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REVIEW ARTICLE

COMPARATIVE ASSESSMENT OF TITANIUM VERSUS ZIRCONIA DENTAL IMPLANTS: NARRATIVE REVIEW

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ABSTRACT

Background: Dental implant therapy is a predictable and widely accepted treatment modality for the rehabilitation of partially and completely edentulous patients. Titanium has long been considered the gold standard implant material because of its excellent biocompatibility, mechanical strength, and long-term clinical success. However, esthetic limitations and concerns regarding metal sensitivity have stimulated interest in zirconia implants as a metal-free alternative.

Objective: The aim of this narrative review was to compare titanium and zirconia dental implants with respect to osseointegration, biological response, clinical outcomes, mechanical performance, esthetic properties, and long-term predictability.

Materials and Methods: A literature search was performed using PubMed, Scopus, and Web of Science databases for studies published between 2000 and 2026. Clinical trials, systematic reviews, meta-analyses, prospective and retrospective studies, and relevant in vitro and in vivo investigations were analyzed. Due to heterogeneity among the included studies, a qualitative narrative synthesis was performed.

Results: Titanium implants demonstrated excellent long-term clinical performance, with survival rates ranging from 92% to 100% and highly predictable osseointegration. Zirconia implants showed favorable soft tissue response, high biocompatibility, reduced bacterial adhesion, and improved esthetics, particularly in patients with thin gingival biotypes. Reported survival rates for zirconia implants ranged from 87% to 95%, although greater variability was observed among studies. Titanium exhibited superior fracture toughness, fatigue resistance, and prosthetic flexibility, whereas zirconia showed increased brittleness and limited long-term clinical evidence.

Conclusion: Titanium remains the gold standard for dental implants because of its superior long-term survival, mechanical reliability, and extensive scientific validation. Zirconia implants represent a promising esthetic and metal-free alternative, particularly in anterior regions and selected clinical situations. Nevertheless, additional long-term studies are required to confirm their biomechanical reliability and long-term predictability.

Keywords: Dental implants, titanium, zirconia, osseointegration, implant survival, peri-implantitis, biomaterials.

INTRODUCTION

Dental implantology has undergone remarkable scientific and clinical evolution over recent decades and is now considered one of the most predictable treatment modalities for the rehabilitation of partially and completely edentulous patients[1,2]. The introduction of osseointegration fundamentally transformed restorative dentistry by enabling direct structural and functional integration between implant surfaces and surrounding bone tissue[3]. This breakthrough significantly improved oral function, patient comfort, esthetics, and long-term prosthetic stability.

Since the pioneering work of Brånemark and colleagues, titanium has been widely accepted as the gold standard material for dental implants because of its excellent biocompatibility, corrosion resistance, favorable mechanical properties, and highly predictable osseointegration[4].

Long-term clinical studies have demonstrated survival rates exceeding 90–95% after more than ten years of function, confirming the reliability and durability of titanium implant systems[5,6].

The stable oxide layer naturally formed on titanium surfaces contributes to excellent tissue compatibility and corrosion resistance within the oral environment[7,8].
Continuous improvements in implant surface technologies, including sandblasting, acid etching, plasma spraying, laser modification, and anodization, have further enhanced bone-to-implant contact, accelerated healing, and improved implant stability[9-12]. These developments have reinforced the dominant role of titanium implants in modern implant dentistry.
Despite these advantages, certain limitations associated with titanium implants have stimulated the search for alternative biomaterials. One important concern relates to esthetics, particularly in patients with thin gingival biotypes or gingival recession, where the gray metallic color of titanium may become visible through peri-implant tissues[13,14]. In addition, concerns regarding titanium particle release, corrosion, and rare hypersensitivity reactions have increased interest in metal-free restorative options[15-18].
In this context, zirconia (zirconium dioxide, ZrO_2) has emerged as one of the most promising alternatives to titanium implants. Zirconia is a high-strength ceramic biomaterial characterized by excellent chemical stability, high compressive strength, favorable wear resistance, and low plaque affinity[19-21]. The introduction of yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) significantly improved fracture toughness and mechanical performance, allowing broader biomedical and dental applications[22,23].
One of the major advantages of zirconia implants is their superior esthetic appearance. Their white, tooth-like color minimizes soft tissue discoloration and eliminates the gray shine-through commonly associated with titanium implants24-27. Consequently, zirconia implants are increasingly used in esthetically demanding clinical situations, especially in the anterior region and in patients with thin peri-implant mucosa[28,29].
In addition to esthetic benefits, zirconia implants have demonstrated favorable biological behavior. Several studies have reported excellent soft tissue response and osseointegration comparable to titanium implants[30,31]. Some investigations also suggest reduced plaque accumulation and lower bacterial adhesion on zirconia surfaces, which may contribute to improved peri-implant tissue health[32-34].
However, zirconia implants are not without limitations. Compared with titanium, ceramics are inherently more brittle, making zirconia implants more susceptible to fracture under excessive occlusal loading or unfavorable biomechanical conditions35,36. Earlier zirconia implant systems were predominantly manufactured as one-piece designs, limiting prosthetic flexibility and restorative versatility[37-39].
Although newer two-piece zirconia systems have demonstrated encouraging outcomes, long-term clinical evidence remains less extensive than for titanium implants [40-42].
Another concern is low-temperature degradation (LTD), also referred to as aging, which may result in surface roughening, microcrack formation, and deterioration of mechanical properties over time [43,44]. Although modern manufacturing techniques have reduced this risk, the long-term clinical implications continue to be investigated.
Recent systematic reviews and comparative studies have evaluated titanium and zirconia implants with respect to survival rates, marginal bone loss, peri-implant tissue response, and patient satisfaction [45-47]. While many studies report comparable biological and esthetic outcomes, differences in long-term mechanical reliability and predictability remain important concerns, particularly for zirconia implants [48-50]. Some studies have also suggested a slightly increased risk of early failure and mechanical complications with zirconia implants, especially in areas subjected to high occlusal forces [51,52].
At the same time, zirconia implants offer important advantages for patients seeking highly esthetic and metal-free treatment solutions. Consequently, the selection between titanium and zirconia implants remains a topic of ongoing debate in contemporary implant dentistry [53-55].
Therefore, the aim of the present narrative review is to provide a comparative assessment of titanium and zirconia dental implants with focus on material properties, osseointegration, biological response, mechanical performance, esthetic outcomes, clinical survival, and practical considerations for daily clinical practice.

MATERIALS & METHODS

Study Design

This study was conducted as a narrative review aimed at evaluating and comparing the biological, mechanical, and clinical performance of titanium and zirconia dental implants. The review focused on contemporary evidence regarding osseointegration, peri-implant tissue response, implant survival, esthetic outcomes, and mechanical complications associated with titanium and zirconia implant systems [3,20,27,28,40,44].

An initial electronic search identified 136 studies. After removal of duplicates, 93 studies were screened based on titles and abstracts. Following eligibility assessment, 60 studies were ultimately included in the qualitative synthesis.

Search Strategy

A comprehensive literature search was performed using PubMed, Scopus, and Web of Science databases. Studies published between January 2000 and March 2026 were considered eligible. Additional manual searches of reference lists were also conducted to identify relevant studies not retrieved electronically.

The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to implant materials and clinical outcomes. Main search terms included: “titanium dental implants”, “zirconia dental implants”, “osseointegration”, “implant survival”, “peri-implantitis”, “implant surface modification”, “marginal bone loss”, “biocompatibility”, “implant fracture”, and “esthetic outcomes”.

Boolean operators (“AND”, “OR”) were applied to optimize the search strategy. Representative combinations included: “titanium implants AND zirconia implants”, “zirconia implants AND osseointegration”, “dental implants AND peri-implant soft tissue response”, and “implant survival rate AND zirconia”. Priority was given to high-level evidence, including randomized controlled trials, systematic reviews, and meta-analyses 27,28,40,44,47.

Inclusion and Exclusion Criteria

Included studies comprised human clinical trials, randomized controlled trials, prospective and retrospective cohort studies, systematic reviews, meta-analyses, and relevant in vitro and in vivo comparative investigations evaluating titanium and/or zirconia implants. Studies reporting outcomes related to implant survival, osseointegration, marginal bone loss, peri-implant soft tissue response, bacterial adhesion, esthetic outcomes, and mechanical complications were considered eligible. Preference was given to studies with a minimum follow-up period of 12 months [24,25,27,31,46,47,51].

Case reports with limited sample size, editorials, conference abstracts, non-English publications, animal studies lacking translational relevance, and studies with insufficient methodological or clinical data were excluded. Duplicate publications and overlapping patient populations were carefully screened and excluded when appropriate.

Study Selection and Data Analysis

Titles and abstracts were initially screened for relevance, followed by full-text evaluation according to predefined eligibility criteria. Particular emphasis was placed on studies investigating long-term clinical performance, peri-implant tissue stability, and esthetic outcomes of titanium and zirconia implants [24,27,28,40,44,48]. Due to methodological heterogeneity among the included studies, a quantitative meta-analysis was not performed. Therefore, a qualitative narrative synthesis approach was applied [27,28,40,47].

RESULTS

Material Characteristics and Properties

Titanium and zirconia implants differ significantly in physicochemical composition, microstructure, and mechanical behavior. Titanium implants, mainly manufactured from commercially pure titanium or Ti-6Al-4V alloy, have been widely used in implant dentistry since the 1960s and remain the reference standard in modern implantology [1,3,5]. Their clinical success is primarily related to the formation of a stable titanium dioxide (TiO_2) layer, which provides excellent corrosion resistance and promotes predictable osseointegration [5,8]. Titanium surfaces can be modified through techniques such as sandblasting, acid etching (SLA), anodization, and laser structuring, which enhance surface roughness, protein adsorption, and bone-to-implant contact [6,9,12]. These modifications improve osteoblastic activity and implant stability. Zirconia implants are ceramic biomaterials mainly composed of yttria-stabilized tetragonal zirconia polycrystal (Y-TZP), characterized by high compressive strength, favorable wear resistance, and tooth-like optical properties [20,22]. These characteristics make zirconia particularly attractive in esthetic regions [11,20].

However, zirconia is inherently more brittle than titanium and is susceptible to low-temperature degradation (LTD), which may result in microcrack formation and gradual deterioration of mechanical properties over time [43,44,45.]

Osseointegration and Biological Response

Both titanium and zirconia implants demonstrate excellent biocompatibility and the ability to achieve osseointegration. Titanium remains the gold standard, supported by extensive histological and clinical evidence demonstrating stable bone integration and survival rates exceeding 95% [2,4,5]. Titanium osseointegration involves adsorption of plasma proteins onto the TiO_2 layer followed by osteoblast adhesion and mineralized bone formation at the implant interface [3,5].This process has been extensively documented over decades of clinical use.

Zirconia implants also demonstrate favorable osseointegration with comparable bone-to-implant contact values in experimental and short-term clinical studies [21,24,26]. However, long-term evidence remains less robust compared with titanium systems [28,41].From a soft tissue perspective, zirconia surfaces may demonstrate reduced bacterial adhesion and biofilm formation compared with titanium [13,33,34]. In addition, zirconia has been associated with favorable epithelial attachment and reduced inflammatory infiltrate [23,30.] Nevertheless, most long-term studies report minimal clinically significant differences between titanium and zirconia regarding peri-implant tissue health [28,31,33].

Survival Rates and Clinical Outcomes

Long-term evidence demonstrates survival rates ranging from 92% to 100% for titanium implants over follow-up periods exceeding 10 years [4,5,6]. These results confirm the high predictability and durability of titanium implant systems. Zirconia implants generally show survival rates ranging from 87% to 95%, particularly in short- and medium-term studies [25,29,41]. Greater variability has been observed in zirconia-related outcomes, especially in early-generation implant systems [41,42]. Systematic reviews and meta-analyses confirm superior long-term predictability for titanium implants, whereas zirconia implants continue to demonstrate encouraging but heterogeneous clinical outcomes [28,41]. Marginal bone loss remains relatively stable for both materials, although zirconia outcomes may be more variable in one-piece systems and posterior loading situations [19,32].

Table 1. Comparative Clinical Outcomes of Titanium and Zirconia Implants

Parameter	Titanium	Zirconia
Survival rate	92.6–100%	87.5–95%
Bone loss	Stable	More variable
Peri-implantitis	Low incidence	Similar incidence

Mechanical Properties and Stability

Titanium implants demonstrate excellent mechanical performance characterized by high fatigue resistance, ductility, and an elastic modulus closer to cortical bone [3,5,35]. These properties allow favorable stress distribution and make titanium suitable for posterior regions and full-arch rehabilitations. Zirconia implants exhibit high compressive strength but limited plastic deformation capacity, making them more susceptible to fracture under overload conditions [14,36,47]. Surface defects or microstructural flaws may further increase fracture risk. Consequently, titanium remains mechanically superior in functionally demanding clinical situations.

Esthetic Outcomes

One of the main advantages of zirconia implants is their superior esthetic appearance. Their white, tooth-like coloration eliminates the gray shine-through sometimes associated with titanium implants in patients with thin gingival biotypes [7,11]. Zirconia implants also demonstrate favorable soft tissue integration and improved peri-implant mucosal coloration, particularly in anterior maxillary regions [11,29]. In contrast, titanium implants may occasionally cause visible soft tissue discoloration in highly esthetic situations [7]. Therefore, zirconia implants are often preferred in anterior esthetic zones.

Biocompatibility and Soft Tissue Response

Both titanium and zirconia demonstrate excellent biocompatibility. Titanium is biologically inert because of its stable oxide layer, although rare hypersensitivity reactions and inflammatory responses to titanium particles have been reported

[8,19,25]. As a metal-free ceramic material, zirconia may be advantageous in patients with metal sensitivities. It has also been associated with lower bacterial colonization and favorable epithelial sealing properties [13,17,30]. Despite these biological differences, overall implant success rates are generally not significantly influenced by implant material alone [16,31].

Prosthetic Considerations and Flexibility

Titanium implants provide excellent prosthetic versatility because of the availability of both one-piece and two-piece systems, allowing angulation correction and individualized restorative planning [20,35,48].Zirconia implants are still predominantly manufactured as one-piece systems, which limits prosthetic flexibility and requires more precise surgical placement [15,42]. Although newer two-piece zirconia systems have improved restorative possibilities, they remain more technique-sensitive.Therefore, titanium implants continue to provide superior prosthetic adaptability in complex rehabilitations.

Complications and Limitations

Titanium implants are associated with low complication rates, with peri-implantitis representing the most common biological complication [5,18,28]. Zirconia implants present favorable biological properties but remain limited by increased brittleness and susceptibility to low-temperature degradation (LTD), which may compromise long-term structural integrity [17,43,44]. These limitations restrict zirconia use in high-stress clinical environments.

Cost and Clinical Practicality

Titanium implants are widely available, cost-effective, and supported by extensive long-term clinical evidence, making them the most commonly used implant system in modern dentistry [5,50].Zirconia implants are generally more expensive because of complex manufacturing processes and increased surgical sensitivity. Their more limited prosthetic flexibility also restricts routine clinical application [20,45].

Advantages, Disadvantages, and Clinical Indications

Titanium implants provide excellent long-term success, mechanical reliability, and prosthetic versatility. However, esthetic limitations and rare hypersensitivity reactions may occur in susceptible patients [3,8].

Zirconia implants offer superior esthetics, low plaque affinity, and metal-free composition. Nevertheless, they remain limited by greater fracture risk, lower prosthetic flexibility, and less extensive long-term evidence [14,16].

Clinically, titanium implants are preferred for posterior load-bearing regions, full-arch rehabilitations, and complex restorations, whereas zirconia implants may be advantageous in anterior esthetic regions and in patients requesting metal-free rehabilitation [16,18].

Clinical Indications, Clinical Decision-Making, and Comparative Summary

Selection of implant material should be based on biomechanical requirements, esthetic demands, anatomical conditions, and patient-related factors. Titanium implants remain the most universally applicable system because of their superior mechanical stability, long-term predictability, and prosthetic versatility [3,5,35].

Their ability to withstand high occlusal forces makes them particularly suitable for posterior regions and full-arch rehabilitations [20,48]. Zirconia implants are primarily indicated in esthetically demanding situations and in patients with suspected metal hypersensitivity because of their favorable optical properties and metal-free composition [11,17,29,30]. However, zirconia implants remain mechanically more limited due to brittleness and susceptibility to low-temperature degradation [43,44,45].

In addition, many zirconia systems still demonstrate limited prosthetic flexibility [15,42].

Titanium implants remain the gold standard because of their superior long-term evidence, mechanical reliability, and prosthetic versatility. Zirconia implants represent a promising esthetic alternative but still demonstrate limitations related to brittleness and reduced long-term clinical evidence. Clinical selection should therefore remain evidence-based and indication-driven.

Table 2. Clinical Indications

Clinical Situation	Preferred Material	Rationale
Posterior load-bearing	Titanium	Mechanical strength
Full arch	Titanium	Stability
Anterior esthetics	Zirconia	Esthetics
Metal allergy	Zirconia	Biocompatibility
Complex cases	Titanium	Flexibility

Table 3. Expanded Comparative Overview

Parameter	Titanium Implants	Zirconia Implants
Material type	Metallic (Ti-6Al-4V / CP Ti)	Ceramic (Y-TZP)
Clinical history	Extensive long-term evidence	Newer generation material
Osseointegration	Highly predictable [1,2,4]	Comparable but less evidence [21,26,38]
Survival rate	92–100% [4,5,43]	87–95% [16,19,41]
Mechanical strength	High fatigue resistance [3,35]	Brittle behavior [14,47]
Esthetics	Possible discoloration [7]	Excellent appearance [11,44]
Bacterial adhesion	Moderate biofilm formation	Lower bacterial adhesion [13,27,48]
Prosthetic flexibility	High [20,35]	More limited [15,16]
Cost	Lower	Higher
Evidence level	Very high	Moderate

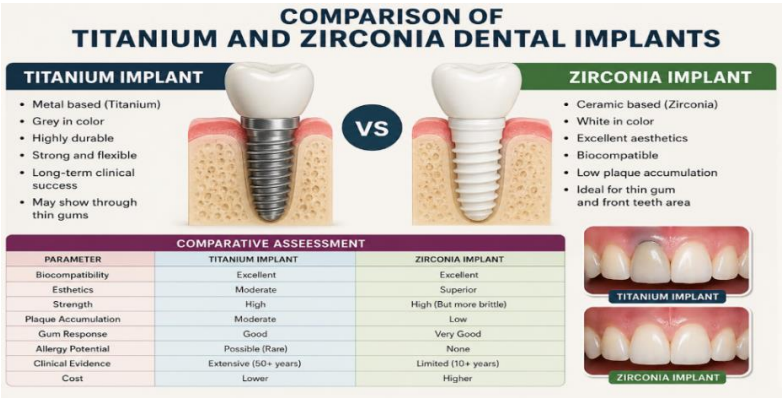

Figure 1. Comparative Assessment of Titanium versus Zirconia Dental Implants

DISCUSSION

The present narrative review provides a comparative assessment of titanium and zirconia dental implants with emphasis on biological behavior, mechanical performance, esthetic outcomes, and long-term clinical applicability. The reviewed literature demonstrates that both implant materials can achieve successful osseointegration and satisfactory clinical outcomes; however, important differences remain regarding long-term predictability, biomechanical stability, prosthetic versatility, and scientific validation.

Titanium remains the gold standard in implant dentistry because of its excellent biocompatibility, corrosion resistance, mechanical strength, and extensive long-term documentation [1–6]. Since the introduction of osseointegration by Brånemark and colleagues [4], titanium implants have consistently demonstrated survival rates exceeding 90–95% during long-term follow-up periods [5,6]. Their biological success is closely associated with the formation of a stable titanium oxide layer that promotes direct bone-to-implant contact and cellular adhesion [3,7,8]. Furthermore, advances in implant surface technologies, including SLA surfaces, hydrophilic modifications, laser treatments, and nanoscale surface engineering, have improved early osseointegration and reduced healing periods [9–12].

In recent years, zirconia implants have gained increasing attention as a metal-free alternative, particularly in patients with high esthetic demands or concerns regarding metal hypersensitivity [20,38,39]. Zirconia demonstrates favorable biocompatibility, low plaque affinity, excellent soft tissue response, and superior esthetics because of its tooth-like white color [20,21,23,30]. Several studies have reported reduced bacterial adhesion and biofilm accumulation on zirconia surfaces compared with titanium [33,34]. However, current evidence does not consistently demonstrate clinically significant reductions in peri-implantitis or implant failure rates [28,41,48].

Osseointegration remains one of the most important determinants of implant success. Experimental and clinical studies have shown that zirconia implants can achieve bone-to-implant contact values comparable to titanium implants [24,56,59]. Histological investigations have also demonstrated favorable osteoblastic activity and direct bone apposition around zirconia surfaces [24,56]. Nevertheless, compared with titanium implants, zirconia systems still lack extensive long-term clinical evidence beyond 10 years [25,41].

Mechanical reliability represents another important distinction between the two materials. Titanium possesses excellent fracture toughness, fatigue resistance, and ductility, making it highly suitable for posterior restorations, full-arch rehabilitations, and patients with parafunctional habits [3,8]. In contrast, zirconia demonstrates high compressive strength but lower fracture toughness and increased brittleness [35,58]. Consequently, zirconia implants may be more susceptible to fracture under excessive occlusal loading [36,55]. Earlier one-piece zirconia systems demonstrated higher complication rates, particularly in posterior regions [27,36,55]. Although newer two-piece zirconia implants have shown improved outcomes [26,42,47], long-term biomechanical evidence remains limited.

Another concern associated with zirconia implants is low-temperature degradation (LTD) or hydrothermal aging [43,44,58]. This phenomenon may lead to surface roughening, microcrack formation, and progressive deterioration of mechanical properties [43,44]. Although modern yttria-stabilized zirconia ceramics appear less susceptible to aging, the long-term clinical implications remain insufficiently understood. From an esthetic perspective, zirconia implants offer important advantages over titanium implants. Their white color minimizes gray shine-through in patients with thin gingival biotypes and contributes to improved peri-implant soft tissue esthetics [11,15,20]. Several studies have also reported enhanced mucosal integration and higher patient satisfaction in anterior esthetic regions [23,29,30].

Despite these esthetic benefits, prosthetic flexibility remains more limited with zirconia implants. Titanium systems are available in multiple configurations, including one-piece and two-piece designs, angulated abutments, and customized prosthetic components [3,20]. Historically, zirconia implants were mainly manufactured as one-piece systems, limiting restorative flexibility [27,38]. Although newer two-piece zirconia systems have expanded treatment options [26,42,47], evidence supporting their long-term stability remains less comprehensive than for titanium implants.

Biocompatibility and immunological response have also become important considerations in implant dentistry. Although titanium is generally highly biocompatible, rare hypersensitivity reactions and adverse tissue responses have been reported [16–19]. Zirconia, as a metal-free ceramic material, may therefore represent a suitable alternative in selected patients with suspected metal sensitivity [19,20]. However, true titanium allergy remains uncommon, and current evidence does not support routine replacement of titanium implants based solely on hypersensitivity concerns [17–19]. Peri-implant diseases remain a significant challenge regardless of implant material [28,49]. Although zirconia surfaces may exhibit lower bacterial colonization [33,34], peri-implantitis remains a multifactorial disease influenced by oral hygiene, smoking, systemic conditions, prosthetic design, and maintenance compliance [31,49].

Current systematic reviews indicate no conclusive evidence that zirconia implants significantly reduce peri-implant disease prevalence compared with titanium implants [28,41,48].Economic and practical considerations also influence implant selection. Titanium implant

systems are widely available, cost-effective, and supported by decades of clinical experience [5,6]. In contrast, zirconia implants are generally associated with higher manufacturing costs, greater technical sensitivity, and a steeper learning curve [20,42,47].

Overall, current evidence suggests that titanium implants remain the most predictable and universally applicable implant system for routine implant rehabilitation, particularly in complex and load-bearing situations[3–6,40]. Zirconia implants should currently be considered a valuable complementary alternative, especially in esthetically demanding cases and in patients seeking metal-free treatment solutions [20,29,45]. However, limitations related to brittleness, aging susceptibility, prosthetic flexibility, and the relative lack of long-term evidence continue to restrict their universal application [41–45,47].

Limitations

Several limitations of this narrative review should be acknowledged. Considerable heterogeneity existed among the included studies regarding implant design, surface treatment protocols, loading conditions, follow-up duration, and outcome assessment methods, limiting direct comparison between studies.

In addition, the literature concerning zirconia implants remains less extensive than that for titanium implants. Many zirconia studies included small sample sizes, short- or medium-term follow-up periods, and variability between one-piece and two-piece implant systems [28,41,42]. Consequently, the long-term predictability of zirconia implants remains less clearly established. Many included studies were observational or retrospective in nature and therefore subject to potential selection bias and confounding variables. Patient-related factors such as smoking, oral hygiene, systemic diseases, parafunctional habits, and bone quality may also have influenced clinical outcomes [31,49]. Furthermore, zirconia implant technology continues to evolve, and newer ceramic processing methods, yttria stabilization techniques, and surface modifications may improve biological and mechanical performance [42–44]. However, long-term evidence regarding these contemporary systems remains limited. Finally, because this study was conducted as a narrative review rather than a formal systematic review with meta-analysis, interpretation of the findings should be approached with caution.

Future Directions

Future research should focus on well-designed multicenter randomized controlled trials directly comparing contemporary titanium and zirconia implant systems under standardized clinical conditions, particularly with long-term follow-up beyond 10 years [25,41,47]. Additional investigations are needed to improve the biomechanical reliability of zirconia implants, especially in posterior load-bearing regions. Advances in ceramic processing technologies, bioactive surface coatings, aging-resistant zirconia formulations, and implant surface modifications may further enhance long-term clinical outcomes [42–44].

Future studies should also evaluate peri-implant microbiome interactions, patient-reported outcomes, digital workflows, CAD/CAM integration, and cost-effectiveness of zirconia implant systems. Standardized diagnostic criteria for implant success and peri-implant disease would improve comparability among future studies.

As implant biomaterials and ceramic technologies continue to evolve, zirconia implants may become a more predictable and widely applicable alternative to titanium implants in modern implant dentistry.

CONCLUSION

Titanium implants remain the gold standard in implant dentistry because of their excellent long-term survival, mechanical reliability, prosthetic versatility, and extensive scientific validation [3–6,40]. Their predictable osseointegration and broad clinical applicability make them the most reliable option for routine implant rehabilitation.

Zirconia implants represent a promising metal-free alternative with favorable esthetic properties, soft tissue integration, and reduced bacterial adhesion [20,23,29,30]. These characteristics make zirconia particularly attractive in anterior esthetic regions and in patients seeking metal-free treatment solutions.

However, current evidence indicates greater variability in long-term survival and mechanical performance for zirconia implants compared with titanium systems [28,41,45,47]. Limitations related to brittleness, low-temperature degradation, prosthetic flexibility, and limited long-term evidence continue to restrict their universal application. Therefore, implant material selection should be based on evidence-based clinical decision-making integrating biomechanical, esthetic, prosthetic, anatomical, and patient-related factors. Continued advancements in ceramic biomaterials and implant technology may further improve the predictability and clinical applicability of zirconia implant systems in the future.

DECLARATIONS

Conflict of Interest

The author declare no conflict of interest.

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Ethical Approval

Ethical approval was not required as this is a narrative review of published literature.

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