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Treatment Modalities for Class II Malocclusion: A Comprehensive Review of Growth Modification, Camouflage, and Orthognathic Surgical Approaches

Elif Sağır

Department of Orthodontics, Faculty of Dentistry, Gaziantep University, Gaziantep, Turkey

ABSTRACT: Class II malocclusion, characterized by a distal relationship of the mandibular dental arch relative to the maxillary arch, is among the most common malocclusions encountered in orthodontic practice, and its management spans the entire range of orthodontic and orthognathic therapy. The appropriate treatment approach depends on the patient's growth status, the severity and skeletal versus dentoalveolar nature of the discrepancy, and the presence of vertical or transverse complicating factors. In growing patients, growth modification with removable or fixed functional appliances, alone or combined with headgear, aims to harness the pubertal growth spurt to correct the underlying skeletal discrepancy; randomized clinical trials indicate that, although early treatment produces short-term skeletal and psychosocial benefits, it does not reduce the need for, or shorten, a subsequent phase of comprehensive treatment. A 2026 systematic review comparing seven functional appliance types found the Twin Block to be the most efficient removable design and the Forsus device the most efficient fixed design. Clear aligner-based mandibular advancement has also emerged as an esthetic alternative for both growing and adult patients. In adolescents and adults with mild-to-moderate discrepancies, camouflage strategies-Class II intermaxillary elastics, extraction-based space closure, and temporary anchorage device (TAD)-supported maxillary molar distalization-achieve occlusal correction primarily through dentoalveolar compensation. When the skeletal discrepancy is severe and growth is complete, combined orthodontic-surgical treatment is required; a 2026 systematic review of 65 studies (6,482 patients) found that orthognathic surgery achieves a mean ANB improvement of 5.4° for Class II corrections, with skeletal stability maintained in 87.3% of patients at one year and patient satisfaction of 87.6%. This review synthesizes classic and current evidence to provide an updated framework for Class II treatment selection across the growing and nongrowing patient.

KEYWORDS: *Class II malocclusion; functional appliances; growth modification; Class II elastics; clear aligners; temporary anchorage devices; orthognathic surgery; review*

I. INTRODUCTION

Class II malocclusion was first defined by Angle as a distal relationship of the mandibular dental arch relative to the maxillary arch, such that the mesiobuccal cusp of the maxillary first molar occludes mesial to the buccal groove of the mandibular first molar [1]. It remains one of the most prevalent malocclusions worldwide, and its correction can be pursued through markedly different treatment philosophies depending on the patient's age, growth potential, and the severity of the underlying skeletal discrepancy. In the growing patient, growth modification seeks to redirect or enhance mandibular growth, or to restrain maxillary growth, during the pubertal growth spurt. In adolescents and adults with mild-to-moderate discrepancies, camouflage orthodontics-including, increasingly, clear aligner-based approaches-corrects the occlusal relationship primarily through dentoalveolar compensation without directly altering the skeletal bases. In patients with severe skeletal discrepancies whose growth is complete, combined orthodontic-surgical treatment is required. This review provides a comprehensive, updated overview of the epidemiology, diagnostic assessment, and full range of contemporary treatment modalities available for Class II malocclusion, drawing on both foundational studies and systematic reviews published through 2026.

II. EPIDEMOLOGY AND ETIOLOGY

A systematic review pooling data from 53 studies worldwide reported that Class II malocclusion affects approximately 19.6% of individuals in the permanent dentition and 23% in the mixed dentition, making it the second most common Angle classification after Class I; the prevalence of Class II was found to be highest among Caucasian populations and in the European continent [2] (Fig. 1). Etiologically, Class II malocclusion is a heterogeneous condition that may arise from mandibular skeletal retrognathism, maxillary skeletal protrusion, a combination of both, or from purely dentoalveolar factors, and may occur with or without an accompanying vertical or transverse component. Mandibular retrognathism is the most common skeletal component underlying Class II malocclusion, although the relative contribution of maxillary and mandibular factors varies among populations and

individual patients. This heterogeneity underlies the wide range of treatment modalities discussed in this review, since the optimal approach depends on correctly identifying whether the discrepancy is primarily skeletal or dentoalveolar, and which jaw (or both) is principally responsible.

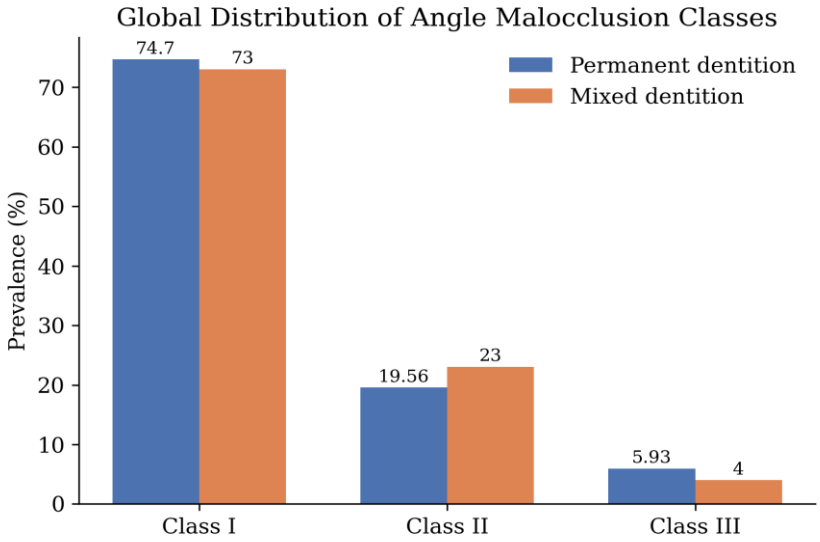

Fig. 1. Global distribution of Angle malocclusion classes in permanent and mixed dentition, pooled from 53 studies worldwide. Data from Alhammadi et al. [2].

III. DIAGNOSIS AND TREATMENT TIMING

A. Clinical and Cephalometric Diagnosis

Diagnosis of Class II malocclusion begins with Angle's molar-based classification and its division into Division 1 (proclined maxillary incisors, increased overjet) and Division 2 (retroclined maxillary central incisors, often with a deep bite) [1]. A complete diagnostic workup requires extraoral and intraoral examination, dental cast analysis, and lateral cephalometric radiography to determine whether the discrepancy is skeletal or dentoalveolar in origin and to identify the jaw(s) responsible. Sagittal skeletal relationships are typically assessed using the SNA, SNB, and ANB angles and the Wits appraisal, while the vertical growth pattern is assessed using measurements such as the mandibular plane angle and the Jarabak ratio; these measurements directly inform the choice between growth modification, camouflage, and surgical treatment.

B. Assessment of Growth Timing

Because the effectiveness of growth modification depends on treatment coinciding with an active growth phase, assessment of skeletal maturity is a key component of treatment planning in growing patients. The cervical vertebral maturation (CVM) method, which stages skeletal maturity from the morphology of the second through fourth cervical vertebrae on the same lateral cephalogram used for orthodontic diagnosis, is the most widely used clinical method for this purpose, with the peak in mandibular growth occurring between cervical stages 3 and 4 [3] (Fig. 2). Treatment with functional appliances timed to coincide with this pubertal peak is generally considered to maximize the skeletal contribution to Class II correction.

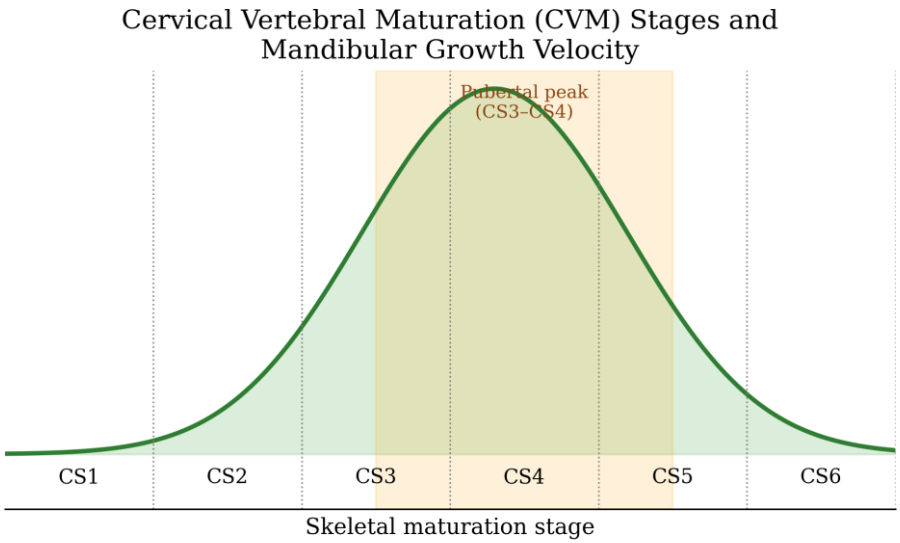

Fig. 2. Schematic representation of cervical vertebral maturation (CVM) stages (CS1-CS6) relative to mandibular growth velocity, with the pubertal growth peak occurring between CS3 and CS4, based on the staging method of Baccetti et al. [3].

IV. GROWTH MODIFICATION IN THE GROWING PATIENT

A. Removable Functional Appliances

Removable functional appliances correct Class II malocclusion by holding the mandible in a postured-forward position, which is thought to stimulate condylar and glenoid fossa remodeling while also producing dentoalveolar compensation. The Twin Block appliance, introduced by Clark, uses two separate acrylic bite blocks with interlocking inclined planes to posture the mandible forward and is designed for full-time wear, which improved patient comfort and compliance relative to earlier monobloc-type appliances [8].

B. Fixed Functional Appliances and Comparative Efficiency

Fixed functional appliances were developed to correct Class II malocclusion without depending on patient compliance. The Herbst appliance, reintroduced into clinical practice by Pancherz after a long period of dormancy following its original description by Emil Herbst, uses bilateral telescoping rods rigidly attached to the maxillary and mandibular dentition to hold the mandible continuously forward; Pancherz's cephalometric analysis of Herbst-treated cases demonstrated that occlusal correction results from a combination of mandibular skeletal advancement, restraint of maxillary growth, and dentoalveolar tooth movement [9]. The mandibular anterior repositioning appliance (MARA), a tooth-borne fixed functional appliance, produces a similar combination of skeletal and dentoalveolar effects, including mandibular length increase and maxillary molar distalization, with reported molar correction of approximately 7 mm and overjet reduction of approximately 4.7 mm in adolescent patients [10]. A comprehensive 2026 systematic review comparing seven functional appliance designs across 3,064 treated patients-including the Twin Block, Fränkel, Herbst, activator, Forsus, MARA, and bionator (Fig. 3)-calculated a coefficient of efficiency for each appliance based on mandibular length change per month of treatment, finding that the Twin Block was the most efficient removable appliance (0.46 mm/month) and the Forsus fatigue-resistant device the most efficient fixed appliance (0.41 mm/month) [7]. Fixed functional appliances are generally favored over removable designs in patients for whom compliance is a concern, since their effect does not depend on patient wear time.

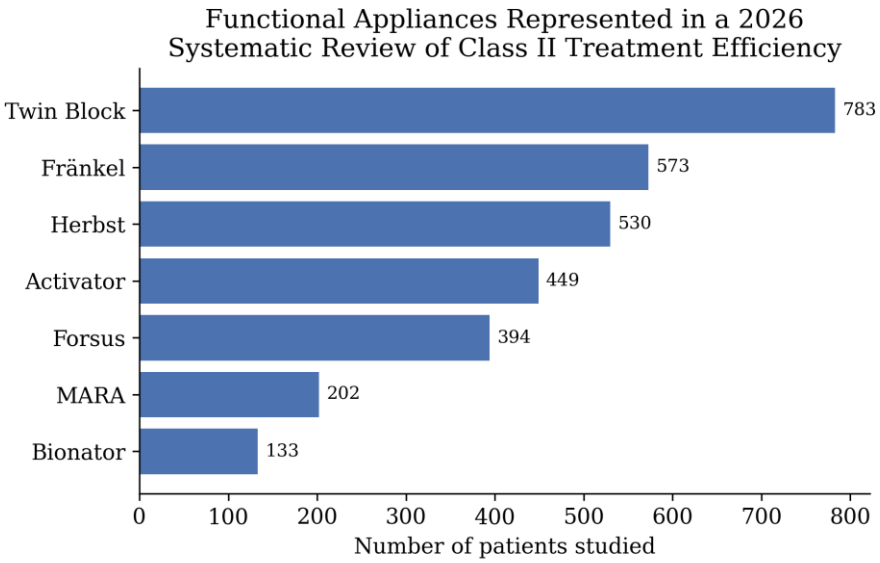

Fig. 3. Number of patients studied for each functional appliance type in a 2026 systematic review comparing the efficiency of Class II functional appliance therapy. Data from Venkatesan et al. [7].

C. Headgear and Extraoral Traction

Extraoral headgear, applied via cervical or high-pull traction to the maxillary molars, restrains or redirects maxillary skeletal and dentoalveolar growth and is most appropriately indicated when the Class II discrepancy has a significant maxillary protrusive component. Headgear has historically been used both as a stand-alone early treatment modality and in combination with fixed appliances or functional appliances during comprehensive treatment.

D. Evidence on the Timing of Growth Modification

The question of whether early (two-phase) treatment produces better long-term outcomes than a single, later phase of comprehensive treatment has been directly addressed by randomized clinical trials. The University of North Carolina trial randomized preadolescent children with an overjet greater than 7 mm to early treatment with headgear, a functional appliance (modified bionator), or observation; although approximately 75% of children receiving early treatment showed favorable skeletal change during the first treatment phase, a subsequent phase of comprehensive fixed appliance treatment eliminated most of the between-group differences in skeletal pattern, dental alignment, occlusion, and treatment duration and complexity by the end of definitive treatment [4]. Similarly, a large multicenter UK randomized controlled trial of early Twin Block treatment confirmed short-term dental and skeletal benefits of early treatment but did not demonstrate a long-term advantage over a single later phase of treatment [5]. Consistent with these trials, a Cochrane systematic review of orthodontic treatment for prominent upper front teeth concluded that early treatment reduces the incidence of incisal trauma but does not produce a clinically meaningful long-term skeletal or psychosocial advantage over treatment started in adolescence [6]. Taken together, this evidence supports individualizing the decision to treat early primarily on the basis of incisor trauma risk, psychosocial impact, and specific clinical circumstances, rather than on the assumption that earlier treatment is inherently more effective.

V. CLEAR ALIGNER-BASED CORRECTION OF CLASS II MALOCCLUSION

Clear aligner therapy has expanded rapidly as an esthetic treatment option for Class II malocclusion in both growing and adult patients, using integrated mandibular advancement features (precision cuts, ramps, or auxiliary elastics) to posture the mandible forward in a manner conceptually similar to fixed functional appliances. A 2025 systematic review and meta-analysis of functional clear aligners for Class II correction in growing patients found that aligner-based mandibular advancement produces measurable skeletal and dentoalveolar correction, although the evidence base remains smaller and more heterogeneous than that available for conventional functional appliances [13]. A complementary 2025 narrative review of clear aligner use across pediatric and adult Class II patients similarly concluded that aligners can achieve effective sagittal correction and molar distalization, while noting that control of the vertical dimension and achieving purely skeletal (rather than dentoalveolar) change remain areas requiring further clinical refinement and longer-term evidence [14]. Clear aligner-based mandibular advancement is therefore best regarded as an emerging, esthetically driven alternative to conventional functional appliances and Class II elastics, appropriate for motivated patients with mild-to-moderate discrepancies, rather than a replacement for fixed appliance or surgical treatment in more severe cases.

VI. CAMOUFLAGE ORTHODONTIC TREATMENT

A. Class II Intermaxillary Elastics

Class II elastics, worn from the maxillary anterior region to the mandibular posterior region, are among the most widely used mechanics for correcting residual Class II relationships during comprehensive fixed appliance treatment in adolescents and adults. A systematic review of their effects concluded that Class II elastics are effective in correcting the occlusal relationship, but that the correction is achieved predominantly through dentoalveolar movement-lingual tipping, retrusion, and extrusion of the maxillary incisors; labial tipping and intrusion of the mandibular incisors; and mesial movement and extrusion of the mandibular molars-rather than through skeletal change, and their use is associated with a degree of clockwise occlusal plane rotation that should be anticipated in treatment planning, particularly in patients with an already increased mandibular plane angle [11].

B. Extraction-Based Dental Camouflage

In adolescents and adults with mild-to-moderate skeletal Class II discrepancies and an acceptable facial profile, extraction of maxillary premolars (or, less commonly, a combination of maxillary and mandibular extractions) allows retraction of the maxillary anterior segment to correct the overjet and molar relationship without surgical intervention. This approach depends on careful anchorage control, since the amount of achievable dentoalveolar compensation is limited, and it is generally reserved for patients whose skeletal discrepancy and facial profile fall within the range that dental compensation can adequately address.

C. TAD/Miniscrew-Supported Molar Distalization

Temporary anchorage devices (TADs) have expanded the nonextraction camouflage options available for Class II correction by providing skeletal anchorage for maxillary molar distalization without the reciprocal anchorage loss associated with tooth-borne distalization appliances. A systematic review of miniscrew-supported distalization appliances found that they produce effective maxillary molar distalization with minimal loss of anterior anchorage, at the cost of a variable degree of distal crown tipping depending on appliance design [12]. TAD-supported distalization is particularly useful in patients who wish to avoid premolar extraction or who are not considered good candidates for compliance-dependent removable appliances.

VII. COMBINED ORTHODONTIC-SURGICAL (ORTHOGNATHIC) TREATMENT

A. Indications and Patient Selection

When the skeletal component of a Class II discrepancy is severe and growth has been completed, neither growth modification nor dental camouflage can adequately correct the underlying jaw-base relationship, and combined orthodontic-surgical treatment becomes the appropriate approach. Patient selection is guided by the magnitude of the ANB angle and Wits appraisal, the degree of dentoalveolar compensation already present, and the patient's facial esthetic goals; presurgical orthodontics is typically required to decompensate the dentition before surgical repositioning of the jaw bases.

B. Mandibular Advancement (Bilateral Sagittal Split Osteotomy)

Mandibular advancement is the surgical procedure most commonly indicated for Class II skeletal discrepancies caused by mandibular retrognathism. The bilateral sagittal split osteotomy (BSSO), first described by Trauner and Obwegeser for the surgical correction of mandibular prognathism and subsequently adapted and refined for mandibular advancement, remains the standard technique, allowing the mandible to be repositioned forward while the proximal (condylar) segments maintain their relationship to the temporomandibular joints [15].

C. Maxillary Procedures and Bimaxillary Surgery

When a maxillary component-such as vertical maxillary excess or a component of maxillary protrusion-is also present, maxillary surgery (impaction, setback, or repositioning via a Le Fort I osteotomy) may be performed either alone or in combination with mandibular surgery as part of a bimaxillary procedure. Bimaxillary surgery allows independent three-dimensional repositioning of both jaws and is particularly valuable when the discrepancy has both maxillary and mandibular components or when a rotational (asymmetry) correction is also required.

D. Contemporary Outcomes, Stability, and Complications

The long-term stability of orthognathic surgical movements varies according to the direction and magnitude of the movement and the type of fixation used. According to the hierarchy of stability described by Proffit and colleagues on the basis of a large surgical outcomes database, mandibular advancement performed with rigid fixation is one of the more stable orthognathic procedures, particularly in patients in whom anterior facial height is maintained or increased, whereas isolated mandibular setback and inferior repositioning of the maxilla are comparatively less stable [16]. A large 2026 systematic review and meta-analysis of 65 studies (6,482 patients) provided updated, quantitative confirmation of this general picture specifically for Class II corrections: mean ANB angle improvement was 5.4°, skeletal stability was maintained at one year or more in 87.3% of patients, and patient satisfaction reached 87.6%, with higher satisfaction for aesthetic than for functional outcomes (Fig. 5) [17]. The same review reported an overall complication rate of 32.4% (mostly minor and self-limiting), a relapse rate greater than 2 mm in 18.7% of patients, and neurosensory

disturbance in approximately half of bilateral sagittal split osteotomy patients, of whom 92.6% recovered by 12 months and only 3.4% experienced a permanent alteration [17]. These contemporary figures reinforce the importance of individualized surgical planning-including consideration of the vertical facial pattern and the magnitude of planned advancement, both of which were identified as relapse risk factors-when combined orthodontic-surgical treatment is planned for Class II correction.

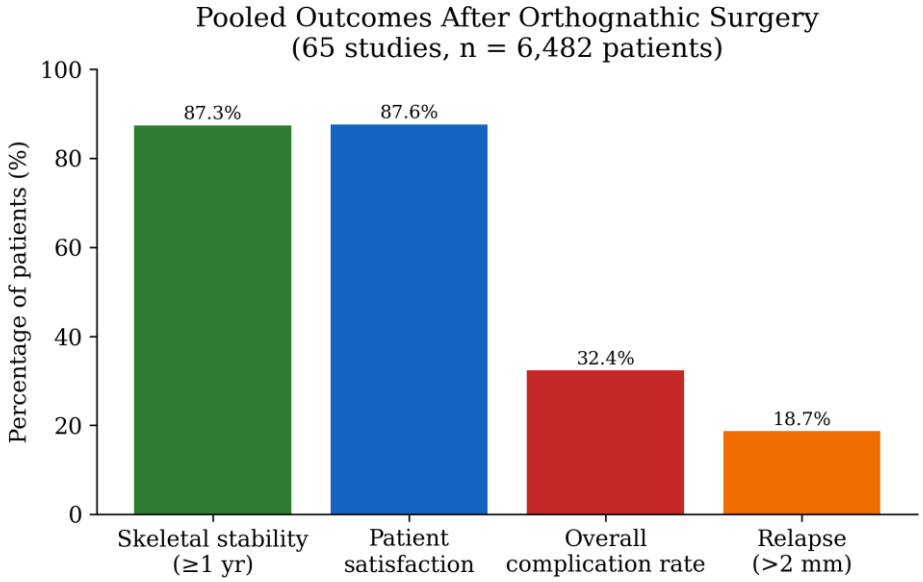

Fig. 4. Pooled outcomes following orthognathic surgery from a 2026 systematic review and meta-analysis of 65 studies (6,482 patients), including skeletal stability, patient satisfaction, overall complication rate, and relapse. Data from Ebenezer et al. [17].

VIII. COMPARATIVE SUMMARY AND DECISION FRAMEWORK

Table 1 summarizes the treatment modalities discussed in this review according to their typical indication, primary mechanism of correction, a representative quantitative benchmark, and supporting evidence, and Figure 5 presents a simplified decision framework synthesizing how growth status and discrepancy severity guide the choice among these modalities in practice.

TABLE 1

Summary of Treatment Modalities for Class II Malocclusion

Treatment modality	Typical indication	Primary mechanism of correction	Quantitative benchmark	Key references
Removable functional appliances (Twin Block, activator, bionator)	Growing patients; mild-to-moderate mandibular deficiency; near/at the pubertal growth peak	Postural mandibular advancement stimulating condylar/glenoid fossa remodeling, combined with dentoalveolar compensation	Twin Block: 0.46 mm/mo efficiency	[7,8]
Fixed functional appliances (Herbst, MARA, Forsus-type devices)	Growing patients; moderate-to-severe deficiency; limited patient compliance with removable appliances	Continuous (noncompliance-dependent) bite-jumping force producing skeletal and dentoalveolar effects	Forsus: 0.41 mm/mo efficiency	[7,9,10]
Clear aligner-based mandibular advancement	Growing and adult patients; mild-to-moderate deficiency; esthetic preference	Integrated aligner ramps/precision cuts posture the mandible forward, similar in principle to fixed functional appliances	Effective but more variable than conventional appliances	[13,14]
Headgear (cervical- or high-pull)	Growing patients with a maxillary excess/protrusive component	Restrains or redirects maxillary skeletal and dentoalveolar growth	-	[4]
Class II intermaxillary elastics	Adolescents and adults; mild-to-moderate dentoalveolar Class II	Reciprocal intermaxillary traction; effects are predominantly dentoalveolar	-	[11]
TAD/miniscrew-supported molar distalization	Adolescents and adults; mild-to-moderate Class II; extraction- or compliance-averse patients	Skeletally anchored distalizing force applied to the maxillary dentition	-	[12]

Extraction-based dental camouflage	Adults; mild-to-moderate skeletal discrepancy with an acceptable facial profile	Dental compensation through premolar extraction and space closure/retraction	-	-
Orthognathic surgery (BSSO mandibular advancement, Le Fort I procedures, bimaxillary surgery)	Nongrowing adults; severe skeletal discrepancy beyond the limits of camouflage	Direct surgical repositioning of the maxillary and/or mandibular skeletal bases	ANB improvement 5.4°; 87.3% stability ≥1 yr	[15,16,17]

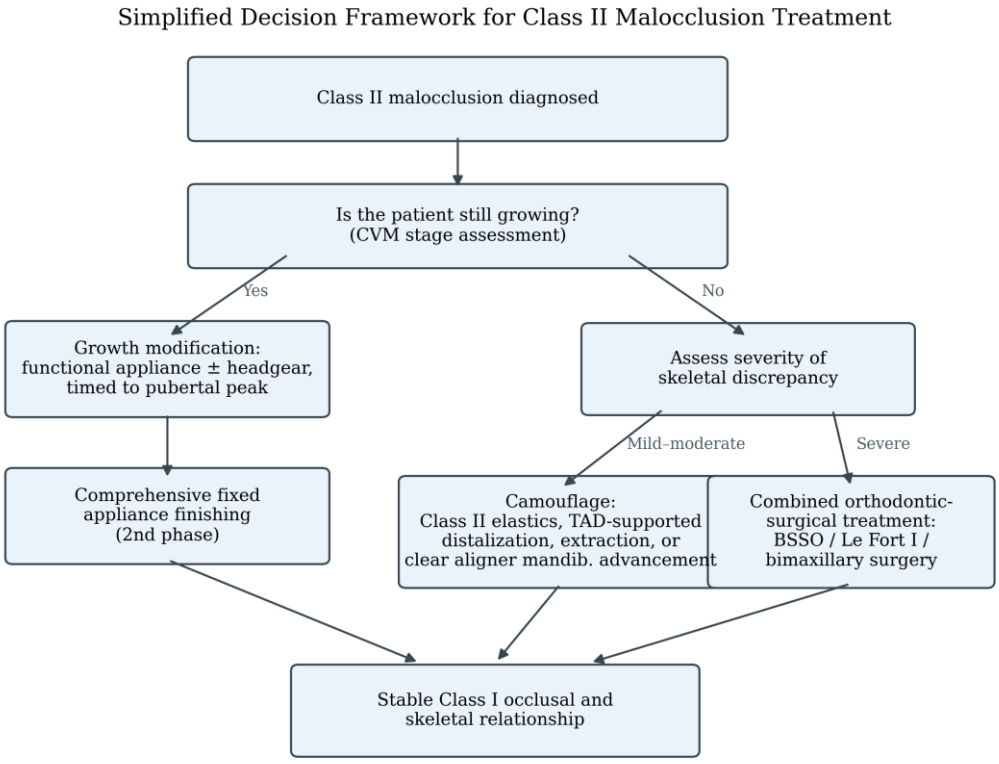

Fig. 5. Simplified decision framework for Class II malocclusion treatment, integrating growth status (assessed via CVM staging) and skeletal severity to guide selection among growth modification, camouflage, and orthognathic surgical approaches.

As Table 1 and Figure 5 illustrate, the choice among these modalities is governed less by a single decisive measurement than by the convergence of the patient's growth status, the severity of the skeletal (as opposed to dentoalveolar) component of the discrepancy, and any accompanying vertical or transverse complicating factors. In the growing patient with an active pubertal growth phase remaining, functional appliance therapy-fixed, removable, or increasingly aligner-based, depending on compliance and esthetic considerations-offers the opportunity to harness residual growth, although the evidence reviewed above indicates that this opportunity should be weighed against trauma risk and psychosocial factors rather than assumed to shorten overall treatment. In the adolescent or adult with a mild-to-moderate, largely dentoalveolar discrepancy, camouflage strategies, ranging from Class II elastics to TAD-supported distalization to extraction-based space closure to clear aligner mandibular advancement, can achieve a stable Class I occlusion without surgical intervention. Once growth is complete and the skeletal discrepancy exceeds what dentoalveolar compensation can reasonably mask, combined orthodontic-surgical treatment remains the only approach capable of correcting the jaw-base relationship itself, and contemporary pooled data now allow this decision to be discussed with patients using quantitative estimates of expected skeletal correction, stability, satisfaction, and complication risk.

IX. CONCLUSION

Class II malocclusion encompasses a heterogeneous group of skeletal and dentoalveolar discrepancies for which orthodontics offers a correspondingly broad range of treatment modalities, from growth modification with functional or clear aligner appliances in the growing patient, through camouflage mechanics and TAD-supported tooth movement in adolescents and adults with milder discrepancies, to combined orthodontic-surgical correction in nongrowing patients with severe skeletal discrepancies. Selecting

among these approaches requires an individualized assessment of growth status, skeletal severity, and facial esthetics, supported by the cephalometric and growth-timing tools reviewed here and, increasingly, by large contemporary systematic reviews that quantify the comparative efficiency of functional appliances and the stability and safety of orthognathic surgery. Continued long-term, randomized evidence-particularly regarding clear aligner-based mandibular advancement and the comparative long-term stability of contemporary fixed functional appliances and orthognathic procedures-will further refine this decision-making framework.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this review.

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