NARRATIVE REVIEW

Endodontic therapy or extraction and tooth replacement with implants? Decision-making criteria

ABSTRACT

Objective *The decision between preserving a compromised tooth through endodontic therapy or replacing it with a dental implant remains a frequent clinical dilemma. This narrative review aims to evaluate the available evidence regarding clinical outcomes, success rates, prognostic factors, and patient-related considerations associated with endodontic treatment and implant therapy to support evidence-based clinical decision-making.*

Materials and Methods *A comprehensive literature search was performed in electronic databases including PubMed, EMBASE, Wiley Online Library, Cochrane Library, and ScienceDirect up to October 2025. Studies evaluating outcomes of endodontic therapy and dental implant treatment in human subjects were included. A total of 13 studies (including cohort, case-control, cross-sectional, and one randomized controlled trial) were selected. Data extraction focused on study characteristics, interventions, follow-up duration, and clinical and patient-reported outcomes. Risk of bias was assessed using a domain-based approach adapted from the RoB 2 tool, modified to account for the inclusion of predominantly non-randomized studies.*

Results *Both endodontic therapy and dental implant treatment demonstrated high long-term survival rates when performed under appropriate clinical conditions. Endodontically treated teeth showed survival rates exceeding 85–90%, while implant survival ranged from 90% to 97%. However, heterogeneity in study design, follow-up duration, and outcome definitions limited direct comparisons. Most included studies presented some concerns to high risk of bias, primarily related to confounding, participant selection, and variability in outcome assessment. Patient-reported outcomes indicated comparable levels of satisfaction and quality of life between treatments, although implant therapy was associated with higher reported levels of pain and fear in some studies. Biological complications differed between modalities, with peri-implant diseases affecting implants and persistent infection or restoration failure influencing endodontic outcomes.*

Conclusions *Both treatment modalities represent predictable therapeutic options. Preservation of the natural tooth through endodontic therapy should generally be considered the first-line approach when prognosis is favorable, while dental implants serve as a reliable alternative when tooth preservation is not feasible. Clinical decision-making should integrate biological, restorative, systemic, and patient-centered factors. The strength of the evidence is limited by the predominance of observational studies and the overall moderate to high risk of bias across included studies.*

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Received 2026, March 05
Accepted 2026, March 18

KEYWORDS *Endodontics; Dental implants; Treatment outcome; Decision making; Root canal therapy.*

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Peer review under responsibility of Società Italiana di Endodonzia

10.32067/GIE.2026.555

Introduction

The preservation of natural dentition in a healthy and functional state remains a fundamental objective in clinical dentistry. However, in certain situations, conservative treatment approaches may fail, necessitating tooth extraction and replacement. Determining whether to retain a compromised tooth or proceed with extraction continues to represent a longstanding clinical challenge and an area of ongoing debate among clinicians (1).
Treatment planning, particularly when deciding between root canal therapy and single-tooth implant placement, is frequently discussed in both scientific literature and routine clinical practice. (2) Each treatment modality presents distinct advantages, limitations, and prognostic considerations, making direct comparisons complex and often dependent on individual clinical scenarios.
A critical component of contemporary dental care is informed consent, which requires clinicians to provide patients with accurate, evidence-based information regarding the potential risks, benefits, and expected outcomes of available treatment options. Consequently, treatment planning should be regarded as a collaborative process in which clinical evidence, practitioner expertise, and patient preferences are integrated. Patients ultimately make decisions based on individual priorities, including predictability, safety, cost-effectiveness, longevity, and overall treatment experience.
Given the variability in reported outcomes, study designs, and patient-reported measures in the literature, there is a need to synthesize and critically appraise the available evidence to better inform clinical decision-making.

Materials and Methods

The present review evaluated the available literature on the clinical outcomes of endodontic therapy and dental implant treatment. A comprehensive search and screening process initially identified a large number of studies, of which 13 studies met the inclusion criteria and were included in the final analysis. The included studies comprised cohort studies, case-control studies, one randomized controlled trial, and one cross-sectional study involving human participants. The interventions assessed included primary root canal treatment, non-surgical retreatment, surgical endodontic procedures, and dental implant placement. Where applicable, comparisons were made between endodontically treated teeth and dental implants in terms of clinical outcomes and long-term prognosis. The primary outcomes evaluated were success and survival rates, biological and mechanical complications, radiographic healing, and treatment failure. In addition, patient-reported outcomes such as quality of life, satisfaction, pain perception, and treatment preferences were analyzed. Follow-up durations varied across studies, ranging from short-term to long-term evaluations. Furthermore, prognostic factors including local anatomical conditions, systemic health, restorative and mechanical variables, clinician-related factors, and technological advancements were considered, as these variables may influence treatment outcomes and clinical decision-making.

Search Strategy

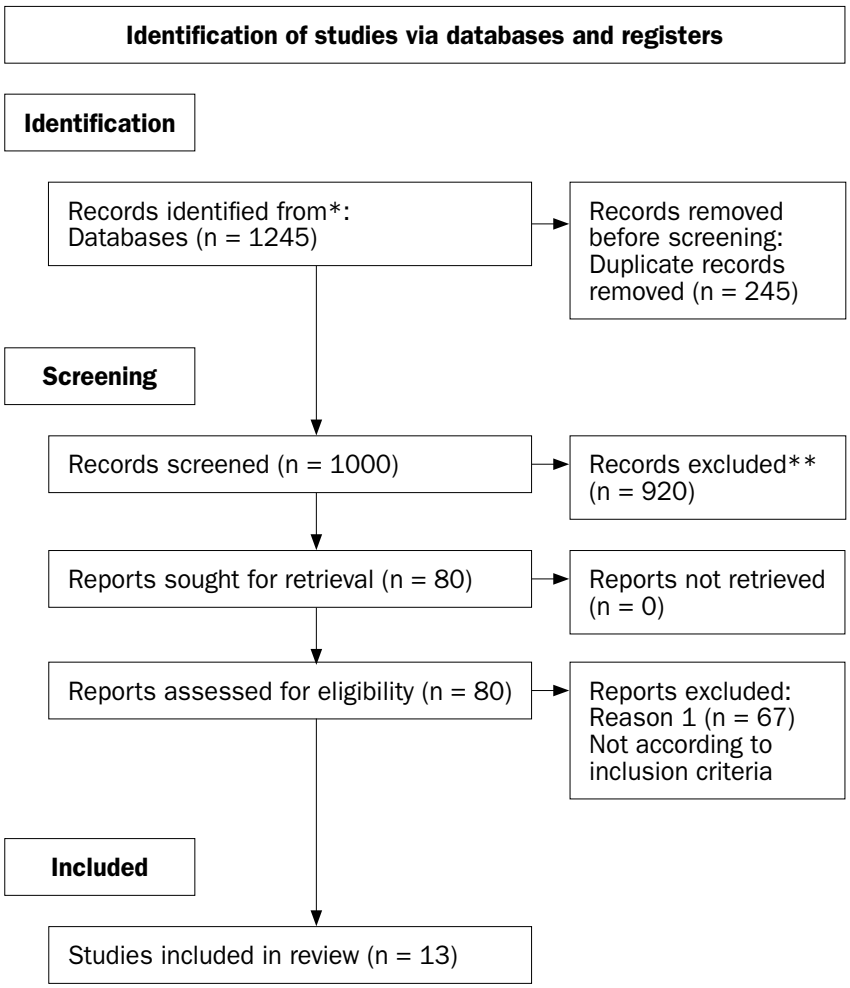
A comprehensive electronic search was conducted in PubMed, EMBASE, Wiley Online Library, Cochrane Library, and ScienceDirect for studies published up to October 2025. The search was limited to full-text articles published in English and involving human subjects. The search terms applied were: implant AND endo AND outcome; outcome OR success AND endo; outcome OR success AND implant; implant AND versus AND endo; failure AND implant; failure AND endo; systematic AND implant; systematic AND endo; survival

AND implant; survival AND endo; prospective OR retrospective AND implant; prospective OR retrospective AND endo; prognosis AND implant OR endo. In addition to the database search, the reference lists of all included studies were manually screened to identify any additional relevant publications.

Eligibility Assessment

Two independent reviewers (SSV and HAS) assessed the eligibility of studies for inclusion in the review. Studies were considered eligible if they were published in English, involved human participants, reported clinical outcomes of endodontic treatment and/or dental implant therapy, and provided sufficient data for extraction. Studies such as case reports, case series, abstracts, letters, and those containing incomplete or methodologically inadequate data were excluded. Articles focusing solely on technical or procedural aspects without reporting clinical outcomes were also excluded, as were studies published in languages other than English. Any disagreements between reviewers were resolved through discussion and consensus.

Figure 1
PRISMA Flow chart.



Data Extraction

Data extraction was independently performed by two reviewers (SSV and HAS). The following data were extracted: root canal treatment outcomes, including influencing factors; implant treatment outcomes, including influencing factors; studies with direct comparisons between the two treatment modalities; patient satisfaction criteria and surveys evaluating factors influencing patient choice; and relevant guidelines where applicable. Additional extracted variables included study characteristics such as author, year, study design, sample size, intervention type, follow-up duration, and clinical outcomes including success, survival, complications, and failure. Patient-reported outcomes such as quality of life, satisfaction, pain perception, and decision-making factors were also recorded. The extracted data were summarized in tabular form to facilitate comparison across studies. Any discrepancies between reviewers were resolved by consensus.

Risk of Bias Assessment

The methodological quality and risk of bias of the included studies were assessed using a domain-based approach adapted from the RoB 2 tool. Given that the majority of included studies were observational in design, the standard RoB 2 domains were modified to enable consistent assessment across different study types (Figure 2 and 3). The evaluation focused on key domains including bias due to confounding and baseline differences, participant selection, outcome measurement, complete-

Groups	D1	D2	D3	D4	D5	Overall
Doyle et al 2006	+	-	-	+	+	-
Hannahan et al 2008	+	+	+	X	+	X
Gatten et al 2011	+	+	+	X	+	X
Torabinjad et al 2014	+	-	X	X	+	X
Chatzopoulos et al 2018	+	+	+	+	-	-
Vahdati et al 2019	+	+	-	+	-	-
Hanasha et al 2019	+	+	-	+	+	-
Esposito et al 2020	+	+	X	X	+	X
Lee et al 2022	+	-	+	+	+	-
Sanz et al 2022	+	+	X	+	+	X
Zang et al 2023	+	X	+	+	-	X
Suganna et al 2024	+	-	+	-	-	-
de España et al 2025	+	+	+	+	+	+

D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended interventions.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement: + High - Some concerns X Low

Figure 2
Risk of bias graph.

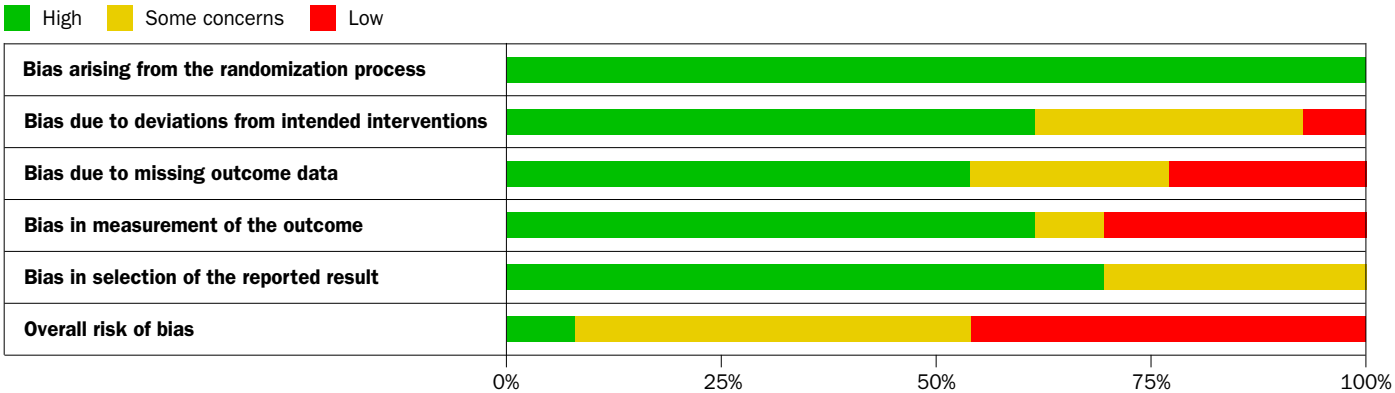
Figure 3
Risk of bias summary.

ness of follow-up data, and selective reporting. Each study was judged as having low risk, some concerns, or high risk of bias within each domain. An overall risk-of-bias judgment was then assigned based on the highest level of bias identified across domains. Overall, the included studies demonstrated variability in methodological quality, with most studies showing some concerns to high risk of bias. This was primarily attributed to confounding factors, retrospective and non-randomized study designs, heterogeneity in outcome definitions, and variations in follow-up duration and outcome assessment.

Results

Study Identification

The study identification process is summarized in Figure 1. A comprehensive search of the electronic databases yielded a large number of records. Following screening and removal of duplicates, 80 studies were assessed for full-text eligibility, of which 67 were excluded. Consequently, 13 studies were included in the final analysis. The methodological characteristics and extracted data of the included studies are presented in Table 1. The risk of bias of the included studies (Figures 2 and 3) was assessed using a domain-based approach adapted from the RoB 2 tool. The assessment demonstrated variability across studies, with the majority being observational in design and showing some concerns to high risk of bias, primarily related to confounding, participant selection, and heterogeneity in outcome definitions. Overall, outcome measurement and reporting were generally consistent across studies; however, differences in study design and methodological approaches limited direct comparability



Author (Year)	Country	Study Design	Sample Size (RCT / DI)	Population Characteristics	Intervention Details	Follow-up Duration	Outcomes Extracted	Key Notes for Extraction
Doyle (2006)(3)	USA	Case-control	196 / 196	Adults, matched by treatment area	NSRCT vs single implant	1 year	Survival, success, failure, complications	Matched comparison within similar anatomical regions
Hannahan (2008)(4)	USA	Cohort	143 / 129	Adult patients	RCT vs implant therapy	1.8–3 years	Success, failure, complications	Unequal follow-up durations
Gatten (2011)(5)	USA	Cohort	17 / 20	Adults	Endodontic vs implant therapy	1–6 years	QoL (OHIP)	Focus on patient-reported outcomes
Torabinejad (2014)(6)	USA	Cohort	24 / 24	Adults ≥18 years	RCT vs single implant	1 year	Pain, satisfaction, complications	Detailed patient-centered outcomes
Chatzopoulos (2018) (7)	USA	Cohort	8,915 / 4,519	Mixed adult population	RCT vs implants	Up to 5 years	Survival, failure	Large retrospective dataset
Vahdati (2019)(8)	USA	Case-control	170 / 170	Same patients (paired)	NSRCT vs implants	~7.5 years	Survival, success, complications	Within-subject comparison
Hamasha (2019)(9)	Saudi Arabia	Case-control	150 / 150	Adults, tooth-matched	RCT with post-core vs implant	1 year	Survival, QoL (OHIP), success	Includes patient QoL assessment
Esposito (2020)(10)	Italy	Randomized controlled trial	10 / 10	Adults with uncertain prognosis	Retreatment vs implant	Up to 5 years	Success, failure, complications	Only RCT; small sample size
Lee (2022)(11)	USA	Cohort	Multiple groups	Adults	Various endodontic approaches vs implants	Up to 5 years	Survival, success	Multiple treatment subgroups
Sanz (2022)(12)	Spain	Case-control	26 / —	Adults	RCT vs implant	2 years	Pain, QoL	Focus on patient experience
Zang (2023)(13)	China	Cohort	76 / 76	Adults	NSRCT vs implant	5 years	Success	Includes economic considerations
Suganna (2024)(14)	India	Cohort	176 / 145	Adults	RCT vs implant	2 years	Survival, success, failure	Recent comparative cohort
de España (2025)(15)	Spain	Cross-sectional	144	Adults treated in anterior zone	RCT, re-treatment, and single implant	5 years	QoL (OHIP-14), satisfaction, pain, fear, decision-making factors	Long-term patient-reported outcomes; esthetics identified as key decision factor; higher fear/pain in implant group

Table 1
Summary of the Methodological and Clinical Characteristics of Included Studies.

between studies.

Clinical decision-making should consider two broad categories of factors, namely objective and subjective parameters. Objective factors include reported success rates, measured outcomes, and mechanical, systemic, local, iatrogenic, and technological variables. Subjective factors include pain control, cost-effectiveness, and patient satisfaction.

Outcome Assessment and Comparison Between Endodontic Therapy and Implants

One of the principal approaches in clinical decision-making between endodontic therapy and implant placement is the analysis of reported outcome studies. However, comparisons between these treatment modalities remain challenging due to significant heterogeneity in study design, outcome definitions, follow-up periods, and evaluation criteria. The lack of standardization among studies often results in inconsistent conclusions regarding treatment success and survival rates. Outcome assessment in both endodontics and implantology is typically based on a combination of clinical, radiographic, and patient-reported parameters, which contributes to variability in interpretation and reporting (16).

A major limitation of the included studies is the inconsistent differentiation between success and survival (Table 2, 3, 4). Survival generally refers to the continued presence of the tooth or implant in the oral cavity, whereas success implies the absence of pathology and optimal functional and biological conditions. Because survival criteria are less stringent, survival rates are frequently higher than success rates in both endodontic and implant studies

Outcome Category	Specific Outcomes Evaluated	Method of Assessment
Primary clinical outcomes	Success rate, survival rate of endodontically treated teeth and dental implants	Clinical examination and long-term follow-up evaluation
Radiographic outcomes	Presence or absence of periapical radiolucency, marginal bone loss around implants, radiographic evidence of healing	Periapical radiographs and cone-beam computed tomography (CBCT) where applicable
Biological complications	Periapical pathology, persistent infection, peri-implant mucositis, peri-implantitis	Clinical signs, probing depth, radiographic changes
Mechanical complications	Crown fracture, restoration failure, implant mobility, prosthetic complications	Clinical examination and prosthetic evaluation
Treatment failure indicators	Persistent symptoms, implant loss, extraction of endodontically treated tooth	Clinical and radiographic diagnosis
Prognostic factors influencing outcomes	Pre-operative periapical lesions, quality of root canal filling, coronal restoration quality, systemic health conditions, anatomical factors	Evaluation of patient records and radiographic analysis
Patient-reported outcomes	Pain perception, patient satisfaction, treatment cost considerations	Patient surveys and clinical follow-up interviews

Table 2
Outcomes assessed among included studies evaluating endodontic therapy and dental implant treatment

(2,17,18). Radiographic interpretation further complicates comparisons due to inter-observer variability and differences in radiographic angulation or imaging techniques. Moreover, some periapical lesions may remain undetected using conventional radiography, leading to potential underestimation of disease prevalence (19). These variations are reflected in the included studies and are summarized in the data extraction tables.

Another important issue in longitudinal studies is the progressive reduction in the number of cases available for follow-up evaluation. Loss of participants over time can significantly affect the reliability and clinical relevance of the results. Consequently, meaningful comparisons between endodontic and implant outcomes require standardized definitions of success and failure, comparable follow-up periods, adequate sample sizes, and consistent outcome measures (2).

In addition to methodological limitations, discrepancies in diagnostic criteria for implant-related diseases and endodontic failure contribute to further confusion in interpreting clinical outcomes. For example, implant failure has been described using various parameters including mobility, radiographic bone loss, bleeding on probing, suppuration, and peri-implant pocket formation. Similarly, endodontic failure is often defined as the persistence or development of periapical radiolucency following treatment. The absence of universally accepted diagnostic thresholds for these conditions has led to variations in reported success rates across studies (20).

Definitions of Peri-Implant and Endodontic Conditions

Several definitions have been proposed in the literature to clarify implant-re-

Table 3
Prognostic factors influencing the outcomes of endodontic therapy and implant treatment

Factor Category	Variables Considered	Influence on Outcome
Local anatomical factors	Bone quality, root morphology, periodontal status	May affect implant stability or endodontic healing
Systemic health factors	Diabetes, smoking, immune disorders	Associated with delayed healing and increased complication risk
Mechanical/restorative factors	Quality of root canal filling, coronal restoration, implant prosthesis	Poor restoration increases fracture or failure risk
Infection-related factors	Presence of periapical lesions, bacterial contamination	Reduces success rates
Clinician-related factors	Operator skill, treatment planning	Influences technical quality of procedures
Patient-related factors	Oral hygiene, compliance, cost considerations	Affects long-term maintenance and success

Parameter	Endodontic Therapy	Dental Implants
Treatment objective	Preserve natural tooth	Replace missing tooth
Success rate	High long-term survival	High survival rates
Biological complications	Persistent infection, periapical lesions	Peri-implant mucositis, peri-implantitis
Mechanical complications	Tooth fracture, restoration failure	Implant mobility, prosthetic complications
Retreatability	Retreatment possible	Limited options if implant fails
Cost	Generally lower	Higher initial and maintenance cost
Treatment time	Usually shorter	May require surgical and healing phases

Table 4
Comparison between endodontic therapy and dental implant treatment.

lated and endodontic pathologies. Peri-implant mucositis is generally described as a reversible inflammatory reaction affecting the soft tissues surrounding an implant without bone loss (21). In contrast, peri-implantitis is characterized by an inflammatory process associated with progressive loss of supporting bone around an osseointegrated implant (21). Histological studies have demonstrated that peri-implantitis lesions contain higher numbers of plasma cells and macrophages compared with mucositis lesions (22).
Another important pathological entity is apical peri-implantitis, also known as retrograde peri-implantitis. This condition presents as a symptomatic periapical radiolucency that develops shortly after implant placement while the coronal portion of the implant remains osseointegrated (23). Residual infection from previously extracted teeth or untreated endodontic lesions of adjacent teeth has been suggested as a possible etiological factor.
In endodontics, treatment success has traditionally been defined by the absence of clinical symptoms and radiographic evidence of periapical pathology, with restoration of normal periodontal ligament structures around the root apex (24). Conversely, endodontic failure is frequently associated with persistent periapical radiolucency or recurrent symptoms following treatment (24). Teeth that cannot be predictably restored or maintained are often classified as failed teeth, whereas structurally weakened or pathologically compromised teeth may be considered compromised teeth requiring restorative intervention or further treatment.

Implant Success Criteria

Several authors have proposed criteria for implant success, reflecting differences in interpretation of clinical outcomes. One of the most widely cited criteria describes successful implants as those exhibiting stable osseointegration, absence of pain or mobility, and limited marginal bone loss following placement (25). Other authors have suggested alternative thresholds for marginal bone loss or additional clinical parameters such as absence of exudate and peri-implant inflammation(25). These variations highlight the absence of a universally accepted definition of implant success, which complicates direct comparisons between studies evaluating implant survival and those assessing the outcomes of endodontic therapy.

Endodontic Therapy: Outcomes and Prognostic Factors

Root canal treatment aims to eliminate infection within the root canal system and prevent or treat apical periodontitis. The healing process following endodontic therapy may take several months or even years, as periapical tissues gradually regenerate after removal of the microbial source of infection (26). Consequently, radiographic signs of healing may appear long after clinical symptoms have resolved.
Unlike implants, which initially demonstrate high success rates that may decline over time, the outcome of root canal treatment may improve gradu-

ally as healing progresses. Long-term studies have reported survival rates exceeding 85–90% for endodontically treated teeth over extended follow-up periods(26,27). A review reported survival rates of approximately 93% at 5 years and 87% at 10 years after treatment(28).

Several factors have been identified as influencing the prognosis of endodontic therapy. Preoperative periapical lesions represent one of the most significant prognostic factors, reducing treatment success compared with teeth without apical pathology.(29) Other important factors include the quality of root canal filling, adequacy of coronal restoration, and presence of coronal leakage. Regenerative endodontics also have shown promising roles in improvising the overall endodontic treatment outcomes in long run (30,31).

The role of restorative treatment is particularly critical in determining the long-term survival of endodontically treated teeth. Studies have shown that teeth lacking proper coronal restoration are significantly more prone to fracture and subsequent extraction. Placement of a definitive restoration following root canal treatment substantially improves long-term survival rates (29).

Endodontic retreatment also represents an important therapeutic option when primary treatment fails. Non-surgical retreatment aims to remove residual infection and improve canal disinfection, while surgical endodontic procedures allow direct access to the periapical region. Systematic reviews have reported success rates ranging from approximately 77% to over 80% for nonsurgical retreatment procedures(26). Advances in microsurgical techniques and modern biomaterials have further improved the outcomes of surgical endodontic procedures.

Implant Therapy: Success Rates and Complications

Dental implants have become a predictable treatment option for replacing missing teeth since their introduction in modern dentistry. Numerous studies have demonstrated high survival rates for implants, typically ranging between 90% and 97% over long-term follow-up periods (32). Despite these favorable outcomes, implant therapy is not free from complications. Biological complications such as peri-implant mucositis and peri-implantitis represent major causes of implant failure. Epidemiological studies have reported mucositis prevalence rates between 20% and 50%, while peri-implantitis has been observed in approximately 10–40% of implant cases over long-term follow-up periods (21).

Implant failures can be classified as early or late failures. Early failures occur before prosthetic loading and are often associated with surgical trauma, infection, inadequate primary stability, or impaired healing. Late failures typically occur after functional loading and are frequently associated with microbial infection or mechanical overload (33). In addition to biological complications, prosthetic complications may also affect implant restorations. Screw loosening, prosthetic fracture, and loss of retention have been reported in a significant proportion of implant-supported restorations (33). Literature has suggested that prosthetic complications may occur more frequently in implant-supported restorations compared with tooth-supported prostheses (33).

Another important factor influencing implant outcomes is bone quality. Implants placed in poor-quality bone, particularly in the posterior maxilla, have been associated with higher failure rates compared with those placed in denser mandibular bone (34). Similarly, systemic factors such as smoking, uncontrolled diabetes, and history of periodontitis may negatively influence implant survival.

Mechanical, Systemic and Local Factors Influencing Treatment Outcomes

Several additional factors may influ-

ence the prognosis of both endodontic and implant therapies. Mechanical factors such as occlusal loading and absence of proximal contacts may increase the risk of fracture in endodontically treated teeth. In addition to mechanical factors such as occlusal loading and the absence of proximal contacts, the quality of the coronal seal provided by the final restoration should also be emphasized, as it is critical to preventing reinfection and significantly influences the long-term prognosis of endodontically treated teeth. Implants, on the other hand, lack periodontal ligament proprioception, resulting in reduced tactile feedback and potentially higher occlusal forces transmitted to the implant restoration (35).

Systemic conditions may also affect treatment outcomes. Diabetes mellitus has been associated with impaired healing of periapical lesions and may influence implant osseointegration, although well-controlled diabetic patients generally demonstrate acceptable implant survival rates.(36) Smoking has also been recognized as a significant risk factor affecting both endodontic and implant outcomes due to its detrimental effects on immune response and wound healing. Even the altered protocols of treatments in root canal irrigation (37,38) or choice of intracanal medicament(39) among the clinicains, could also have some influence on the outcomes. Local factors such as bone density, periodontal status, and oral hygiene also play a critical role in treatment success. Patients with untreated periodontal disease have demonstrated increased risk of implant complications and bone loss around implants (36). Adequate oral hygiene and maintenance programs are therefore essential to ensure long-term implant success. From an aesthetic perspective, preservation of the natural tooth may be preferable in certain situations, particularly in the anterior region where gingival architecture and soft tissue contours are critical for optimal aesthetic outcomes (35).

Patient-Related Considerations

Beyond clinical factors, patient-centered considerations also play an important role in treatment planning. Pain perception, treatment cost, and patient satisfaction may influence treatment preference. Studies have shown that postoperative discomfort following implant surgery may be greater than that experienced after root canal therapy (2). Nevertheless, many patients continue to perceive root canal treatment negatively due to misconceptions regarding pain associated with the procedure.

Economic considerations may also influence decision-making. In many clinical settings, endodontic therapy followed by restoration is generally less expensive than implant therapy. However, cost-effectiveness analyses have suggested that implant therapy may become more economical in cases requiring extensive endodontic retreatment or complex restorative procedures. Patient satisfaction studies have shown that both implant therapy and endodontic treatment significantly improve oral health-related quality of life. Nevertheless, aesthetic concerns such as gingival recession, soft tissue changes, or implant malposition may negatively affect patient perception of implant treatment outcomes.

Discussion

It has been reported that the number of remaining teeth in individuals aged 65–74 has increased over the last 50 years, mainly due to advancements in techniques and materials, particularly in endodontics. Both implantology and endodontology have demonstrated, over recent decades, the ability to achieve predictable long-term outcomes as a result of continuous technological progress (36). However, the lack of standardization in study design and outcome assessment makes comparisons between endodontic treatment and

implant therapy largely empirical and often confusing. This confusion is further compounded by inconsistent definitions and evaluation criteria for similar pathological conditions, leading to variability in reported results.

In many studies evaluating success rates of endodontic or implant treatments, outcomes are based on a combination of clinical, radiographic, and subjective parameters, while the distinction between success and survival is often unclear or not explicitly defined. Additionally, interobserver variability in radiographic interpretation, combined with non-standardized imaging angulations, further limits the reliability of outcome assessment (40). It has also been demonstrated that extensive bone lesions may remain undetected in conventional radiographic examinations. Moreover, although some studies include sufficiently long follow-up periods, the number of patients available for evaluation often decreases significantly over time, potentially compromising the validity and clinical relevance of the findings (26). Therefore, meaningful comparisons require studies with similar follow-up durations, adequate sample sizes, and standardized outcome measures.

Despite the large number of studies reporting success rates for each treatment modality, relatively few investigations directly compare endodontic therapy and implant placement under comparable clinical conditions. Available comparative studies generally report similar success rates for both approaches; however, implant-supported restorations often require more frequent maintenance visits, which may increase the overall cost of treatment. Furthermore, practitioner-related factors such as year of graduation, level of training, and clinical experience have been shown to significantly influence treatment decision-making.

From a biological perspective, both implants and natural teeth are susceptible to plaque accumulation and calculus formation. However, the structural differences in peri-implant tissues make implants more prone to inflammatory processes. Peri-implant inflammation tends to be more aggressive and may lead to faster and more severe tissue destruction compared with periodontal disease affecting natural teeth (41).

This review evaluated outcome measures, definitions of success and survival, biological and mechanical complications, as well as systemic, local, and patient-related prognostic factors, including cost, pain perception, and satisfaction. The findings indicate that both endodontic therapy and implant placement demonstrate high long-term survival rates. However, direct comparison remains challenging due to heterogeneity in study design, outcome definitions, and follow-up protocols, as well as the moderate risk of bias identified among the included studies. Endodontically treated teeth often exhibit favorable long-term survival and offer the advantage of retreatment in cases of failure. In contrast, implant therapy is generally associated with higher costs and potential biological complications such as peri-implantitis.

Overall, clinical decision-making should not rely solely on reported success rates but must incorporate patient-specific factors, biological considerations, restorative feasibility, and economic aspects. Preservation of the natural tooth should remain the preferred approach whenever feasible, while implant therapy serves as a reliable alternative when the prognosis of the natural tooth is unfavorable. Advances in microsurgical techniques and modern biomaterials have further improved the outcomes of surgical endodontic procedures (42).

Several limitations should be considered when interpreting the findings of this review. First, the included studies demonstrated substantial heterogeneity in study design, outcome definitions, and follow-up durations, which limits direct comparison between endodontic and implant outcomes. Second, many

studies reported survival rather than strict success criteria, potentially leading to an overestimation of treatment effectiveness. Third, variability in radiographic interpretation, diagnostic thresholds for peri-implant disease, and criteria used to define endodontic failure may have influenced reported outcomes. Additionally, the progressive loss of participants during long-term follow-up periods may affect the reliability of survival estimates. Finally, although a considerable number of studies were included, relatively few directly compared endodontic therapy and implant treatment under similar clinical conditions, limiting the strength of the conclusions.

Future research should focus on well-designed prospective and randomized clinical studies that directly compare endodontic treatment and implant therapy under standardized conditions. The adoption of uniform definitions for success and survival is essential to improve comparability across studies. Long-term investigations with adequate sample sizes are needed to better understand biological and mechanical complications associated with both treatment modalities. Furthermore, future research should incorporate patient-centered outcomes such as quality of life, functional performance, and patient satisfaction, alongside economic evaluations of treatment costs and maintenance. Novel modifications in imaging, root canal irrigation,(43, 44) biomaterials,(45), and minimally invasive techniques(46) may further influence treatment outcomes, highlighting the need for ongoing evidence-based evaluation.

Conclusion

Clinicians frequently face the complex decision of whether to preserve a compromised tooth or replace it with a dental implant, particularly given the limited high-quality evidence favoring one approach over the other. Both endodontic therapy and implantology have demonstrated predictable long-term outcomes due to significant technological advancements, and professional organizations such as the American Association of Endodontists and the American Dental Association provide guidance to support evidence-based clinical decision-making. Although reported success rates are comparable, endodontically treated teeth often demonstrate stable long-term survival and offer the possibility of retreatment in cases of failure, whereas implant therapy is generally associated with higher costs and more limited management options following complications. Therefore, preservation of the natural tooth should remain the primary treatment objective whenever feasible, with retreatment strategies considered prior to extraction and implant placement. Nonetheless, implants represent a reliable alternative when the prognosis of the natural tooth is poor. Ultimately, treatment decisions should be individualized and based on informed consent, ensuring that patients are fully aware of the benefits, risks, and long-term outcomes of each option.

Clinical Relevance

The decision between preserving a compromised tooth through endodontic therapy or replacing it with a dental implant represents a common clinical challenge in contemporary dental practice. The findings of this review indicate that both treatment modalities achieve high survival and success rates when performed under appropriate conditions. However, treatment planning should not rely solely on reported success rates and must instead consider multiple prognostic factors, including the structural integrity of the remaining tooth, periodontal status, presence of infection, systemic health conditions, and restorative feasibility, as well as patient-related factors such as cost and treatment expectations. Preservation of the natural tooth through endodontic treatment and re-

treatment should generally be considered the first-line approach when the prognosis is favorable. Dental implants provide a predictable and effective alternative when the natural tooth cannot be reliably restored or maintained. Therefore, individualized treatment planning and effective patient communication are essential to support evidence-based decision-making and achieve optimal long-term outcomes.

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