Second Premolar Extraction in Orthodontics: Contemporary Concepts, Biomechanical Considerations, Treatment Outcomes, And Future Perspectives a Narrative Review

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***Abstract*—Background Orthodontic extraction therapy remains one of the most debated treatment modalities in contemporary clinical practice. Although first premolar extraction has historically been ```regarded as the standard approach for managing severe crowding and dentoalveolar protrusion, second premolar extraction continues to represent an important alternative in carefully selected patients. The decision to extract second premolars is influenced by multiple factors, including the severity and distribution of crowding, facial profile, anchorage requirements, molar relationship, periodontal status, growth potential, and long-term stability. Recent investigations have also explored the potential effects of extraction therapy on airway dimensions, facial soft tissues, and overall treatment outcomes, renewing interest in evidence-based extraction protocols. [1–5]**

Objective To critically review the current literature regarding orthodontic second premolar extraction, with emphasis on biological rationale, case selection, biomechanics, treatment outcomes, facial profile changes, airway implications, stability, and future clinical applications. Methods A comprehensive narrative review of the orthodontic literature was performed using peer-reviewed publications from major scientific databases including PubMed, Scopus, Web of Science, and Google Scholar. Original research articles, systematic reviews, meta-analyses, randomized clinical trials, retrospective studies, and classical orthodontic literature addressing second premolar extraction were critically evaluated. Results Current evidence indicates that second premolar extraction provides favorable treatment outcomes in appropriately selected patients, particularly those presenting with moderate crowding, minimal soft tissue protrusion, and reduced anchorage demands. Compared with first premolar extraction, second premolar extraction generally preserves anterior tooth position, minimizes lip retrusion, and facilitates space closure with relatively simplified biomechanics. Long-term occlusal stability appears comparable between extraction protocols when appropriate diagnosis and retention are implemented. Recent investigations suggest that concerns regarding airway compromise following second premolar extraction are not supported by current evidence. Nevertheless, available studies remain limited by retrospective designs, heterogeneous treatment protocols, and relatively small sample sizes.

Conclusion Second premolar extraction remains a valuable treatment option in modern orthodontics. Successful outcomes depend primarily on individualized diagnosis rather than adherence to universal extraction philosophies. Future prospective multicenter investigations employing three-dimensional imaging, digital treatment planning, and patient-reported outcome measures are required to further define optimal clinical indications.

***Index Terms*—Orthodontics; Second premolar extraction; Extraction therapy; Airway; Anchorage; Stability; Facial profile; Biomechanics.**

I. INTRODUCTION

Extraction therapy has remained one of the most controversial topics in orthodontics for more than a century. Since the philosophical debate between Edward H. Angle, who advocated the preservation of all permanent teeth whenever possible, and Calvin S. Case, who supported selective extraction to improve facial esthetics and occlusal stability, clinicians have continuously sought evidence to determine the most appropriate treatment strategy.[1,2] Although extraction rates have fluctuated considerably over time, extraction therapy continues to play an indispensable role in managing dentofacial discrepancies that cannot

be predictably corrected by non-extraction mechanics alone.[3]

Among the various extraction protocols available, first premolar extraction has traditionally been regarded as the standard approach for relieving severe crowding, correcting dentoalveolar protrusion, and facilitating maximum anterior retraction.[4] However, second premolar extraction represents an important alternative for selected patients requiring moderate space gain while maintaining anterior tooth position and minimizing soft tissue changes.[5] The extraction of second premolars allows orthodontists to redistribute space more posteriorly, thereby reducing anchorage requirements and preserving facial convexity in patients with balanced soft tissue profiles.[6]

The choice between first and second premolar extraction should not be viewed as a rigid treatment philosophy but rather as an individualized clinical decision based on comprehensive diagnosis. Contemporary orthodontic treatment planning integrates skeletal relationships, dental crowding, facial esthetics, periodontal health, incisor inclination, growth potential, patient expectations, and long-term stability before selecting an extraction protocol.[7] Recent advances in cone-beam computed tomography (CBCT), three-dimensional digital treatment planning, finite element analysis, and artificial intelligence-assisted orthodontic diagnosis have further refined clinicians' ability to predict treatment outcomes with greater precision.[8]

Historically, the popularity of second premolar extraction has varied considerably. During the late twentieth century, extraction therapy became increasingly associated with first premolar removal because it provided substantial space for incisor retraction in patients with protrusive dentitions.[9] Nevertheless, clinicians managing Class I malocclusions with moderate crowding, mild bimaxillary protrusion, or minimal anchorage requirements frequently reported excellent results following second premolar extraction, particularly when preservation of facial soft tissue support was desired.[10]

One of the principal biomechanical advantages of second premolar extraction lies in its influence on anchorage demands. Because extraction spaces are located posterior to the canine teeth, spontaneous mesial migration of molars and physiologic drift contribute to space closure, thereby decreasing the need for extensive anchorage reinforcement. [11] Consequently, treatment mechanics may become less complex, reducing dependence on extraoral appliances, temporary anchorage devices, or extensive intraoral anchorage systems in carefully selected patients. However, inappropriate case selection may compromise anterior alignment, overjet correction, and sagittal occlusal relationships, emphasizing the importance of individualized treatment planning. [12]

Interest in second premolar extraction has increased in recent years because of renewed concerns regarding the potential influence of orthodontic extraction therapy on upper airway dimensions. Several investigations have suggested that retraction of anterior teeth following extraction may reduce oral cavity volume and alter tongue posture, potentially affecting pharyngeal airway dimensions.[13] However, systematic reviews have reported inconsistent evidence, and recent studies specifically evaluating second premolar extraction have not demonstrated clinically significant reductions in airway volume.[14] In particular, Mladenovic et al. (2024) reported increases in airway volume following treatment in both extraction and non-extraction groups, with no statistically significant intergroup differences, suggesting that growth-related changes rather than extraction therapy alone may explain the observed airway alterations.[15]

Beyond airway considerations, contemporary orthodontic practice increasingly emphasizes patient-centered outcomes, including facial attractiveness, smile esthetics, treatment efficiency, periodontal preservation, and long-term quality of life. Digital workflows, customized appliances, aligner therapy, and skeletal anchorage have expanded treatment possibilities, yet extraction therapy remains indispensable in appropriately selected patients. Rather than representing opposing treatment philosophies, extraction and non-extraction approaches should be considered complementary strategies guided by evidence-based diagnosis and individualized treatment objectives. [16]

Accordingly, the purpose of this narrative review is to critically evaluate the contemporary evidence regarding orthodontic second premolar extraction, with particular emphasis on historical evolution, biological rationale, case selection, biomechanics,

facial profile changes, airway implications, long-term stability, and future research directions.

II. HISTORICAL EVOLUTION OF SECOND PREMOLAR EXTRACTION

The extraction of permanent teeth as part of orthodontic treatment has been one of the most debated topics in the specialty. During the early twentieth century, Edward H. Angle advocated the preservation of all permanent teeth, believing that ideal occlusion and facial harmony could be achieved without extraction. In contrast, Calvin S. Case argued that selective extraction was often essential to manage severe crowding, dentoalveolar protrusion, and facial imbalance. This philosophical conflict formed the basis of the classical extraction versus non-extraction debate that continues to influence contemporary orthodontic practice. [17–20]

Although first premolar extraction became the predominant extraction protocol following the work of Charles H. Tweed, clinicians soon recognized that not every extraction case required maximum anterior retraction. Patients presenting with moderate crowding, acceptable facial profiles, minimal lip protrusion, and reduced anchorage requirements frequently exhibited superior esthetic outcomes when second premolars were removed rather than first premolars. [21–23]

A major milestone in the development of second premolar extraction philosophy was the publication of Dewel's landmark paper in 1955, which systematically described the principles, indications, biomechanics, and clinical application of second premolar extraction. Dewel emphasized that extraction decisions should never follow rigid rules but instead should be individualized according to arch-length discrepancy, facial profile, anchorage requirements, growth pattern, and soft tissue considerations. He cautioned against excessive lingual movement of the mandibular incisors and highlighted the importance of preserving facial esthetics while obtaining stable occlusal relationships. [24]

Subsequently, Logan (1973) expanded these concepts by presenting detailed clinical guidelines for second premolar extraction in both Class I and Class II malocclusions. Logan demonstrated that extraction of second premolars could effectively relieve moderate crowding while minimizing anterior retraction and preserving lip support. The study also emphasized careful diagnosis, individualized anchorage planning, and maintenance of favorable soft tissue profile as essential determinants of successful treatment outcomes. [25]

Further refinement of the extraction philosophy occurred during the 1970s through the work of de Castro, who introduced practical guidelines for selecting second premolar extraction in borderline malocclusions. He suggested that the extraction site should be selected according to the desired tooth movement rather than following a uniform extraction protocol, thereby reinforcing the concept of individualized treatment planning. [26]

Today, extraction therapy is no longer viewed as a philosophical preference but as a diagnostic decision based on comprehensive evaluation of skeletal, dental, periodontal, functional, and esthetic parameters. Contemporary orthodontics emphasizes evidence-based case selection, integrating digital imaging, cone-beam computed tomography (CBCT), facial soft tissue analysis, and patient-centered treatment objectives into the decision-making process. [19–21]

III. BIOLOGICAL BASIS OF SECOND PREMOLAR EXTRACTION

Orthodontic tooth movement following extraction is mediated through remodeling of the periodontal ligament and alveolar bone. Application of controlled orthodontic forces generates compression and tension within the periodontal ligament, stimulating osteoclastic bone resorption on the pressure side and osteoblastic bone deposition on the tension side. These biologic processes permit controlled movement of teeth while maintaining periodontal health when physiologic force levels are employed. [19 21]

Unlike first premolar extraction, second premolar extraction positions the extraction space posterior to the canine. Consequently, space closure occurs predominantly through mesial movement of posterior teeth rather than extensive retraction of the anterior segment. This difference substantially reduces anchorage demands and limits undesirable lingual displacement of the incisors. [21 24]

Dewel emphasized that extraction decisions should consider five major biological determinants:

- Arch-length discrepancy

- Growth tendency
- Occlusal organization
- Anchorage requirements
- Soft tissue profile

These principles remain central to modern extraction planning and continue to guide case selection. [24]

IV. DIAGNOSIS AND CASE SELECTION

Successful second premolar extraction depends on meticulous diagnosis rather than routine application of extraction protocols. Comprehensive assessment should include skeletal, dental, periodontal, esthetic, and functional analyses before selecting the extraction pattern. [19] [20]

Skeletal Evaluation

Cephalometric assessment should evaluate:

- ANB angle
- Wit's appraisal
- Vertical facial pattern
- Mandibular plane angle
- Facial convexity
- Growth potential

Patients with severe skeletal discrepancies generally require orthognathic surgery or alternative camouflage strategies rather than routine second premolar extraction. [19]

Dental Evaluation

Dental analysis should include:

- Arch-length discrepancy
- Bolton tooth-size analysis
- Curve of Spee
- Incisor inclination
- Molar relationship
- Canine relationship
- Midline discrepancy
- Dental arch symmetry

Second premolar extraction is particularly advantageous in patients exhibiting moderate crowding (approximately 4–7 mm) with relatively well-positioned incisors and minimal need for anterior retraction. [24] [25]

Soft Tissue Assessment

Modern orthodontic treatment emphasizes preservation of facial esthetics. Evaluation should include:

- Lip prominence
- Nasolabial angle
- Mentolabial sulcus
- Smile arc
- Incisor display
- Facial symmetry
- Soft tissue thickness

Patients with balanced facial profiles generally benefit from preserving anterior tooth position, making second premolar extraction preferable to first premolar extraction in appropriate clinical situations. [20] [21]

V. AIRWAY CONSIDERATIONS

Concern regarding the influence of orthodontic extraction on upper airway dimensions has increased during the past decade. The first study specifically evaluating second premolar extraction was published by Mladenovic et al. (2024). Using CBCT, the authors compared 54 second-premolar extraction patients with 59 matched non-extraction patients and found that airway volume increased significantly in both groups, with no statistically significant difference between them. Multivariable regression demonstrated that changes in airway length and minimum constriction area, rather than extraction therapy itself, explained the observed increase in airway volume. [27]

These findings suggest that second premolar extraction does not adversely affect upper airway volume; however, the authors acknowledged limitations related to the retrospective design and the influence of craniofacial growth. Consequently, prospective longitudinal investigations with standardized CBCT protocols remain necessary. [27]

Indications for Second Premolar Extraction

Current evidence supports second premolar extraction in the following situations:

1. Moderate arch-length discrepancy (4–7 mm). [24] [25]
2. Mild dentoalveolar protrusion requiring limited incisor retraction. [24]
3. Balanced facial profile where lip support should be preserved. [20]
4. Reduced anchorage requirement with planned mesial movement of posterior teeth. [21]
5. Class I malocclusion associated with moderate crowding. [25]
6. Mild Class II malocclusion in which excessive anterior retraction is unnecessary. [25]

7. Borderline extraction cases where non-extraction treatment may compromise stability or periodontal health. [26]

Dewel described second premolar extraction as particularly suitable for "average extraction cases" in which preservation of soft tissue harmony and physiologic tooth movement are primary treatment objectives. [24]

Contraindications

Second premolar extraction should generally be avoided in patients presenting with:

- Severe bimaxillary protrusion requiring maximum incisor retraction. [19]
- Maximum anchorage requirements. [21]
- Severe Class II malocclusion requiring substantial anterior retraction. [25]
- Large overjet associated with proclined incisors. [19]
- Significant skeletal discrepancies requiring orthognathic correction. [20]
- Patients in whom facial profile improvement depends upon considerable reduction of lip prominence. [21]

Under these circumstances, first premolar extraction frequently provides superior biomechanical control and greater capacity for anterior tooth movement. [19–21]

VI. CRITICAL APPRAISAL

The literature consistently supports the principle that extraction decisions should be individualized rather than dictated by fixed treatment philosophies. Dewel's biologically oriented principles published nearly seven decades ago remain remarkably consistent with contemporary evidence-based orthodontics. [24]

Recent CBCT evidence from Mladenovic et al. has addressed concerns regarding airway compromise after second premolar extraction and found no significant detrimental effect on airway volume compared with non-extraction treatment. [27] Nevertheless, most available studies remain retrospective and heterogeneous, underscoring the need for prospective multicenter trials with standardized treatment protocols and long-term follow-up. [27]

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