reports, and facilitate comparative analysis.[16] The C-R-Eval combines variables that contribute toward the success of OT, including the alignment, buccolingual inclination, overjet, occlusal contacts, occlusal relationships, marginal ridges, interproximal contacts, and root parallelism.[12] The authors incorporated the measurements of OB, leveling of COS, and control of IMPA in the main study outcomes

Table 5. Linear Regression Analyses for the Main Treatment Outcomes[a]

Dependent Variable	Independent Variable (Predictor)	β	*P*
Decrease in COS	Age	−0.010	.861
	Gender (male vs female)	0.208	.331
	Race	0.013	.875
	Skeletal malocclusion	0.113	.510
	Dental malocclusion	−0.157	.313
	Bonding 7's (bond vs not)	0.240	.254
Decrease in OB	Age	−0.041	.546
	Gender (male vs female)	0.261	.296
	Race	0.111	.230
	Skeletal malocclusion	0.191	.336
	Dental malocclusion	−0.066	.713
	Bonding 7's (bond vs not)	0.088	.720
Decrease in IMPA	Age	−0.029	.953
	Gender (male vs female)	−1.190	.512
	Race	−0.768	.250
	Skeletal malocclusion	−0.136	.925
	Dental malocclusion	−0.879	.499
	Bonding 7's (bond vs not)	1.456	.413
Decrease in the overall ABO C-R-Eval	Age	−0.233	.526
	Gender (male vs female)	−1.547	.251
	Race	0.333	.505
	Skeletal malocclusion	−1.468	.170
	Dental malocclusion	−0.308	.751
	Bonding 7's (bond vs not)	7.550	<.001

[a] COS indicates curve of Spee; OB, overbite; IMPA, incisor mandibular plane angle; ABO C-R-Eval, American Board of Orthodontics Cast-Radiograph Evaluation; 7's, second molars; β, unstandardized coefficients; *P*, statistical significance when $P < .05$.

as they are intertwined with a functional and stable occlusal outcome and are not integrated in the C-R-Eval score. Treatment duration and number of emergency visits were recorded to incorporate parameters of treatment efficiency and patient satisfaction.

Bonding of the second molars during the initial phase of OT yielded a superior OT outcome, as documented by the significantly lower overall mean C-R-Eval score in the bonded than in the not-bonded group (17.70 ± 2.97 vs 25.25 ± 3.98). This improvement did not lead to a prolonged treatment duration, as the mean duration of OT was comparable among groups (~25–27 months). Comparison of the C-R-Eval total scores and scores from the second molars only per individual categories revealed that most significant differences among study groups were attributed to improved positioning of the second molars in the bonded group. Until recently, the belief that bonding the second molars improves OT outcomes remained largely anecdotal. An exception to this lack of evidence is a study conducted by Dritsas et al.,[11] which explored the impact of the timing of second molar bonding (early vs delayed) on the duration of mandibular dental arch leveling. Their findings suggested that early bonding of second molars may expedite the completion of the leveling phase. Their findings were in agreement with those of the present study, which showed that early bonding of the second molars leads to a superior treatment outcome, without any discernible impact on treatment duration.

In the present study, bonding of the second molars resulted in a tendency toward improved leveling of the COS, correction of OB, and control of IMPA; however, none of those differences was statistically significant. It is noteworthy that the present study sample included mainly patients with Class I or mild Class II/III dental malocclusion, mild crowding, and with an ANB angle falling close to the accepted norms. Patients with more severe dentoskeletal characteristics requiring OT with extractions and/or surgical procedures were excluded. It could be speculated that bonding of the second molars might offer additional treatment benefits in patients with more severe types of malocclusion requiring OT in combination with extractions, orthognathic surgery, and/or additional appliances such as functional appliances. For instance, it has been reported that incorporating second molars in the posterior anchorage unit may facilitate control in maximum anchorage extraction cases and may help control mandibular incisor proclination in patients undergoing OT with functional appliances and/or Class

Table 6. Comparison of the ABO C-R-Eval Total Scores and Scores From Second Molars Only per Individual Categories Between Study Groups[a]

ABO C-R-Eval Category	Total Score (per Category)			Score From Second Molars Only (per Category)		
	Bonded Group, Mean ± SD	Not-Bonded Group, Mean ± SD	*P* Value	Bonded Group, Mean ± SD	Not-Bonded Group, Mean ± SD	*P* Value
Alignment	4.30 ± 3.10	5.31 ± 2.60	.090	1.87 ± 3.22	3.97 ± 2.73	.002
Marginal ridges	2.13 ± 1.91	2.53 ± 2.06	.500	0.77 ± 1.68	1.47 ± 1.59	.013
Buccolingual inclination	3.37 ± 2.39	4.69 ± 2.31	.026	1.27 ± 2.29	3.50 ± 2.59	.001
Overjet	3.97 ± 1.83	4.38 ± 1.95	.464	0.97 ± 1.56	2.53 ± 1.88	.001
Occlusal contacts	1.40 ± 1.45	2.28 ± 1.80	.054	0.63 ± 1.30	1.69 ± 1.71	.012
Occlusal relationships	2.30 ± 1.90	2.53 ± 1.46	.317	2.30 ± 1.90	2.53 ± 1.46	.317
Interproximal contacts	0.53 ± 0.73	0.47 ± 0.80	.512	0.00 ± 0.00	0.25 ± 0.62	.025
Root angulation	1.07 ± 1.36	1.53 ± 1.74	.356	—	—	—

[a] ABO C-R-Eval indicates American Board of Orthodontics Cast-Radiograph Evaluation; bonded group, bonding of second molars; not-bonded group, not bonding of second molars; SD, standard deviation; *P* value, Mann-Whitney test for statistical comparison among study groups, statistical significance when $P < .05$.

II dentoalveolar correctors.[17,18] In addition, Levine et al. indicated that second molar angulation to the occlusal plane is significantly correlated with anteroposterior skeletal discrepancies and, particularly, with skeletal Class III malocclusion; this may lead to occlusal interferences in postsurgical orthognathic cases.[19] Further studies are needed to assess the impact of second molar bonding in patients with severe types of malocclusion receiving OT with extractions, functional appliances, and/or combined with orthognathic surgery.

A limitation of this study was the inclusion of a retrospective convenience sample, which may limit the generalizability of the results. In addition, the risk of selection bias cannot be overlooked. The authors applied strict eligibility criteria to enhance homogeneity of the study sample, and all patients were treated with a comprehensive nonextraction fixed OT approach, including conventional bracket system, archwires, bite turbos, and intermaxillary elastics. However, the variability in treatment-related factors cannot be excluded because, from an ethical perspective, patients were treated based on their individual needs. Strengths of this study included the use of a power-adjusted sample size, the fact that groups were well-matched for basic demographic and malocclusion-related characteristics, and the high intra- and interobserver reliabilities and blinding of the outcome assessor, which minimized the risk of measurement errors/biases. To further minimize the risk of selection biases, all adolescent patients included in the present study had second molars at least partially or fully erupted at the beginning of OT, and patients in the bonded group had the second molars bonded within the first 2 months of treatment. In addition, treatment of all patients was supervised by two ABO-certified full-time orthodontic faculty to facilitate standardization.

A higher number of emergency appointments related either to poking wires and/or breakage of the terminal molar tube was noted in the bonded group, indicating that bonding of second molars may potentially increase the number of emergency visits during fixed OT. It is pertinent to mention that it is challenging to fully isolate the impact of second molar bonding on the occurrence of orthodontic emergencies, especially since patients may experience poking wire emergencies and molar bracket failures even in the absence of bonded second molars. In the study by Jung,[20] survival rates of bonded metallic brackets to the teeth were assessed in 127 patients, 12-month failure rates of molar brackets were 11.6%, and bond failures did not differ significantly between first and second molars. From a clinical perspective, these findings highlight the importance of proper bonding technique and saliva/moisture isolation to minimize the risk of bonding failure. Also, diligent clipping or cinching of the distal end of the archwires to decrease the risk of wire displacement during fixed OT is needed. Proper patient education regarding the challenges associated with second molar bonding and appliance care may also be beneficial in this regard.

Results of the present study indicated the importance of second molar bonding to enhance the OT outcome, particularly when assessed via the ABO C-R-Eval score. Nonetheless, additional clinical factors such as the eruption stage of the second molars during OT, feasibility to bond second molars based on the patient's mouth-opening capabilities, patient compliance to achieve adequate moisture control, patient comfort and cooperation with avoiding bracket breakage, and occlusal interferences may affect clinician choice regarding the bonding of the second molars.

CONCLUSIONS

- Bonding of second molars enhances the outcome of nonextraction fixed OT as demonstrated by C-R-Eval, without increasing the treatment duration.
- An increased number of emergency visits might be expected in adolescents undergoing fixed OT with bonded second molars.

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SUPPLEMENTAL DATA

The Appendix 1 with supplemental data is available online.

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