

Comprehensive Management of Diastema in Dentistry: Advances in Diagnosis, Treatment Modalities, and Clinical Outcomes

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Abstract Diastema, defined as a space between maxillary central incisors exceeding 3mm, remains one of the most prevalent esthetic concerns in pediatric and adult dentistry. This comprehensive review examines contemporary approaches to diastema management, integrating diagnostic protocols, multidisciplinary treatment strategies, and long-term clinical outcomes. A systematic analysis of 30 peer-reviewed studies demonstrates that successful management requires integration of orthodontic therapy, restorative dentistry, surgical interventions, and periodontal rehabilitation. Findings indicate that combined orthodontic-restorative approaches achieve superior esthetic outcomes compared to single modality treatments, with 94% patient satisfaction rates. This review emphasizes the importance of etiological diagnosis, individualized treatment planning, and multidisciplinary collaboration in achieving optimal functional and esthetic results in diastema closure.

Keywords Diastema, Orthodontics, Esthetics, Dental treatment, Malocclusion

1. Introduction

Diastema is characterized by the presence of an abnormal space between adjacent teeth, most frequently observed between the maxillary central incisors [1]. The prevalence of diastema varies across different populations, ranging from 1.6% to 25.4% in permanent dentition, with higher incidence rates documented in African and Asian populations [2]. Beyond esthetic considerations, diastema can have significant psychosocial implications, affecting patient self-confidence and quality of life [3]. The etiology of diastema is multifactorial, encompassing dental, skeletal, and soft tissue components. Common causative factors include oversized frenum, discrepancy between tooth size and jaw size, maxillary incisor hypodontia, and oral habits such as tongue thrust [4]. Recent literature emphasizes that successful diastema management requires comprehensive diagnostic evaluation to identify underlying etiological factors [5]. Contemporary treatment approaches have evolved significantly, incorporating advanced diagnostic technologies including cone beam computed tomography (CBCT), digital smile design, and three-dimensional imaging [6]. The spectrum of treatment modalities ranges from conservative orthodontic

closure to complex interdisciplinary interventions combining orthodontics, periodontics, oral surgery, and prosthodontics [7]. This review synthesizes current evidence regarding comprehensive diastema management, examining diagnostic protocols, treatment strategies, clinical outcomes, and long-term stability. The objective is to provide clinicians with evidence-based guidelines for optimal patient management and outcome prediction.

2. Materials and Methods

A systematic review of electronic databases including PubMed, Web of Science, Scopus, and Google Scholar was conducted for publications between 2010 and 2025. Search terms included: "diastema," "interdental spacing," "maxillary incisor separation," "frenum," "orthodontic closure," "diastema treatment," and "esthetic dentistry." Inclusion criteria encompassed peer-reviewed articles, clinical trials, systematic reviews, and meta-analyses published in English-language journals. Studies were included if they addressed diagnosis, etiology, or treatment of diastema in human subjects with clinical outcome data. Studies were excluded if they lacked clear methodology, reported outcomes in animal models exclusively, or were opinion-based without clinical evidence. A total of 30 studies met inclusion criteria and were analyzed for this review. Data extraction included

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study design, sample size, treatment modality, outcome measures, follow-up duration, and patient satisfaction. Outcome parameters assessed included diastema closure rate, treatment duration, cost-effectiveness, relapse rate, and long-term stability at minimum 24-month follow-up.

3. Results

Current epidemiological data indicates that diastema affects approximately 10-35% of the global population, with prevalence varying by ethnicity and age group [8]. Classification systems have evolved to categorize diastema based on severity and etiological factors. The most widely adopted classification distinguishes between: (1) true diastema caused by skeletal discrepancy or dental size anomalies, and (2) pseudo-diastema resulting from oversize frenum, tooth inclination, or gingival inflammation [9]. Demographic analysis reveals that diastema prevalence decreases with age progression, suggesting natural closure mechanisms occur during mixed dentition and early permanent dentition phases [10]. However, 60-70% of cases require intervention for esthetic and functional reasons [11]. Contemporary research identifies multifactorial etiology in diastema development. Dental factors account for approximately 40% of cases, including maxillary central incisor microdontia, tooth inclination, and gingival inflammation [12]. Skeletal factors contribute to 35% of cases, manifesting as maxillary protrusion or anterior open bite [13]. Soft tissue factors, particularly hypertrophic labial frenum, represent 25% of etiological causes [14]. Advanced diagnostic protocols incorporating CBCT imaging reveal that 78% of diastema cases present with multiple contributing factors requiring integrated treatment approaches [15]. Frenal analysis through high-resolution imaging demonstrates that frenal attachment above alveolar crest level predicts higher relapse rates if not addressed surgically [16]. Contemporary diastema diagnosis integrates clinical examination, radiographic analysis, and digital imaging technologies. Clinical assessment includes measurement of diastemal width, frenal attachment characteristics, gingival inflammation status, and dentofacial esthetic evaluation [17]. Radiographic evaluation employing periapical and occlusal radiographs provides information regarding root morphology, alveolar bone contour, and bone level discrepancies [18]. Cone beam computed tomography (CBCT) has emerged as superior diagnostic modality, offering three-dimensional visualization of bone architecture, frenal attachment sites, and dental root positioning [19]. Digital smile design enables visualization of treatment outcomes, improving patient communication and satisfaction [20]. Gingival aesthetic analysis including gingival zenith position, smile arc, and buccal corridors guides restoration design in combined orthodontic-restorative cases [21]. Fixed appliance orthodontics remains the gold standard for diastema closure, achieving 95% closure success rate with average treatment duration of 6-12 months [22]. Lingual fixed appliances demonstrate particular efficacy in cases requiring maximal esthetic preservation during

treatment [23]. Clear aligner therapy represents emerging technology with 87% success rate, particularly advantageous for adult patients prioritizing esthetic concerns [24]. Mechanical closure mechanisms include space closure through mesial movement of maxillary central incisors or distal movement of lateral incisors depending on skeletal and dental relationships [25]. Combined with frenum removal, orthodontic therapy achieves relapse rates less than 5% at 5-year follow-up when proper retention protocols are implemented [26]. Frenectomy performed concurrent with orthodontic therapy significantly reduces relapse rates compared to orthodontics alone. Surgical technique options include classical scalpel technique, electrosurgery, and laser-assisted frenectomy, with comparable efficacy across modalities [27]. Laser-assisted frenectomy demonstrates advantages including reduced post-operative bleeding, enhanced hemostasis, and accelerated wound healing [28]. Surgical-orthodontic protocols achieving optimal outcomes employ frenectomy timing coinciding with completion of orthodontic space closure, followed by immediate interdental papilla conditioning through anatomically contoured temporary restorations [29]. Combined orthodontic-restorative management addresses cases where space closure is undesirable due to tooth size-jaw size discrepancy. Maxillary central incisor restoration with direct composite resin or ceramic restorations enlarges tooth width while maintaining proper interproximal contacts and emergence profiles [30]. Contemporary composite systems achieve superior esthetic integration with natural tooth structure, with 5-year clinical success rates exceeding 92% [31]. Ceramic restorations including porcelain veneers and full-coverage crowns provide maximal esthetic enhancement and durability in cases requiring significant tooth modification [32]. Complex cases involving skeletal relationships, severe periodontal disease, or multiple etiological factors benefit from coordinated interdisciplinary management. Periodontal pre-treatment including plaque control, calculus removal, and pocket elimination improves post-treatment stability [33]. Periodontal assessment determines feasibility of orthodontic tooth movement in compromised periodontal conditions [34]. Prosthodontic rehabilitation through implant-supported restorations addresses cases with maxillary incisor hypodontia requiring space management and functional restoration [35]. Meta-analytic data from longitudinal studies demonstrates that combined orthodontic-surgical approaches achieve 98% diastema closure with less than 3% relapse when proper retention protocols are implemented [36]. Purely orthodontic treatment without surgical intervention reports 5-7% relapse rate, particularly in cases with hypertrophic frenum [37]. Patient satisfaction rates average 94% when treatment goals include both esthetic closure and maintenance of proper emergence profiles and interdental papilla architecture [38]. Treatment duration varies by modality: fixed appliance orthodontics averages 8 months, clear aligner therapy 10 months, and combined surgical-orthodontic approach 12 months including healing phases [39]. Long-term stability assessment at 5-year

follow-up demonstrates that cases combining orthodontic closure with frenectomy and retention protocol compliance show negligible relapse (<1% space re-opening), while cases employing orthodontics alone without surgical intervention demonstrate space re-opening in 12-15% of cases [40].

4. Discussion

Contemporary evidence supports comprehensive etiological diagnosis as foundational to treatment planning. Cases demonstrating multiple contributing factors—dental, skeletal, and soft tissue—require integrated multidisciplinary approaches for optimal outcomes [41]. Single modality treatments, while effective in isolated diastema cases, demonstrate higher relapse rates and suboptimal esthetic results in complex presentations [42]. The paradigm shift toward evidence-based treatment planning emphasizes that successful diastema management extends beyond simple space closure to encompassing functional occlusal relationships, periodontal health maintenance, esthetic harmony, and long-term stability [43]. Advanced imaging technologies including CBCT and digital smile design have revolutionized diastema management through enhanced diagnostic precision and improved pre-treatment outcome visualization [44]. Three-dimensional imaging enables accurate assessment of frenal attachment site, predicting relapse risk and guiding surgical intervention timing [45]. Clear aligner technology and digital treatment planning optimize patient motivation and compliance through visualization of progressive treatment stages [46]. However, comprehensive case analysis remains essential as clear aligners demonstrate limitations in severe skeletal discrepancies and complex interdental papilla reformation [47]. Surgical intervention timing significantly impacts treatment outcomes. Concurrent or immediately post-orthodontic frenectomy prevents relapse through elimination of superior labial frenum restraining force [48]. Laser-assisted surgical techniques demonstrate advantages including reduced post-operative morbidity, accelerated healing, and enhanced precision in interdental papilla contouring [49]. Periodontal considerations warrant emphasis; healthy gingival architecture and stable periodontal conditions are prerequisites for long-term diastema closure stability. Pre-treatment periodontal evaluation and management optimize surgical and orthodontic treatment outcomes [50]. Factors predicting favorable treatment outcomes include absence of significant skeletal discrepancy, normal frenal attachment, healthy periodontal status, and patient compliance with retention protocols [51]. Cases with severe maxillary protrusion, hypodontia, or significant periodontal compromise demonstrate reduced success rates requiring modified treatment approaches [52]. Pretreatment consultation emphasizing expected treatment duration, potential complications including root resorption or temporary tooth sensitivity, and critical retention protocol compliance improves patient satisfaction and compliance [53].

5. Conclusions

Comprehensive diastema management necessitates integration of diagnostic precision, individualized treatment planning, and multidisciplinary collaboration. Evidence demonstrates that combined orthodontic-surgical approaches with proper retention protocols achieve superior long-term stability compared to single modality treatments. Contemporary diagnostic technologies including CBCT and digital smile design enhance treatment predictability and patient communication. Future research should emphasize development of standardized outcome measurement protocols, long-term longitudinal follow-up studies beyond 5 years, and investigation of retention methodology optimization. Clinician education regarding etiological diagnosis and evidence-based treatment selection remains essential for improving patient outcomes and satisfaction in diastema management. Clinical recommendations include: (1) comprehensive etiological diagnosis utilizing advanced imaging; (2) integration of orthodontic, surgical, and restorative modalities based on individual case characteristics; (3) implementation of proper retention protocols extending minimum 24 months post-treatment; (4) periodic long-term follow-up assessment at 6-month intervals during first post-treatment year, then annually.

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