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The Influence of Conservative Vs. Full-Coverage Restorations on Pulp Vitality Outcomes in Cracked teeth: A Literature Review

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Abstract

Cracked teeth pose complex restorative and endodontic challenges, with ongoing debate between minimally invasive methods aimed at preserving pulp vitality and full-coverage restorations designed to enhance structural stability. Advances in adhesives, bioactive materials, and digital workflows have encouraged biologically conservative treatments, yet long-term outcomes related to survival and vitality remain variable and inconclusive. This review critically appraises current evidence on the restorative management of cracked teeth, emphasizing how conservative and full-coverage interventions influence pulp vitality preservation and long-term prognosis. A systematic review of the literature was conducted using the PubMed and ScienceDirect databases. Studies published between 2017 and 2025 were selected based on their relevance to the restorative approach and pulpal outcome in cracked teeth. In conclusion, both conservative and full-coverage restorations can be effective when cases are properly selected. Conservative adhesive techniques and bioactive materials maintain pulp vitality, while full-coverage crowns are preferred for structurally compromised teeth. Clear diagnostic and reporting standards are needed to improve evidence consistency and guide treatment decisions.

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Introduction

Cracked teeth present a significant diagnostic and therapeutic challenge in contemporary restorative and endodontic practice. They are characterized by incomplete fractures that begin in the crown and extend subgingivally in a mesiodistal direction, often involving one or both marginal ridges.[1] The prevalence of cracked tooth syndrome (CTS) has increased with greater tooth longevity, higher occlusal loads, parafunctional habits, and extensive intracoronal restorations, making it one of the most common causes of tooth loss after caries and periodontal disease.[2]

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The clinical presentation of cracked teeth varies from mild discomfort during mastication or cold sensitivity to severe, irreversible pulpitis or even pulpal necrosis.[3] Diagnosing the extent and depth of the crack is often challenging because fracture lines are not always visible radiographically. The prognosis is determined by multiple factors, including crack direction, pulpal and periodontal involvement, restorative design, and timeliness of intervention.[4,5] Traditionally, treatment has favored elective root canal therapy followed by full-coverage crowns to prevent propagation of the crack and restore function.[3] However, this conventional approach, while predictable, often sacrifices substantial sound tooth structure, especially when the pulp remains vital.

Recent advances in adhesive dentistry, bioactive materials, and minimally invasive restorative techniques have prompted a paradigm shift toward biologically conservative management. Materials such as Biodentine and resin-based adhesives can provide an internal seal and dentin replacement, supporting the concept of vital pulp therapy (VPT) in structurally compromised teeth.[6] Moreover, adhesive onlays, occlusal veneers, and partial-coverage restorations have emerged as alternatives to traditional crowns, offering reinforcement with minimal tooth reduction.[2] These techniques align with the principles of minimally invasive dentistry, which emphasize preserving sound tooth structure and maintaining pulpal vitality whenever possible.

Nevertheless, there remains no universal consensus on when to preserve pulp vitality and when to proceed with root canal treatment and full coverage. Some studies demonstrate that early placement of full-coverage crowns significantly increases long-term tooth survival, particularly in endodontically treated cases.[5,7] Meanwhile, others report comparable or superior short-term success rates for conservative adhesive restorations when applied to teeth with reversible pulpitis.[2,3] Moreover, systematic reviews have confirmed that lack of cuspal coverage and deep crack propagation are key predictors of pulpal complications and tooth loss.[8]

Given these evolving concepts, comprehensive understanding of the relationship between the restorative approach and pulpal outcome is crucial for evidence-based decision-making. This narrative review aims to synthesize recent literature on the management of cracked teeth, emphasizing the comparative outcomes of conservative and full-coverage restorative techniques. The discussion highlights prognostic indicators, pulp vitality preservation, and long-term clinical performance, providing clinicians with a structured framework to guide restorative choices in the context of cracked tooth syndrome.

Methods

Search Strategy

A narrative review methodology was employed to synthesize current evidence on restorative strategies and pulpal outcomes in cracked teeth. The review focused on identifying peer-reviewed studies that compared conservative adhesive restorations such as occlusal veneers, onlays, or vital pulp therapy–based treatments, with full-coverage restorations (such as crowns) regarding pulp vitality preservation, survival rates, and clinical prognosis.

A comprehensive search was conducted in PubMed, ScienceDirect, and Google Scholar databases. The search covered publications from January 2017 to March 2025 to capture recent advances in the minimally invasive and bioactive restorative techniques. The following keywords were used: cracked tooth, cracked tooth syndrome, pulp vitality, vital pulp therapy, occlusal veneer, full-coverage crown, bioactive materials, endodontically treated cracked teeth, survival rate, and prognosis.

Inclusion and Exclusion Criteria

Articles were included if they met the following criteria.

Population

Human clinical studies involving posterior cracked teeth (vital or endodontically treated).

Intervention

Any restorative or pulp-preserving management approach, including onlays, occlusal veneers, bioactive cements, full-coverage crowns, or hybrid adhesive systems.

Outcome Measures

Tooth survival, pulp vitality retention, post-treatment complications, or overall success rate.

Study Design
Prospective or retrospective clinical studies, cohort studies, case series (≥10 teeth), and systematic reviews.

Follow-up
Minimum follow-up duration of six months.

Exclusion criteria were

- Case reports with fewer than 10 teeth, in vitro or finite element analyses, and animal studies.
- Studies focusing exclusively on vertical root fractures, split teeth, or trauma-related fractures.
- Articles without outcome data related to pulp vitality or restoration survival.

Study Selection
After the initial screening of 142 titles and abstracts, 28 articles met the inclusion criteria for full-text review. Of these, nine studies were selected for final synthesis based on methodological relevance and outcome clarity. The included works comprised.

- Clinical studies evaluating survival and success rates of cracked teeth treated with full crowns, onlays, or occlusal veneers.[2,4,7]
- Prospective and retrospective cohort studies assessing endodontically treated cracked teeth with radicular extensions.[3,5]
- Case-based and observational studies on conservative pulp-preserving strategies using bioactive materials.[6,9]
- A systematic review and meta-analysis providing pooled quantitative outcomes for both vital and endodontically treated cracked teeth.[8]

Data Extraction and Synthesis
Each study was evaluated for key variables, including

Restorative Type
full-coverage crown, occlusal veneer, onlay, or direct restoration.

Pulpal Status
vital, reversible pulpitis, or root canal–treated.

Outcome Measures
survival rate, pulp vitality rate, incidence of posto-perative pain, and presence of periapical pathology.

Follow-up period and sample size were recorded to identify temporal outcome patterns.

Given the heterogeneity in the study designs and parameters, a narrative synthesis instead of a meta-analysis was conducted, emphasizing the most clinically rigorous findings while also identifying methodological limitations or gaps. The evidence was categorized under two major domains.

- Conservative adhesive and vitality-preserving approaches
- Full-coverage restorations after endodontic or extensive structural loss.

Table 1: Summary of Reviewed Studies on Restorative Approaches and Pulp Vitality Outcomes in Cracked Teeth

Author (Year)	Study Design / Sample Size	Restorative Approach	Pulpal Status at Baseline	Follow-up Duration	Key Findings / Outcomes
Kanamaru *et al*. (2017)[1]	Clinical Observational study of 44 cracked *vital* molars in 40 patients.	Initial management: occlusal adjustment, resin coating, restoration or follow-up only. - Final	All teeth included were *vital* at the first visit.	Follow-up period ranged from 1 to 3 years (since they report “range, 1-3 years” in the pulp-	- 81.8% (36/44) of teeth had been restored; 18.2% were not restored. - Non-working side interference (occlusal) was found in 86.4% of.

		treatments: In the pulp-preserved group, 19 teeth (70.4%) received metal full crowns; others had occlusal adjustment, composite resin or no treatment. Endodontically treated group: all 17 teeth received metal full crowns.		preserved group).	cases (38/44) - All cases had good clinical prognosis in the follow-up period. - Crack extension to the pulp was significantly more frequent in the endo-dontic-treatment group; implies that deeper cracks increase risk of pulp /endodontic involvement. - Coverage (full-crown) restorations recommended for cracked *vital* molars, especially where occlusal interferences exist.
Liao *et al*. (2022)[4]	Retrospective observational study of 77 cracked teeth from 65 patients.	Various treatment modalities recorded (not limited to one standardized restoration). The focus was on survival/risk factors rather than a specific restoration protocol.	Majority of the cracked teeth were *vital* (non-endodontically treated), 94.81 % were non-endodontically-treated teeth.	Follow-up at 6 months, 1 year, and 2 years post-treatment.	Higher survival rates were associated with:absence of pre-operative pain to palpation, absence of spontaneous pain, minimal mobility, and presence of pulp vitality.
Zhao *et al*. (2024)[2]	Clinical follow-up study; 27 cracked teeth in 24 patients.	The teeth were restored with occlusal veneers (lithium disilicate ceramic) covering the cracked surface (when cracks involved enam-el and dentin, not pulp).	The included teeth had cold and/or biting pain without spontaneous/ nocturnal pain; two of the 27 had pulpitis at baseline. So majority vital/ no irreversible pulp involvement.	Mean follow-up of about 22.4 months (~1.9 years)	12-month cumulative pulp survival rate: 92.6%. 12-month tooth survival rate: 100%. Latest recall success rate: 92.6%. Patient-reported outcomes improved (pain, occlusal discomfort, eating difficulties decreased).

Holme (2021)[9]	Prospective cohort study; 34 cracked teeth in patients diagnosed with reversible pulpitis.	A "bidirectional splinting" protocol: (1) immediate stainless-steel band external splint, then (2) internal splintingvia crack-line removal and resin filling, then (3) external splinting via temporary crown followed by final crown placement.	Vital pulp with diagnosis of reversible pulpitis (teeth with signs of irreversible pulpitis or necrosis were excluded).	Up to 4 years; follow-ups at 3, 6, 12 months, then annually.	Tooth survival rate: 100% (no extractions) over the follow-up period. Pulp survival (i.e., maintaining vitality without root canal) was approx. 72% after initial banding, and ~91% after final crown placement. Key prognostic factor: presence of pain on percussion at baseline significantly reduced pulp survival (46% vs 94% in those without percussion tenderness; hazard ratio ~11.77).
De Toubes *et al*. (2022)[7]	Long-term retrospective clinical study: 86 cracked teeth in 71 patients followed for 1 – 11 years	Early definitive restoration with either onlay or full-coverage crown (mostly CAD/CAM E-MAX). Protocol: caries removal → temporary composite splint → definitive adhesive restoration; RCT if indicated	Mixed pulpal diagnoses — 29 % reversible pulpitis,55.8 % symptomatic irreversible pulpitis, 5.8 % necrotic, 7 % previously treated	1 to 11 years (mean ≈ 3.3 years) with annual recalls	Overall success rate 93 %; tooth survival 98.6 % (1 yr), 94.9 % (5 yrs), 55.9 % (11 yrs) • Full-coverage crowns significantly reduced tooth loss compared to onlays (P = .009). • Previously endodontically treated teeth and those with posts showed lower survival rates (HR ≈ 10 – 17). • Crack direction had no effect on survival. • Conclusion: Early placement of adhesive full-coverage crowns optimizes cracked-tooth longevity regardless of crack orientation.
Wu *et al*. (2019)[3]	Retrospective cohort study;	Initial stabilization with	Vital teeth diagnosed	Minimum 3 years; recall	71 % of teeth remained *vital* after

	184 patients with 199 cracked teeth diagnosed as reversible pulpitis	orthodontic bands, followed by full-coverage crowns (if tooth remained asymptomatic after 3 months).	with reversible pulpitis (positive to cold,non-lingering; no periapical pathosis).	at ≥ 3 years post-diagnosis; 5-year survival estimated via Kaplan –Meier.	3 years. 29 % developed pulpal complications (66 % irrever-sible pulpitis ~1.2 yrs; 34 % necrosis ~2 yrs). Absence of full-coverage crown ↑ risk of pulp complica-tions (OR 8.74, p = .000). 5-year survival = 81 % with crown vs 37 % without. Males had slightly higher risk (OR 1.96).
Lim *et al*. (2025)[6]	Case report involving one mandibular molar (tooth #47) in a 56-year-old male	*Vital* pulp therapy (VPT) using selective caries removal and Biodentine as a bioactive core; followed by delayed full-coverage monolithic zirconia crown after 6 months of provisionalization	*Vital* pulp with deep caries and visible crack, respon-ded normally to cold and EPT (reversible pulpitis / stressed pulp)	30 months after final crown cementation	Pulp *vitali*ty and apical health maintained throughout 30 months. Demonstrated that selective caries removal + Biodentine core + delayed indirect restoration can preserve vitality and stability in cracked, carious teeth. Case supports minimally invasive, biolo-gically based VPT as an alternative to elective RCT in questionable cases
Davis & Shariff (2019)[5]	Prospective cohort study; 70 cracked posterior teeth in 69 patients with cracks extending 0–5 mm below the canal orifice	Non-surgical root canal treatment (RCT) with microscope-assisted intra-orificebarriers (Giomer), complete occlusal reduction, and full-coverage crown placed promptly after RCT	Mixed: 40 % irreversible pulpitis, 51 % pulpal necrosis, 8 % previously treated	2 – 4 years (mean ≈ 2.8 years)	Survival rate: 100 % (2 yrs), 96.6 % (4 yrs). Success rate: 90.6 %. Outcomes not significantly affected by crack depth, marginal ridge involvement, pulpal diagnosis, or lesion presence. Cracked teeth with radicular extensions

					can achieve outcomes comparable to standard endodontically treated teeth when managed with modern endodontic techniques, intraorifice barriers, occlusal reduction, and timely full crowns
Zhang *et al*. (2024)[8]	Systematic review and meta-analysis of 27 studies (26 in meta-analysis)	Compared monitoring, direct restorations (with and without cuspal coverage), full-crown restorations, and RCT with or without crowns	Included both vital teeth (CT-VDP) and RCT-treated teeth (CT-RCT)	1–14 years, depending on included studies	Tooth survival rate (CT-VDP): 92.8–97.8 % (1–6 yrs) Pulp survival rate (CT-VDP): 85.6–90.4 % (1–3 yrs) Success rate (CT-VDP): 80.6–89.9 % (1–3 yrs) Tooth survival (CT-RCT): 90.5–91.1 % (1–2 yrs) Success (CT-RCT): 83.0–91.2 % (1–4 yrs) Direct restorations without cuspal coverage significantly ↑ risk of pulpal complications (RR = 3.2) and extraction (RR = 8.1) vs crowns. RCT teeth without crowns were 11.3× more likely to be extracted than crowned ones. Conclusion: Full-coverage crowns strongly recommended for symptomatic cracked teeth or after RCT; monitoring acceptable for asymptomatic cases

Discussion

The management of cracked teeth has evolved from a traditionally aggressive approach, elective root canal therapy followed by full-coverage crowns, to a more biologically conservative philosophy emphasizing pulp preservation. The reviewed literature consistently supports the notion that early detection and prompt restoration are the most influential determinants of long-term prognosis.[4,5,8] Across the nine studies analyzed, tooth survival rates ranged between 90% and 98% following appropriate restorative intervention, regardless of the restorative modality used. However, the method of coverage, the pulpal diagnosis at the time of intervention, and occlusal factors significantly affected outcomes.

Recent years have witnessed a strong trend toward minimally invasive treatments aimed at preserving pulp vitality and reducing unnecessary endodontic intervention. Lim *et al*. reported successful management of a cracked tooth with a deep carious lesion using vital pulp therapy (VPT) and Biodentine as a bioactive core material, followed by a delayed indirect restoration.[6] This approach, which maintained pulp vitality while preventing crack propagation, illustrates the synergy between bioactive materials and selective caries removal. Similarly, the bidirectional splinting technique reported by Holme achieved 72% pulp survival at a one-year follow-up, with a 100% tooth survival rate, highlighting how mechanical stabilization combined with internal sealing can protect the pulp in reversible pulpitis cases.[9] Moreover, Zhao *et al*. evaluated 27 cracked teeth treated with occlusal veneer restorations fabricated from lithium disilicate ceramics. After an average of 22 months, the pulp survival and success rates reached 92.6%, with significant improvements in masticatory function and patient-reported outcomes.[2] These findings reinforce the concept that adhesive partial-coverage restorations can effectively preserve vitality when cracks are limited to enamel and dentin without pulpal communication.

Furthermore, the systematic review by Zhang *et al*. synthesized data from 26 clinical studies and found that cracked teeth with vital pulps restored with direct or indirect adhesive restorations achieved a pulp survival rate of 85–90% at 1–3 years of follow-up.[8] In contrast, full-coverage crown restorations showed slightly higher survival but at the expense of greater tooth reduction. The authors emphasized that direct restorations without cuspal coverage tripled the risk of pulpal complications, underscoring the importance of occlusal protection, even in conservative designs. Collectively, these studies support a biological driven hierarchy of intervention, beginning with sealing and cuspal stabilization in teeth with reversible pulpitis and reserving endodontic treatment for those showing irreversible pulpal inflammation or radicular extension.

In terms of prognosis, common prognostic indicators identified across the literature include.

Pulpal Status

Teeth with reversible pulpitis or healthy pulps consistently outperform those with necrotic pulps in survival and success.

Cuspal Coverage

Absence of coverage significantly increases the risk of pulpitis and fracture.[8]

Crack Depth and Direction

Mesiodistal cracks extending beyond the pulpal floor markedly reduce survival.[5]

Occlusal Interference

Non-working-side interferences and bruxism are strongly correlated with crack propagation.[1]

Timeliness of Restoration

Early intervention prior to bacterial penetration or pulpal involvement yields better vitality preservation.[3,6]

Full-coverage crowns remain the gold standard for cracked teeth with extensive structural loss, previous endodontic treatment, or confirmed pulpal necrosis. De Toubes *et al*. conducted a long-term retrospective study with a follow-up of 1–11 years involving 86 cracked teeth and reported overall survival rates of 98.6% at one year, 94.9% at five years, and 55.9% at eleven years.7 Teeth restored with full-coverage crowns had significantly lower failure rates compared with those restored with onlays. The authors concluded that early placement of full-coverage crowns, preferably adhesive type, markedly improves longevity.

Davis and Shariff evaluated endodontically treated cracked teeth with radicular extensions, revealing a 96.6% survival rate up to four years when strict endodontic protocols and full-coverage restorations were used.5 Success rates paralleled those of intact endodontically treated teeth, challenging the assumption that cracks extending below the orifice level necessarily predict failure. Wu *et al*. further corroborated these findings, showing that cracked teeth with reversible pulpitis treated with full-coverage crowns retained pulp vitality in 71% of cases after three years, while the absence of cuspal coverage increased pulpal complication risk by eightfold.[3]

Kanamaru *et al*. linked non-working-side occlusal interference and metal inlays to higher crack incidence and poorer prognosis. In their cohort, over 86% of cracked teeth exhibited occlusal interference, and coverage-type restorations yielded the best clinical outcomes in both pulpal and mechanical terms.[1] These findings underscore that biomechanical stabilization through coverage, whether achieved by full crowns or adhesive overlays, is crucial in managing occlusal stress and preventing crack propagation.

While full-coverage crowns provide proven mechanical stability, they often require substantial tooth reduction and may increase the risk of pulpal devitalization during preparation.[2,6] Conversely, conservative adhesive restorations preserve more enamel and dentin, reducing thermal and dehydration-related trauma to the pulp. The evidence suggests that when pulpal vitality is intact and cracks are confined to the coronal dentin, adhesive occlusal veneers or onlays provide an optimal balance between protection and conservation. However, once pulpal inflammation becomes irreversible or cracks extend to the root, endodontic treatment followed by full-coverage restoration remains the definitive solution for long-term survival.[5,7]

The transition between these two approaches relies heavily on the accurate diagnosis of pulpal status, occlusal evaluation, and the clinician's judgment regarding structural compromise. Technologies such as CBCT imaging, fiber-optic transillumination, and operative microscopy have improved diagnostic precision; however, there remains variability in how the term "cracked tooth" is defined across studies, which limits direct comparisons of outcomes.

Despite these strong clinical implications, several methodological limitations persist. Most studies are observational and heterogeneous in their design, with variable diagnostic criteria, restorative protocols, and follow-up durations. Well-designed randomized controlled trials comparing conservative and full-coverage restorations are lacking. Furthermore, few studies integrate patient-reported outcomes or cost-effectiveness analyses, which are essential for guiding clinical evidence-based practice.

For clinicians, the collective evidence supports a stepwise pulp-preserving strategy. *Early detection and occlusal stabilization* in cases of reversible pulpitis using adhesive onlays or occlusal veneers. *Vital pulp therapy* with bioactive materials when dentin exposure or deep caries is present, but pulp remains responsive. *Root canal treatment followed by full-coverage restoration* for teeth exhibiting irreversible pulpitis or radicular crack extension. By adopting this biologically graded approach, practitioners can achieve both structural reinforcement and pulpal preservation, improving prognosis while minimizing overtreatment.

Conclusion

The evidence synthesized in this review highlights a clear evolution in the management of cracked teeth, from conventional full-coverage restorations following root canal therapy toward conservative, biologically based approaches that prioritize pulpal vitality preservation. According to the reviewed studies, both adhesive partial-coverage restorations and full-coverage crowns demonstrated high clinical success when case selection was appropriate and intervention occurred early in the disease process. Conservative strategies, including occlusal veneers, onlays, and vital pulp therapy with bioactive materials such as Biodentine, were particularly effective in teeth diagnosed with reversible pulpitis or shallow cracks confined to enamel and dentin. These techniques not only maintained pulp vitality rates exceeding 90% but also minimized structural loss, aligning with the principles of minimally invasive dentistry.

Conversely, full-coverage crowns remain the treatment of choice for teeth with extensive structural compromise, prior endodontic treatment, or radicular crack extension. Their ability to provide complete cuspal protection and load redistribution continues to yield superior long-term survival, often exceeding 95% within the first five years after treatment.

Prognostic outcomes depend on multiple interrelated factors, including pulpal status at the time of diagnosis, crack depth and direction, occlusal loading, and restorative coverage. Early detection, immediate stabilization, and appropriate restorative design are pivotal to achieving favorable long-term results. Clinicians should consider a graded treatment pathway, beginning with conservative adhesive methods whenever pulp vitality can be preserved and progressing to full-coverage restoration once irreversible pulpal changes or severe structural loss are confirmed.

From a research standpoint, further well-designed prospective controlled trials are warranted to standardize diagnostic criteria, evaluate newer adhesive and bioactive materials, and compare the long-term cost-effectiveness of conservative versus full-coverage approaches. Integration of patient-reported outcomes alongside digital diagnostic tools (e.g., high-resolution CBCT, optical coherence tomography) will also enhance clinical decision-making.

In summary, a biologically centered, evidence-based approach combining pulp preservation, adhesive reinforcement, and mechanical protection offers the most comprehensive framework for managing cracked teeth. Optimal treatment should be individualized, balancing structural conservation with long-term functional and biological success.

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Author Contributions
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- **Toleen Mazloum:** Data Collection, Writing – Review & Editing.
- **Betti Shahin:** Visualization, Supervision, Project Administration.

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