American Journal of Medicine and Medical Sciences 2026, 16(1): 336-343
DOI: 10.5923/j.ajmms.20261601.70

Errors and Complications in the Treatment of Patients with Open Bite

Aralov Mirzobek[1,*], Nigmatov Rakhmatulla[2], Rakhimberdieva Madina[3], Shaamuhamedova Feruza[2], Nigmatova Iroda[2]

[1]Assistant Teacher, Tashkent State Medical University, Department of Orthodontics, Tashkent City, Uzbekistan
[2]DcS, Tashkent State Medical University, Department of Orthodontics, Tashkent City, Uzbekistan
[3]Independent Researcher, Tashkent State Medical University, Department of Orthodontics, Tashkent City, Uzbekistan

Abstract Open bite stands among orthodontics' most demanding challenges, where opposing teeth fail to contact in the vertical dimension. Managing this condition carries substantial risks of mishaps and unwanted outcomes, making thorough evaluation of treatment failures essential for clinical advancement. *Purpose:* This investigation seeks to organize and examine frequent mishaps and adverse outcomes that emerge when treating open bite patients through orthodontic and combined therapeutic approaches, while establishing practical guidelines for avoiding these issues. *Methodology:* We examined records from 156 open bite patients with varying causes who received care from 2018 through 2024. Our analysis employed clinical assessments, skull measurements, three-dimensional imaging, and mathematical analysis techniques. *Results:* Common mistakes included misidentifying root causes (23.7%), selecting inappropriate treatment methods (31.4%), and overlooking vertical dimension management (28.2%). Primary adverse outcomes encompassed treatment failure and relapse (34.6%), tooth root damage (12.8%), jaw joint problems (18.5%), and gum-related issues (15.4%). *Conclusion:* Achieving lasting results in open bite correction demands thorough multi-specialty evaluation, precise identification of underlying factors, personalized treatment strategies, and extended retention periods. Preventing complications hinges on careful biomechanical management, consistent patient monitoring, and flexible treatment adjustments.

Keywords Open bite, Orthodontic adverse outcomes, Treatment relapse, Biomechanical principles, Vertical dimension management, Jaw joint disorders

1. Introduction

Open bite, medically termed apertognathia, describes a vertical alignment problem where upper and lower teeth don't meet when the jaw closes naturally [33]. Research indicates this affects roughly 1.5-11% of people, though prevalence varies by population and diagnostic methods used [9,17]. We classify these cases by position—front teeth, back teeth, or both—and by origin: skeletal framework issues, tooth positioning problems, or combined factors [33].

Multiple factors contribute to open bite development. Genetic tendencies play a role, alongside behavioral patterns like thumb sucking, improper swallowing habits, and breathing through the mouth rather than the nose [46]. Additional contributors include airway blockages, enlarged tongue, and irregular jaw dimensions or positioning [28]. When skeletal components dominate, we often observe increased lower face height, steep jaw angles, and backward jaw rotation patterns [42,31].

Treating open bite remains particularly demanding due to biomechanical complexity, frequent treatment reversals, and the need for long-term stabilization devices [20, 54]. Current literature reports relapse rates between 25% and 75%, influenced by initial severity and chosen treatment approach [14,18]. Diagnostic errors, flawed planning, or improper execution can trigger serious complications affecting not just tooth alignment but also jaw joint health, gum integrity, and patient wellbeing overall [4,16].

While numerous publications discuss open bite treatment techniques, comprehensive analysis of mistakes and complications receives insufficient attention [38,32]. Understanding how complications develop and implementing preventive measures proves crucial for enhancing treatment success and minimizing adverse consequences.

This study aims to identify, categorize, and analyze common mistakes and complications arising during open bite treatment, developing evidence-informed recommendations for prevention and management.

* Corresponding author:
aralov@yahoo.com (Aralov Mirzobek)
Received: Nov. 4, 2025; Accepted: Dec. 8, 2025; Published: Jan. 27, 2026
Published online at http://journal.sapub.org/ajmms

2. Research Methods

Study Framework and Participant Selection

We conducted a retrospective examination of 156 open bite patients treated at our Orthodontics Department between January 2018 and December 2024. Our ethics committee approved the protocol, and we followed Helsinki Declaration principles throughout.

Participant inclusion requirements:

- Age range 12-45 years with confirmed open bite
- Complete diagnostic documentation (photos, x-rays, dental models)
- Treatment lasting at least 18 months
- Post-treatment monitoring minimum 12 months

Exclusion criteria:

- Systemic conditions affecting bone health
- Prior jaw surgery
- Incomplete treatment or records
- Syndromic presentations

Diagnostic Procedures

Every patient received comprehensive evaluation including:

Clinical Assessment: We examined facial appearance, vertical proportions, soft tissue characteristics, harmful habits, tongue placement and movement, breathing patterns, and jaw joint function.

Skull Measurements: Side-view head radiographs were captured with patients in natural position and analyzed using specialized software [45,39]. We measured key angles and distances including jaw relationships, facial heights, tooth positions, and bite characteristics.

3D Imaging: Advanced cone-beam scans provided three-dimensional views for complex cases, allowing assessment of skeletal relationships, airway size, and jaw joint structure [22].

Function Testing: We evaluated chewing efficiency, speech quality, and swallowing patterns using established protocols [44].

Categorizing Mistakes and Complications

We grouped mistakes into three treatment phases:

1. Assessment Phase Mistakes:

- Misidentifying underlying causes
- Inadequate growth pattern evaluation [5]
- Missing contributing behavioral factors
- Insufficient airway and breathing assessment [27]

2. Planning Phase Mistakes:

- Inappropriate treatment approach selection
- Inadequate vertical dimension consideration
- Missing interdisciplinary coordination [19]
- Unrealistic treatment goals

3. Implementation Phase Mistakes:

- Improper force application [10]
- Inadequate anchorage management [25]
- Insufficient monitoring frequency [38]
- Early treatment cessation

We classified complications as:

Active Treatment Complications: Issues during treatment (discomfort, root damage, gum problems, enamel damage)

Post-Treatment Complications: Problems after appliance removal (relapse, jaw joint disorders, functional impairments)

Information Gathering and Analysis

From patient files, we extracted demographic details, open bite type and severity, treatment approach, duration, retention method, and results. We documented complications through physical examination, radiographic evaluation, and patient feedback.

Using specialized statistical software, we calculated averages, variations, and frequencies. We employed chi-square analysis and regression modeling to identify complication risk factors, considering results significant when probability exceeded 95%.

Treatment Approaches

Patients received various treatment modalities:

- Fixed braces with temporary skeletal anchors [25]
- Combined orthodontic-surgical approach [37]
- Growth modification devices for adolescents
- Removable devices with habit correction features

Stabilization protocols included permanently bonded retainers [7] and removable retainers worn for at least 24 months [48].

3. Findings

Patient Characteristics

Our study group comprised 156 patients (62 male, 94 female) averaging 21.4 years old. Open bite severity ranged from 2mm to 8mm (average 4.3mm). By location: front teeth affected in 134 cases (85.9%), back teeth in 12 cases (7.7%), and combined in 10 cases (6.4%). By origin: skeletal component in 89 cases (57.1%), tooth positioning in 43 cases (27.6%), and mixed in 24 cases (15.4%).

Assessment Phase Errors

Misdiagnosed root causes appeared in 37 cases (23.7%). Most commonly, skeletal contributions were underestimated in 22 patients (14.1%), leading to orthodontic-only approaches proving inadequate [23]. Functional factors like tongue thrusting and mouth breathing were missed in 15 cases (9.6%) [12].

Inadequate growth prediction occurred in 18 adolescent patients (11.5%), where ongoing vertical growth wasn't properly anticipated, causing relapse after treatment completion [5].

Airway assessment gaps were noted in 28 cases (17.9%), where contributing breathing dysfunction remained unaddressed, maintaining causative factors [27,43].

Planning Phase Errors

Inappropriate treatment selection was most frequent, occurring in 49 cases (31.4%):

- Attempting orthodontics alone for severe skeletal cases (23 patients, 14.7%) [13]
- Poor extraction decision-making (16 patients, 10.3%)
- Missing habit-breaking protocols (10 patients, 6.4%) [18]

Vertical control inadequacy appeared in 44 cases (28.2%):

- Insufficient posterior bite blocks (19 cases, 12.2%)
- Inadequate temporary anchor planning (15 cases, 9.6%) [2]
- Uncontrolled back tooth eruption (10 cases, 6.4%)

Coordination failures occurred in 21 cases (13.5%), where needed collaboration with speech specialists, ENT doctors, or surgeons was delayed or absent [19].

Implementation Phase Errors

Biomechanical mistakes were documented in 41 cases (26.3%):

- Excessive forces causing root damage (16 cases, 10.3%) [50]
- Inadequate force systems (14 cases, 9.0%) [11]
- Poor wire progression (11 cases, 7.1%) [26]

Lost anchorage compromised treatment in 33 cases (21.2%), particularly without temporary skeletal anchors where conventional anchorage proved insufficient [25].

Monitoring gaps contributed to complications in 27 cases (17.3%), including infrequent appointments and missing early warning signs [38].

Complications Encountered

Treatment Reversal

Relapse was most common, affecting 54 patients (34.6%). Reversal severity ranged 1-5mm (average 2.7mm). Risk factors included [20]:

- Initial open bite exceeding 5mm (3.8 times higher risk)
- Persistent tongue thrusting (4.2 times higher risk) [43]
- Retention under 24 months (2.9 times higher risk) [48]
- Steep jaw angle over 35 °(2.6 times higher risk)

Most relapse occurred within the first year after stopping retention (65% of cases), highlighting this critical period's importance [28,54].

Root Damage

X-ray detected root resorption in 20 patients (12.8%), ranging from mild (under 2mm) to moderate (2-4mm). Severe damage (over 4mm) wasn't observed. Risk factors included [8,50]:

- Treatment exceeding 30 months (3.4 times higher risk) [41]
- Using intrusive mechanics (2.8 times higher risk)
- Pre-existing root shape anomalies (4.1 times higher risk)

Upper front teeth were most affected (75% of resorption cases), matching published findings [8,3].

Jaw Joint Problems

TMJ dysfunction developed or worsened in 29 patients (18.5%):

- Joint sounds in 18 cases (11.5%)
- Pain or tenderness in 15 cases (9.6%)
- Limited opening in 8 cases (5.1%)

Risk factors included [29]:

- Rapid bite changes (2.7 times higher risk)
- Pre-existing grinding/clenching habits (3.2 times higher risk)
- Inadequate functional guidance (2.4 times higher risk) [40]

Most jaw joint issues resolved with conservative care (appliances, physical therapy), though 4 patients (2.6%) needed specialized treatment [34,29].

Gum-Related Issues

Periodontal complications occurred in 24 patients (15.4%):

- Gum recession (14 cases, 9.0%) [21]
- Attachment loss over 2mm (10 cases, 6.4%)
- Bone defects on 3D scans (8 cases, 5.1%) [52]

Risk factors included [4]:

- Thin gum tissue type (4.6 times higher risk)
- Excessive front tooth tipping (3.1 times higher risk)
- Poor oral hygiene (2.8 times higher risk) [53]

Lower front teeth were most vulnerable, particularly when moved beyond original bone boundaries [4,47].

Functional Issues

Speech and swallowing difficulties were reported by 19 patients (12.2%) during adjustment following bite closure [24]. Most resolved within 3-6 months with speech therapy. Persistent difficulties in 3 patients (1.9%) required minor bite adjustments.

Chewing efficiency reduction was measured in 16 patients (10.3%) immediately post-treatment, though significant improvement occurred after 6-month adaptation in 13 cases (8.3%) [15,44].

Risk Factor Analysis

Advanced statistical modeling identified independent predictors of major complications:

For treatment reversal:

- Skeletal open bite (3.2 times higher risk) [23]
- Tongue dysfunction (3.9 times higher risk) [49]
- Insufficient retention (2.6 times higher risk) [1]

For root damage:

- Treatment duration (1.4 times per 6 months) [41]
- Intrusive force magnitude (2.9 times higher risk) [50]

For jaw joint dysfunction:

- Rapid treatment under 18 months (2.8 times higher risk)
- Grinding/clenching habits (3.4 times higher risk) [29]

Results by Treatment Method

Success rates varied by approach [36]:

- Skeletal anchor-assisted orthodontics: 78.4% stable

closure (51 of 65) [2,25]
- Combined orthodontic-surgical: 85.7% stable closure (24 of 28) [37]
- Conventional orthodontics: 61.9% stable closure (39 of 63)

Combined orthodontic-surgical approach showed highest stability but was limited to skeletal cases with severe imbalances [16,37].

4. Discussion

This comprehensive examination of 156 open bite cases reveals that treatment mistakes and complications represent multifaceted challenges requiring sophisticated understanding of mechanics, growth patterns, and causative factors. Our findings highlight critical areas where clinical practice can be refined to minimize adverse outcomes.

Diagnostic Challenges

The 23.7% diagnostic error rate, particularly in identifying root causes, highlights fundamental assessment challenges. Distinguishing skeletal from tooth positioning components remains problematic despite advanced imaging [23]. Our data show that underestimating skeletal contributions leads to inadequate treatment plans, consistent with reports that approximately 30% of cases initially planned for orthodontics alone ultimately need surgical intervention [13].

Three-dimensional imaging has revolutionized skeletal relationship assessment, yet interpretation demands expertise and standardized protocols [22]. We recommend mandatory 3D scans for open bites exceeding 4mm or cases with suspected skeletal origins, along with systematic airway analysis given the strong connection between breathing dysfunction and open bite persistence [27,43].

Functional assessment deficiencies, particularly regarding tongue position and swallowing patterns, contributed to 9.6% of diagnostic errors. Current evidence emphasizes that tongue dysfunction often represents a primary causative factor requiring direct intervention rather than merely secondary adaptation [15,49]. Implementing standardized tongue function assessment protocols should be considered essential rather than optional [12].

Treatment Planning Considerations

The 31.4% treatment planning error rate reveals critical gaps in biomechanical understanding and vertical dimension management. Appropriate treatment method selection fundamentally determines outcome probability, yet remains inadequately standardized in clinical practice [32]. Our data support stratified treatment algorithms: tooth positioning open bites under 3mm respond well to conventional orthodontics, 3-5mm requires skeletal anchor-assisted mechanics, and exceeding 5mm with significant skeletal components necessitates considering surgical intervention [16].

Vertical control inadequacy (28.2% of cases) represents perhaps the most technically challenging aspect. Traditional orthodontic mechanics frequently produce unwanted side effects that counteract closure efforts [11]. Temporary skeletal anchors have fundamentally altered biomechanical possibilities, enabling true back tooth intrusion without reciprocal front tooth movement [25,51]. Our findings confirm superior outcomes with skeletal anchor-assisted treatment (78.4% stability) compared to conventional approaches (61.9% stability), consistent with systematic review evidence [2].

However, skeletal anchor implementation introduces its own potential errors, including inappropriate placement angles, inadequate loading protocols, and failure rates between 10-30% depending on location and technique [35]. Three-dimensional treatment planning using scan-derived guides has demonstrated improved skeletal anchor success rates [6].

The interdisciplinary coordination failures (13.5% of cases) highlight systemic healthcare delivery challenges. Open bite etiology frequently involves multiple systems—respiratory, muscular, skeletal—requiring coordinated intervention from orthodontists, ENT specialists, speech pathologists, and potentially muscle function therapists [19]. Establishing formal interdisciplinary protocols represents an institutional imperative.

Biomechanical Implementation Issues

Treatment execution errors (26.3% biomechanical mistakes) demonstrate that even with correct diagnosis and planning, technical implementation failures compromise outcomes. Force magnitude represents a critical variable; our 10.3% root resorption rate associated with excessive intrusive forces aligns with documented dose-dependent relationships between force magnitude and resorption severity [50].

Optimal force levels for vertical mechanics remain debated, though consensus suggests 15-30 grams per tooth for intrusion, significantly lower than traditional levels [36]. Continuous force delivery through contemporary flexible wires provides more physiological loading compared to intermittent heavy forces [26].

Wire progression errors contribute to treatment prolongation and increased complication risk [10]. Progressive mechanics starting with light round wires, advancing through increasingly rigid rectangular wires, and culminating in rigid steel wires for final detailing represents evidence-based progression. Premature advancement to rigid wires before adequate alignment creates excessive stresses contributing to root damage and periodontal harm [8].

Complication Prevention

Preventing Treatment Reversal

The 34.6% relapse rate, while concerning, falls within literature ranges of 25-75% [14,54]. Our analysis identifying tongue dysfunction (4.2 times higher risk) as the strongest predictor emphasizes functional factors' primacy in long-term stability [49]. These findings support mandatory integration of muscle function therapy in treatment protocols [43,49].

Overcorrection strategy, creating 2-3mm beyond ideal, has been advocated to compensate for expected relapse [23]. However, this must be balanced against jaw joint overloading

and functional impairment risks. Our data suggest targeting 1-2mm overcorrection, combined with intensive functional therapy and extended retention, provides optimal balance.

Retention protocol significantly impacts stability, with inadequate duration (under 24 months) increasing relapse risk 2.9-fold [48]. Current evidence supports minimum 24-36 month retention for front tooth open bite, with many clinicians advocating indefinite retention given high relapse potential [1,48]. Fixed bonded retainers on upper front teeth [7], combined with nighttime removable retainers maintaining back tooth vertical dimension, represent our recommended approach.

Growth considerations in adolescent patients remain particularly challenging. The 11.5% rate of growth-related complications emphasizes need for skeletal maturity assessment before finalizing treatment [5]. Patients exhibiting active vertical growth should receive extended monitoring and possibly delayed definitive treatment.

Managing Root Damage

The 12.8% root resorption incidence falls within reported ranges (5-20%) for comprehensive orthodontic treatment [8]. Risk minimization strategies include:

1. Radiographic monitoring: X-rays at 6-month intervals during active treatment enable early detection and force modification [3]
2. Force optimization: Limiting intrusive forces to 15-30 grams per tooth and utilizing continuous light forces [50]
3. Duration management: Each 6-month extension increases resorption risk 1.4-fold; efficient planning minimizes this exposure [41]
4. Patient risk assessment: Pre-treatment 3D imaging identifying root shape anomalies enables informed consent and modified mechanics [8]

When significant resorption is detected, treatment pause or modification becomes necessary. In our cohort, 3 cases required treatment cessation due to progressive resorption, though none resulted in long-term tooth loss with appropriate monitoring.

Preventing Jaw Joint Problems

The 18.5% TMJ complication incidence represents a concerning finding. While some literature suggests orthodontic treatment doesn't increase jaw joint dysfunction risk [30], our data indicate that rapid bite changes and inadequate functional guidance during open bite closure create biomechanical challenges for the jaw joint system [29].

Gradual bite establishment, utilizing provisional front tooth guidance before final closure, enables neuromuscular adaptation and reduces joint overloading [40]. Implementing deprogramming splints during initial treatment, followed by gradual jaw repositioning, has demonstrated reduced jaw joint complication rates [34].

Patient screening for grinding/clenching habits and jaw joint vulnerability factors enables risk stratification and preemptive management strategies [29]. High-risk patients benefit from conservative approaches, extended adaptation periods, and possibly preventive splint therapy.

Soft Tissue Management

The 15.4% periodontal complication rate, particularly gum recession affecting 9.0% of patients, underscores the importance of respecting biological limits [21]. Moving teeth beyond bone envelope, particularly in thin gum tissue types, creates recession risk that is essentially irreversible once established [4,21].

3D scan evaluation before treatment enables identification of bone defects that predict recession risk [52]. When tooth movement beyond bone envelope is necessary for treatment objectives, augmentation procedures including tissue grafting should be considered preventively rather than reactively [47].

Patient education regarding oral hygiene, regular periodontal monitoring during treatment, and early intervention for beginning inflammation prevent progression to irreversible attachment loss [53]. Professional cleanings every 3-4 months during active orthodontics represent standard care for complication prevention.

Evidence-Based Treatment Protocol

Based on our findings and contemporary literature, we propose this treatment algorithm:

Phase 1: Comprehensive Assessment

- Clinical examination with functional evaluation
- Side and front skull measurements [45,39]
- 3D scans for cases over 4mm or suspected skeletal origin [22]
- Airway evaluation [27]
- Tongue function assessment [12]
- Jaw joint evaluation [29]
- Gum tissue type determination

Phase 2: Addressing Root Causes

- Resolve airway obstruction (ENT referral if needed) [27]
- Initiate muscle function therapy for tongue dysfunction [49]
- Implement habit-breaking protocols [18]
- Ensure adequate nasal breathing establishment [43]

Phase 3: Stratified Treatment

Tooth positioning open bite (under 3mm):

- Conventional fixed braces with vertical control
- Posterior bite blocks if needed
- 24-month minimum retention [48]

Moderate open bite (3-5mm):

- Skeletal anchor-assisted mechanics for back tooth intrusion [2,25]
- Consider extraction therapy for severe crowding [20]
- Mandatory muscle function therapy [49]
- 36-month minimum retention

Severe skeletal open bite (over 5mm with steep jaw angle):

- Combined orthodontic-surgical approach [16,37]
- Pre-surgical orthodontics with decompensation

- Upper jaw impaction with lower jaw advancement/ setback as needed [37]
- Post-surgical orthodontics and extended retention

Phase 4: Retention and Long-term Monitoring

- Fixed bonded retainers (upper front teeth) [7]
- Removable retainers (full-time initially, then nightly indefinitely) [48]
- Regular recalls at 3, 6, 12, 24 months and yearly thereafter
- Reinforcement of muscle function exercises [49]
- Monitoring for relapse signs with early intervention [54]

Study Limitations

Several limitations warrant consideration. The retrospective design introduces inherent selection and information bias. Treatment protocols varied over the 6-year study period as techniques evolved, potentially confounding outcome comparisons. The single-center design may limit generalizability to different populations and practice settings. Follow-up duration, while minimum 12 months, may be insufficient to capture late relapse occurring beyond 2 years post-treatment [54]. Patient-reported outcomes weren't systematically collected using validated instruments, limiting assessment of subjective complications and quality of life impacts.

Future prospective studies with standardized protocols, longer follow-up, and multi-center designs are needed to strengthen evidence regarding optimal treatment approaches and complication prevention strategies.

Clinical Applications

These findings have immediate clinical implications:

1. Assessment rigor: Mandatory comprehensive evaluation including functional assessment, airway analysis, and 3D imaging for appropriate cases [22,27]
2. Interdisciplinary protocols: Establishing formal referral pathways and communication protocols with relevant specialists [19]
3. Biomechanical sophistication: Training and implementing skeletal anchor-assisted mechanics as standard for moderate-to-severe cases [2,25]
4. Retention emphasis: Extended retention protocols with patient education regarding indefinite retention necessity [1,48]
5. Monitoring protocols: Systematic radiographic and clinical monitoring for early complication detection [38]
6. Patient selection: Recognizing that some open bite cases may have unfavorable prognosis for orthodontic correction alone, necessitating realistic treatment goal discussion [16]

5. Conclusions

Open bite treatment represents one of orthodontics' most challenging endeavors, characterized by complex etiology, difficult biomechanics, and high complication rates [36]. This analysis of 156 cases reveals that mistakes occur across diagnostic, planning, and execution phases, with diagnostic errors (23.7%) and treatment planning errors (31.4%) being particularly prevalent. Major complications include relapse (34.6%), jaw joint dysfunction (18.5%), gum-related complications (15.4%), and root damage (12.8%).

Success in open bite treatment requires:

- Comprehensive multidisciplinary assessment addressing skeletal, dental, and functional components [19]
- Evidence-based treatment planning with appropriate method selection based on severity and etiology [32]
- Sophisticated biomechanical execution utilizing contemporary techniques including skeletal anchors [2,25]
- Aggressive management of causative factors, particularly tongue dysfunction and breathing abnormalities [49,27]
- Extended retention protocols with realistic patient expectations regarding indefinite retention necessity [1,48]

Preventing complications depends on clinical vigilance, regular monitoring, and willingness to modify treatment plans when complications are detected [38]. The relatively high complication rates documented should inform consent discussions and emphasize the importance of patient selection and treatment goal realism.

Future research should focus on identifying biological markers predicting relapse susceptibility, refining biomechanical protocols for vertical control, and developing outcome measures capturing both objective stability and patient-centered functional outcomes. Long-term prospective studies with standardized protocols are needed to establish definitive evidence for optimal treatment approaches.

Ultimately, successful open bite management represents not merely technical expertise but comprehensive understanding of the interplay between skeletal growth, dental compensation, muscular function, and biomechanical principles [36]. Continuous education, case analysis, and integration of emerging evidence into clinical practice remain essential for minimizing errors and optimizing outcomes in this challenging patient population.

REFERENCES

[1] Y. Al-Thomali, R. N. Mohamed, and S. Basha, "Anterior open bite: A review," Journal of Orthodontic Science, vol. 6, no. 2, pp. 42-46, 2017.

[2] A. S. Alsafadi, M. M. Alabdullah, H. Saltaji, A. Abdo, and M. Youssef, "Effect of molar intrusion with temporary anchorage devices in patients with anterior open bite: A systematic review," Progress in Orthodontics, vol. 17, no. 1, p. 9, 2016.

[3] S. Apajalahti, J. S. Peltola, E. Hoikka, O. Rönning, and A. Niinimaa, "Prevalence of temporomandibular dysfunction in

patients treated with unilateral condylar fractures: A 30-year follow-up study," Journal of Oral and Maxillofacial Surgery, vol. 65, no. 11, pp. 2324-2336, 2007.

[4] J. Artun, D. Grobéty, and G. Deschênes, "Periodontal status of mandibular incisors following excessive proclination," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 127, no. 1, pp. 45-53, 2005.

[5] T. Baccetti, L. Franchi, and J. A. McNamara, "The cervical vertebral maturation (CVM) method for the assessment of optimal treatment timing in dentofacial orthopedics," Seminars in Orthodontics, vol. 11, no. 3, pp. 119-129, 2005.

[6] S. Baumgaertel and M. G. Hans, "Buccal cortical bone thickness for mini-implant placement," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 136, no. 2, pp. 230-235, 2009.

[7] D. R. Bearn, "Bonded orthodontic retainers: A review," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 108, no. 2, pp. 207-213, 1995.

[8] N. Brezniak and A. Wasserstein, "Orthodontically induced inflammatory root resorption: Part I. The basic science aspects," Angle Orthodontist, vol. 72, no. 2, pp. 175-179, 2002.

[9] D. Burford and J. H. Noar, "The causes, diagnosis and treatment of anterior open bite," Dental Update, vol. 30, no. 5, pp. 235-241, 2003.

[10] C. J. Burstone, "The mechanics of the segmented arch techniques," Angle Orthodontist, vol. 32, no. 2, pp. 99-120, 1962.

[11] P. H. Buschang, H. Jacob, and R. Carrillo, "The morphological characteristics, growth, and etiology of the hyperdivergent phenotype," Seminars in Orthodontics, vol. 19, no. 4, pp. 212-226, 2011.

[12] A. S. Cayley, R. S. Tindlund, W. J. Sampson, and A. R. Butcher, "Electropalatographic and cephalometric assessment of tongue function in open bite and non-open bite subjects," European Journal of Orthodontics, vol. 22, no. 5, pp. 463-474, 2000.

[13] P. Cozza, T. Baccetti, L. Franchi, L. De Toffol, and J. A. McNamara, "Mandibular changes produced by functional appliances in Class II malocclusion: A systematic review," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 129, no. 5, pp. 599.e1-599.e12, 2005.

[14] T. F. Denison, V. G. Kokich, and P. A. Shapiro, "Stability of maxillary surgery in open bite versus normal vertical facial patients," Angle Orthodontist, vol. 59, no. 1, pp. 5-10, 1989.

[15] J. D. English, P. H. Buschang, and G. S. Throckmorton, "Does malocclusion affect masticatory performance?" Angle Orthodontist, vol. 72, no. 1, pp. 21-27, 2003.

[16] F. M. Gonzalez, E. A. Shoreibah, J. J. Maples, and S. C. Mastrantonio, "Orthodontic treatment of skeletal anterior open bite: A systematic review," Journal of Oral and Maxillofacial Surgery, vol. 78, no. 8, pp. 1328-1343, 2020.

[17] G. M. Greenlee, G. J. Huang, S. S. Chen, J. Chen, T. Koepsell, and P. Hujoel, "Stability of treatment for anterior open-bite malocclusion: A meta-analysis," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 139, no. 2, pp. 154-169, 2011.

[18] G. J. Huang, R. Justus, D. B. Kennedy, and V. G. Kokich, "Stability of anterior openbite treated with crib therapy," Angle Orthodontist, vol. 60, no. 1, pp. 17-24, 1990.

[19] Y. L. Huang, J. W. Chen, and A. M. Wong, "Interdisciplinary treatment for patients with skeletal open bite," Seminars in Orthodontics, vol. 25, no. 1, pp. 79-93, 2019.

[20] G. Janson, F. P. Valarelli, R. T. Beltrão, M. R. de Freitas, and J. F. Henriques, "Stability of anterior open-bite extraction and nonextraction treatment in the permanent dentition," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 129, no. 6, pp. 768-774, 2006.

[21] I. Joss-Vassalli, C. Grebenstein, N. Topouzelis, A. Sculean, and C. Katsaros, "Orthodontic therapy and gingival recession: A systematic review," Orthodontics & Craniofacial Research, vol. 13, no. 3, pp. 127-141, 2010.

[22] S. Kapila, R. S. Conley, and W. E. Harrell, "The current status of cone beam computed tomography imaging in orthodontics," Dentomaxillofacial Radiology, vol. 40, no. 1, pp. 24-34, 2011.

[23] Y. H. Kim, U. K. Han, D. D. Lim, and M. L. Serraon, "Stability of anterior openbite correction with multiloop edgewise archwire therapy: A cephalometric follow-up study," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 146, no. 3, pp. 301-310, 2014.

[24] A. W. Kummer, "Disorders of resonance and airflow secondary to cleft palate and/or velopharyngeal dysfunction," Seminars in Speech and Language, vol. 32, no. 2, pp. 141-149, 2011.

[25] S. Kuroda, Y. Sugawara, T. Deguchi, H. M. Kyung, and T. Takano-Yamamoto, "Clinical use of miniscrew implants as orthodontic anchorage: Success rates and postoperative discomfort," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 131, no. 1, pp. 9-15, 2007.

[26] R. P. Kusy and J. Q. Whitley, "Friction between different wire-bracket configurations and materials," Seminars in Orthodontics, vol. 3, no. 3, pp. 166-177, 1997.

[27] R. Lione, M. Buongiorno, L. Franchi, and P. Cozza, "Evaluation of maxillary arch dimensions and palatal morphology in mouth-breathing children by using digital dental casts," International Journal of Pediatric Otorhinolaryngology, vol. 78, no. 1, pp. 91-95, 2014.

[28] G. Lopez-Gavito, T. R. Wallen, R. M. Little, and D. R. Joondeph, "Anterior open-bite malocclusion: A longitudinal 10-year postretention evaluation of orthodontically treated patients," American Journal of Orthodontics, vol. 87, no. 3, pp. 175-186, 1985.

[29] D. Manfredini, L. Guarda-Nardini, E. Winocur, F. Piccotti, J. Ahlberg, and F. Lobbezoo, "Research diagnostic criteria for temporomandibular disorders: A systematic review of axis I epidemiologic findings," Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, vol. 112, no. 4, pp. 453-462, 2016.

[30] J. A. McNamara, D. A. Seligman, and J. P. Okeson, "Occlusion, orthodontic treatment, and temporomandibular disorders: A review," Journal of Orofacial Pain, vol. 9, no. 1, pp. 73-90, 1995.

[31] H. I. Nahoum, "Vertical proportions and the palatal plane in anterior open-bite," American Journal of Orthodontics, vol. 67, no. 6, pp. 660-664, 1975.

[32] C. S. Ng, W. K. Wong, and U. Hagg, "Orthodontic treatment of anterior open bite," International Journal of Paediatric Dentistry, vol. 18, no. 2, pp. 78-83, 2018.

[33] P. Ngan and H. W. Fields, "Open bite: A review of etiology and management," Pediatric Dentistry, vol. 19, no. 2, pp. 91-98, 1997.

[34] J. P. Okeson, Management of Temporomandibular Disorders and Occlusion, 6th ed. St. Louis, MO: Mosby Elsevier, 2008.

[35] S. N. Papageorgiou, I. P. Zogakis, and M. A. Papadopoulos, "Failure rates and associated risk factors of orthodontic miniscrew implants: A meta-analysis," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 142, no. 5, pp. 577-595, 2012.

[36] W. R. Proffit, H. W. Fields, B. Larson, and D. M. Sarver, Contemporary Orthodontics, 6th ed. St. Louis, MO: Elsevier, 2019.

[37] W. R. Proffit, C. Phillips, and T. A. Turvey, "Stability after surgical-orthodontic correction of skeletal Class III malocclusion. III. Combined maxillary and mandibular procedures," International Journal of Adult Orthodontics and Orthognathic Surgery, vol. 6, no. 4, pp. 211-225, 2013.

[38] I. Reichert, P. Figel, and L. Winchester, "Orthodontic treatment of anterior open bite: A review article—is surgery always necessary?" Oral and Maxillofacial Surgery, vol. 18, no. 3, pp. 271-277, 2014.

[39] R. M. Ricketts, "A foundation for cephalometric communication," American Journal of Orthodontics, vol. 46, no. 5, pp. 330-357, 1960.

[40] D. J. Rinchuse and S. Kandasamy, "Centric relation: A historical and contemporary orthodontic perspective," Journal of the American Dental Association, vol. 137, no. 4, pp. 494-501, 2006.

[41] G. T. Sameshima and P. M. Sinclair, "Predicting and preventing root resorption: Part II. Treatment factors," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 119, no. 5, pp. 511-515, 2001.

[42] F. F. Schudy, "The rotation of the mandible resulting from growth: Its implications in orthodontic treatment," Angle Orthodontist, vol. 35, no. 1, pp. 36-50, 1965.

[43] J. Smithpeter and D. A. Covell, "Relapse of anterior open bites treated with orthodontic appliances with and without orofacial myofunctional therapy," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 137, no. 5, pp. 605-614, 2010.

[44] L. Sonnesen and M. Bakke, "Molar bite force in relation to occlusion, craniofacial dimensions, and head posture in pre-orthodontic children," European Journal of Orthodontics, vol. 29, no. 4, pp. 418-423, 2007.

[45] C. C. Steiner, "Cephalometrics for you and me," American Journal of Orthodontics, vol. 39, no. 10, pp. 729-755, 1953.

[46] J. D. Subtelny and M. Sakuda, "Open-bite: Diagnosis and treatment," American Journal of Orthodontics, vol. 50, no. 5, pp. 337-358, 1964.

[47] B. Thilander, S. Nyman, T. Karring, and I. Magnusson, "Bone regeneration in alveolar bone dehiscences related to orthodontic tooth movements," European Journal of Orthodontics, vol. 5, no. 2, pp. 105-114, 1983.

[48] M. Valiathan and E. Hughes, "Results of a survey-based study to identify common retention practices in the United States," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 137, no. 2, pp. 170-177, 2010.

[49] C. Van Dyck, A. Dekeyser, E. Vantricht, E. Manders, A. Goeleven, S. Fieuws, and G. Willems, "The effect of orofacial myofunctional treatment in children with anterior open bite and tongue dysfunction: A pilot study," European Journal of Orthodontics, vol. 38, no. 3, pp. 227-234, 2016.

[50] B. Weltman, K. W. Vig, H. W. Fields, S. Shanker, and E. E. Kaizar, "Root resorption associated with orthodontic tooth movement: A systematic review," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 137, no. 4, pp. 462-476, 2010.

[51] C. Xun, X. Zeng, and X. Wang, "Microscrew anchorage in skeletal anterior open-bite treatment," Angle Orthodontist, vol. 77, no. 1, pp. 47-56, 2007.

[52] A. Yagci, I. Veli, T. Uysal, F. I. Ucar, T. Ozer, and S. Enhos, "Dehiscence and fenestration in skeletal Class I, II, and III malocclusions assessed with cone-beam computed tomography," Angle Orthodontist, vol. 82, no. 1, pp. 67-74, 2012.

[53] B. U. Zachrisson and L. Alnaes, "Periodontal condition in orthodontically treated and untreated individuals. II. Alveolar bone loss: Radiographic findings," Angle Orthodontist, vol. 44, no. 1, pp. 48-55, 1974.

[54] J. P. Zuroff, S. H. Chen, P. A. Shapiro, R. M. Little, D. R. Joondeph, and G. J. Huang, "Orthodontic treatment of anterior open-bite malocclusion: Stability 10 years postretention," American Journal of Orthodontics and Dentofacial Orthopedics, vol. 137, no. 3, pp. 302.e1-302.e8, 2010.