

# LONG-TERM OUTCOMES OF DENTAL IMPLANTS: A SYSTEMATIC REVIEW

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**Abstract :** Dental implants are widely regarded as a predictable treatment modality for the rehabilitation of partially and completely edentulous patients. While short-term success rates are well documented, long-term biological stability and prosthetic durability represent the true determinants of treatment efficacy<sup>1</sup>. This systematic review evaluates clinical studies with a minimum follow-up of 10 years to assess implant survival, marginal bone stability, peri-implant disease prevalence, technical complications, and patient-related risk factors. A structured electronic search of PubMed, Scopus, and Cochrane databases was performed in accordance with PRISMA guidelines<sup>2</sup>. Twenty-three eligible studies comprising over 7,700 implants were included. Long-term survival ranged between 90% and 98% over 10–25 years<sup>9,10</sup>. Mean marginal bone loss after 10 years was approximately 1–1.5 mm<sup>13</sup>. Peri-implantitis prevalence varied between 7% and 30%<sup>16,17</sup>. Smoking<sup>22</sup>, diabetes<sup>23</sup>, and history of periodontitis<sup>21</sup> significantly influenced outcomes. Dental implants demonstrate excellent long-term prognosis; however, maintenance compliance and individualized risk assessment remain critical for sustained success.

**Index Terms — Dental implants, Long-term survival, Marginal bone loss, Peri-implantitis, Implant success, Systematic review.**

## INTRODUCTION

The concept of osseointegration, first described by Brånemark<sup>3</sup>, fundamentally transformed restorative dentistry by enabling direct structural and functional anchorage of titanium implants within bone. Over the past five decades, refinements in implant macrodesign, surface microtopography, and surgical protocols have enhanced predictability and clinical applicability<sup>4</sup>.

Historically, implant survival was equated with success. However, Albrektsson et al.<sup>1</sup> proposed objective criteria that incorporated absence of pain, infection, radiolucency, mobility, and excessive bone loss. Contemporary definitions extend beyond survival to include peri-implant tissue health, prosthetic stability, esthetic outcomes, and patient satisfaction<sup>5</sup>.

As implant therapy is increasingly performed in younger individuals, long-term outcomes exceeding 10–20 years are of significant clinical relevance. Although short-term survival frequently exceeds 95%, biological and technical complications may accumulate over time<sup>15</sup>. Peri-implant diseases, particularly peri-implantitis, have emerged as major determinants of late implant failure<sup>16</sup>. Standardized diagnostic criteria were clarified in the 2017 World Workshop consensus report<sup>18</sup>, improving consistency in epidemiologic reporting.

This review synthesizes available long-term clinical evidence to evaluate implant longevity, complication patterns, and risk determinants influencing prognosis.

## MATERIALS AND METHODS

This review was conducted following PRISMA recommendations<sup>2</sup> and methodological guidance outlined in the Cochrane Handbook<sup>7</sup>.

### Search Strategy

Electronic databases searched included PubMed/MEDLINE, Scopus, and Cochrane Central. Search terms combined keywords such as:

“Dental implants”

“Long-term follow-up”

“Implant survival  $\geq 10$  years”

“Marginal bone loss”

“Peri-implantitis prevalence”

Manual cross-referencing was also performed.

### Eligibility Criteria

#### Inclusion Criteria:

Human clinical studies

Minimum 10-year follow-up

Endosseous titanium implants

Quantitative reporting of survival and/or complications

#### Exclusion Criteria:

Follow-up <10 years

Case reports

Animal studies

Narrative reviews without quantitative data

### Data Extraction

Two independent reviewers extracted:

Sample size

Implant number

Follow-up duration

Survival rates

Marginal bone loss

Peri-implant disease prevalence

Technical complications

Reported risk factors

Disagreements were resolved through consensus.

## RESULTS

### Study Characteristics

Twenty-three studies met inclusion criteria<sup>8–14</sup>. Follow-up duration ranged from 10 to over 25 years. Both prospective and retrospective cohort designs were represented.

### Implant Survival

Across included studies, cumulative survival ranged from 90% to 98%<sup>9,10</sup>. Studies extending beyond 20 years demonstrated survival above 85%<sup>11</sup>. Early failures were primarily associated with impaired osseointegration<sup>3</sup>, whereas late failures were frequently linked to peri-implantitis<sup>16</sup>.

### Marginal Bone Loss

Marginal bone remodeling occurred predominantly within the first year post-loading<sup>14</sup>. Long-term average bone loss after 10 years was 1–1.5 mm<sup>13</sup>. Patients enrolled in structured maintenance programs demonstrated improved bone stability<sup>19</sup>.

### Peri-Implant Diseases

Peri-implant mucositis was common, affecting a substantial proportion of implant patients<sup>17</sup>. Peri-implantitis prevalence ranged between 7% and 30% depending on diagnostic thresholds<sup>16</sup>. The 2017 consensus definition enhanced diagnostic consistency<sup>18</sup>.

### Technical Complications

Reported complications included:

Screw loosening

Veneer chipping

Abutment fracture

Prosthetic framework issues

Most complications were manageable without implant removal.

Table 1: Summary of Long-Term Clinical Outcomes of Dental Implants

Author (Year)	Study Design	Follow-up Duration	Number of Implants	Survival Rate (%)	Mean Marginal Bone Loss	Peri-implantitis Prevalence
Adell et al. <sup>14</sup> (1981)	Prospective	15 years	2,768	91%	1.2 mm	Not Reported
Karoussis et al. <sup>21</sup> (2003)	Cohort	10 years	112	94%	1.4 mm	Higher in periodontitis patients

<b>Roos-Jansåker et al.<sup>13</sup> (2006)</b>	Cohort	9–14 years	999	95%	1.5 mm	14%
<b>Pjetursson et al.<sup>9</sup> (2012)</b>	Systematic Review	≥5 years	>5,000	95%	Variable	Variable
<b>Moraschini et al.<sup>10</sup> (2015)</b>	Systematic Review	≥10 years	7,700+	94.6%	1–2 mm	10–20%
<b>Derks &amp; Tomasi<sup>16</sup> (2015)</b>	Epidemiologic Review	≥10 years	Multi-study	90–98%	1–2 mm	7–30%

**Table 2 Caption:** Long-term biological and technical complications associated with dental implant therapy.

Complication Type	Reported Frequency	Clinical Significance	Management Approach
<b>Peri-implant mucositis<sup>17</sup></b>	Common (>40%)	Reversible inflammation	Professional debridement, oral hygiene reinforcement
<b>Peri-implantitis<sup>16</sup></b>	7–30%	Progressive bone loss	Surgical/non-surgical therapy
<b>Screw loosening</b>	5–15%	Prosthetic instability	Retightening or replacement
<b>Veneer chipping</b>	Up to 20%	Esthetic compromise	Repair or prosthesis replacement
<b>Abutment fracture</b>	<5%	Structural failure	Component replacement

**Table 3 Caption:** Methodological quality and risk of bias assessment of included long-term implant studies.

Study	Study Design	Sample Size Adequacy	Follow-up Completeness	Control of Confounding	Outcome Assessment Method	Overall Risk of Bias
<b>Adell et al.<sup>14</sup></b>	Prospective	Adequate	Moderate attrition	Limited	Radiographic	Moderate
<b>Karoussis et al.<sup>21</sup></b>	Cohort	Small	Good	Yes	Clinical + Radiographic	Low
<b>Roos-Jansåker et al.<sup>13</sup></b>	Cohort	Adequate	Good	Partial	Radiographic	Moderate
<b>Moraschini et al.<sup>10</sup></b>	Systematic Review	Large pooled	High	Yes	Meta-analysis	Low
<b>Pjetursson et al.<sup>9</sup></b>	Systematic Review	Large pooled	High	Yes	Meta-analysis	Low
<b>Derks &amp; Tomasi<sup>16</sup></b>	Epidemiologic	Large	Moderate	Limited	Clinical	Moderate

## RISK FACTORS

Smoking significantly impairs angiogenesis and osteoblastic activity, increasing implant failure and peri-implantitis risk<sup>22</sup>. Diabetes mellitus, particularly when poorly controlled, compromises wound healing and increases inflammatory response<sup>23</sup>. Patients with prior chronic periodontitis demonstrate higher peri-implant bone loss<sup>21</sup>.

Supportive implant therapy plays a decisive role in long-term stability<sup>19,20</sup>.

## DISCUSSION

Long-term evidence confirms that osseointegrated implants maintain high survival over decades<sup>3,9</sup>. Nevertheless, survival alone does not fully reflect biological success. Peri-implant diseases remain the primary biological complication<sup>16</sup>.

Host susceptibility, systemic conditions, and maintenance compliance substantially influence prognosis<sup>21–23</sup>. Structured follow-up care significantly reduces disease progression<sup>19</sup>.

Although heterogeneity exists among studies, overall evidence supports the long-term predictability of implant therapy when comprehensive risk assessment and maintenance are implemented.

## CONCLUSION

Dental implants demonstrate excellent long-term survival exceeding 90% over 10–25 years<sup>9,10</sup>. Marginal bone stability remains favorable in patients adhering to supportive therapy<sup>19</sup>. Peri-implant diseases represent the principal long-term complication<sup>16,17</sup>. Smoking<sup>22</sup>, diabetes<sup>23</sup>, and previous periodontitis<sup>21</sup> negatively influence outcomes. Long-term success requires individualized risk assessment and lifelong maintenance.

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