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Review Article

Rebuilding Strength and Sustainability: A Contemporary Prostho-Endo Paradigm for Managing Structurally Compromised Teeth

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Abstract

Introduction: Managing structurally compromised teeth remains a multifaceted challenge in modern dental practice, requiring a coordinated interdisciplinary approach that integrates prosthodontic and endodontic principles to achieve optimal functional and aesthetic rehabilitation.
Objective: This narrative review critically evaluates contemporary evidence-based protocols for restoring structurally compromised teeth, emphasizing the synergistic role of prosthodontic and endodontic strategies.
Literature Review: Structurally compromised teeth exhibit reduced biomechanical integrity, increasing the complexity of restorative procedures and jeopardizing long-term prognosis. Achieving durable outcomes necessitates a treatment philosophy that balances preservation of remaining tooth structure, aesthetic demands, and biomechanical requirements. An interdisciplinary prostho-endo approach—incorporating advanced adhesive dentistry, biologically oriented preparation techniques, surgical crown lengthening when needed, and modern prosthodontic restorations—enhances predictability and improves long-term survival of compromised teeth.
Conclusion: Early interdisciplinary collaboration is fundamental to optimizing tooth longevity, function, and aesthetics. A prostho-endo workflow rooted in minimally invasive, evidence-based principles aligns with contemporary expectations for patient-centered dental care.

Keywords: *Adhesive dentistry, Aesthetics, Biomechanical integrity, Endodontics, Interdisciplinary approach, minimally invasive dentistry, Prosthodontics, structurally compromised teeth, Tooth restoration.*

INTRODUCTION

Structurally compromised teeth (SCT) (Figure 1) refer to teeth with significant loss of coronal and/or cervical structure due to caries, trauma, extensive restorations, endodontic procedures, or operative errors. Such structural loss weakens the mechanical integrity of the tooth, reducing its ability to withstand functional occlusal forces. The resulting discontinuity compromises resistance form, increases susceptibility to cusp fractures, crack propagation, microleakage, and secondary caries, and may negatively affect mastication and comfort.[1] The major etiological factors and their biomechanical implications are summarized in Table 1.

Table 1. Etiology and Clinical Impact of Structurally Compromised Teeth

Etiology	Mechanism of Structural Loss	Resulting Clinical Impact
Dental caries	Progressive demineralization and cavitation	Loss of structural continuity, increased fracture risk
Trauma	Direct impact leading to enamel-dentin fractures	Cusp fractures, pulpal involvement
Extensive restorations	Over-preparation, removal of sound tooth structure	Reduced resistance form, microleakage
Endodontic procedures	Access cavity, instrumentation, dentin dehydration	Weakened pericervical dentin, vertical root fracture risk
Operative errors	Over-tapering, excessive canal shaping	Structural thinning and mechanical failure
Aging	Loss of dentin resilience, reduced elasticity	Increased brittleness and susceptibility to cracks

Aesthetically, SCT often present with contour deformities, discoloration, or missing tooth components that disrupt smile harmony. These changes may diminish patient satisfaction and impact psychosocial well-being.[2] Because SCT affect function, esthetics, and quality of life, timely interdisciplinary intervention is essential.

Ashnagar et al. reported that SCT can frequently be retained long-term when treated using coordinated surgical and restorative procedures, including crown lengthening and adhesive rehabilitation.[3] Thus, an integrated prosthodontic–endodontic (Prostho–Endo) workflow becomes pivotal for restoring biological, mechanical, and functional integrity.

Figure 1 – Structurally Compromised Teeth (SCT)

Structural and Pre-Endodontic Considerations in SCT

SCT typically present with extensive loss of coronal and cervical tooth structure, altering biomechanical behavior and greatly reducing fracture resistance. Post-endodontic teeth suffer further compromise due to dentin removal during access cavity preparation, instrumentation, and irrigation, as well as age-related changes.[4]

Pre-endodontic restoration is a foundational step in SCT management. It stabilizes remaining tooth structure, improves rubber dam isolation, prevents microbial leakage, and enables immediate dentin sealing. Gavriil et al. noted that pre-endodontic buildup significantly improves bond strength and enhances predictability in SCT rehabilitation.[5] The materials and indications for pre-endodontic stabilization are detailed in Table 2.

Table 2. Pre-Endodontic Stabilization Options for SCT

Material / Technique	Advantages	Indications
Resin composite	Superior bonding, immediate dentin sealing	Moderately compromised crowns, need for isolation
Resin-modified glass ionomer (RMGI)	Fluoride release, moisture tolerance	Cervical defects, high caries risk
Flowable bulk-fill materials	Adaptability to cavity walls	Deep cavities, irregular morphology
Provisional crowns	Immediate structural support	Extensive coronal loss, weak cusps
Sectional matrix buildup	Enhances contour, improves adhesive seal	Teeth requiring controlled proximal wall formation

Endodontic Management of Structurally Compromised Teeth

Management of SCT during endodontic therapy is challenging due to weakened roots and reduced dentin thickness. Excess canal enlargement or improper access designs increase the risk of vertical root fracture and restorative failure. Bhuva et al. emphasized that root-filled teeth with substantial structural loss exhibit significantly lower long-term survival.[6]

Key endodontic strategies include:

1. **Minimally invasive endodontics:** Conservative access designs and selective canal instrumentation help preserve pericervical dentin, the region most critical for structural integrity.[7]
2. **Management of root fractures:** Adhesive stabilization (e.g., fiber posts), splinting, surgical extrusion, decoronation, or extraction may be indicated depending on fracture severity.
3. **Use of biomaterials:** Bioceramics and MTA offer excellent sealing and promote biomineralization. They are particularly effective in perforations, resorption defects, and reinforcement of thin dentin walls.[8]
4. **Guided endodontics:** Digital navigation and guided access improve accuracy in calcified canals and reduce unnecessary dentin removal.[9]

A comprehensive summary of endodontic strategies for SCT is provided in Table 3.

Table 3. Endodontic Management Strategies for Structurally Compromised Teeth

Management Area	Key Principles	Clinical Applications
Minimally invasive endodontics	Conservative access, selective shaping	Preserving pericervical dentin, improving fracture resistance
Root fracture management	Adhesive stabilization, splinting, surgical extrusion	Cracked roots, vertical fractures, subcrestal fractures
Use of biomaterials (MTA, Bioceramics)	High sealability, biomineralization	Perforation repair, resorption, apexification
Guided endodontics	Template-guided access, digital navigation	Calcified canals, minimal dentin removal, high accuracy

Prosthodontic Approach to Remaining Tooth Structure

1. **Ferrule Effect**

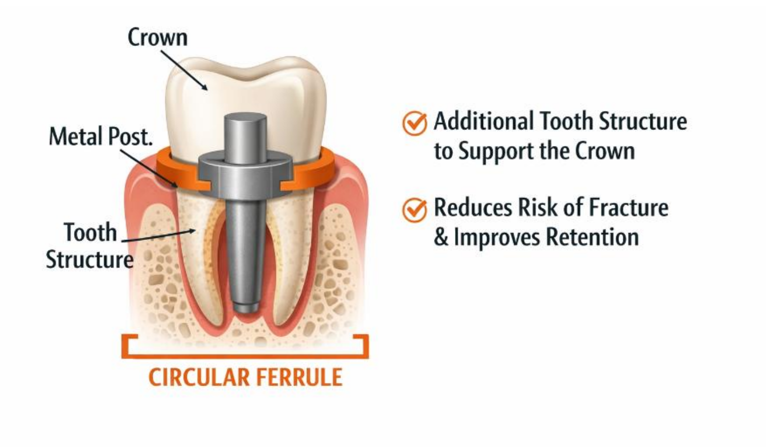

Figure 2 – Ferrule Effect

The ferrule effect (Figure 2) requiring 1.5–2 mm of circumferential tooth structure—is a fundamental determinant of SCT prognosis. Sorensen and Engelman demonstrated that the ferrule significantly enhances fracture resistance and reduces catastrophic failures.[10] Teeth lacking adequate ferrule may require crown lengthening or orthodontic extrusion.

Figure 3 – Fiber-Reinforced Composite Posts

2. **Post and Core Selection** Posts are indicated when coronal tooth structure is insufficient for core retention. Fiber-reinforced composite posts (Figure 3) are preferred due to their dentin-like elasticity, promoting favorable stress distribution.[11] Resin composite cores enhance reinforcement, while cast metal posts (Figure 4) are reserved for select cases.

Figure 4 – Cast Metal Posts

3. **Restorative Material Selection** Material choice affects esthetics, longevity, and functional durability. High-strength ceramics provide superior esthetics and fracture strength, while fiber-reinforced composites offer shock absorption in high-risk situations.[12]

The core prosthodontic principles governing SCT restoration are outlined in Table 4.

Table 4. Prosthodontic Principles in Restoring Structurally Compromised Teeth

Parameter	Clinical Considerations	Evidence-Based Benefits
Ferrule effect	≥1.5–2 mm vertical tooth structure	Improves fracture resistance, reduces catastrophic failure
Fiber posts	Elastic modulus close to dentin	Better stress distribution, favorable failure patterns
Cast metal posts	High rigidity, custom fit	Use in narrow or flared canals
Resin composite cores	Adhesively bonded, strong reinforcement	Increased retention and resistance
Ceramic crowns (Zirconia, Li-disilicate)	High strength, esthetics	Requires adequate tooth structure

Aesthetic and Functional Rehabilitation

1. **Anterior Teeth:** Esthetic Requirements Restoring anterior SCT requires meticulous shade matching, translucency replication, and preservation of optical properties. Layered ceramics or high-performance composites help achieve biomimetic outcomes.[13]
2. **Posterior Teeth:** Functional Requirements Posterior SCT are exposed to high occlusal loads. Durable ceramics and adhesive restorative strategies reduce biomechanical failure rates.[14]

A comparison of esthetic vs functional restorative requirements is summarized in Table 5.

Table 5. Aesthetic and Functional Rehabilitation in SCT

Tooth Region	Key Requirements	Preferred Materials/Techniques
Anterior teeth	Shade matching, translucency, biomimicry	Layered ceramics, nano-hybrid composites
Posterior teeth	High strength, wear resistance	Zirconia crowns, reinforced composites
Both regions	Adhesive bonding, preservation of enamel	Minimal preparation strategies

Clinical Decision-Making in SCT

1. **Stepwise Treatment Planning** A structured approach includes assessment of dentin thickness, periodontal support, occlusal forces, and restorability. Fichera et al. recommended evaluating the most apical sound cervical structure prior to establishing ferrule or planning crown lengthening.[15]
2. **Case Selection** Complex cases with subgingival defects or questionable restorability may require periodontal or orthodontic intervention.
3. **Timing of Procedures** Early pre-endodontic buildup is beneficial. Adhesive cores should ideally be placed immediately after root canal therapy.

The key decision-making parameters for SCT are presented in Table 6.

Table 6. Clinical Decision-Making Framework in SCT Management

Decision Component	Description	Clinical Significance
Dentin thickness evaluation	Assess remaining radicular and cervical dentin	Determines feasibility of restoration
Periodontal assessment	Crown lengthening needs, biological width	Influences ferrule planning
Occlusal load & parafunction	Evaluate bruxism, occlusal forces	Dictates restorative material choice
Restorability criteria	Based on most apical sound cervical structure	Guides need for extrusion, surgery
Timing of procedures	Early buildup, immediate core placement	Enhances sealing and reinforcement

Digital Dentistry in SCT Rehabilitation

Digital workflows enhance diagnostic accuracy and improve treatment predictability in SCT management. CBCT integration, digital smile design, jaw motion tracking, virtual articulators, and CAD/CAM restorations enable individualized planning. Qiu et al. reported that virtual articulators significantly improve occlusal precision and physiological function.[16]

Although digital dentistry greatly enhances precision, variability among scanners and limited long-term evidence highlight the need for standardization.[17]

Table 7 summarizes the primary digital applications and their clinical advantages in SCT rehabilitation.

Table 7. Applications of Digital Dentistry in SCT Rehabilitation

Digital Tool	Application	Clinical Benefit
CBCT	3D dentin thickness evaluation	Precise diagnosis and planning
Digital smile design	Anterior esthetic planning	Predictable outcomes
Guided endodontics	Digitally planned access	Reduced dentin removal
Virtual articulator	Occlusal simulation	Better functional rehabilitation
CAD/CAM crowns	Monolithic restorations	Accurate fit, strength

DISCUSSION

Management of structurally compromised teeth requires synergistic involvement of endodontics, prosthodontics, periodontology, and digital technologies. The central objective is to balance biological preservation with mechanical reinforcement. Minimally invasive endodontics, adhesive dentistry, and fiber-reinforced restorations form the backbone of contemporary SCT rehabilitation.

Despite technological advancements, clinical success still relies on remaining tooth structure, ferrule establishment, and preservation of pericervical dentin. Digital tools enhance accuracy, but biological limitations remain significant. Long-term studies emphasize that restorability—not mere survival after RCT—defines prognosis.

There is a pressing need for standardized protocols, particularly for SCT with extensive cervical structural loss.

Future Directions and Research Gaps

- Development of standardized digital workflows for SCT
- Long-term trials comparing traditional vs digital restorative strategies
- Application of AI-based predictive models for fracture risk
- Studies evaluating cost-effectiveness across diverse clinical settings
- Protocols combining adhesive dentistry with bioceramics in severely compromised cases

CONCLUSION

The rehabilitation of structurally compromised teeth (SCT) requires a genuinely integrated, multidisciplinary approach that begins with precise diagnosis and continues through to the delivery of esthetically pleasing and functionally durable restorations. By combining thorough endodontic management, ferrule-oriented prosthodontic planning, and innovations in digital dentistry, clinicians can preserve the remaining tooth structure, enhance fracture resistance, and improve long-term prognoses.

For clinicians and researchers alike, the overarching message is clear: restoration longevity is optimized not only through sound biomechanical design but also through timely intervention, coordinated interdisciplinary planning, and the thoughtful incorporation of digital technologies. When implemented correctly, this holistic framework provides durable function, superior esthetics, and an improved quality of life for patients with structurally compromised teeth.

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