

From Inevitable Remodeling to Preventable Stability: The Zero Bone Loss Concepts in Implant Dentistry- A Review

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ABSTRACT

Purpose: Crestal bone loss surrounding dental implants has historically been regarded as an unavoidable outcome of implantation and subsequent prosthetic restoration, with conventional standards permitting up to 1.5 mm of marginal bone loss during the initial year. This study presents the Zero Bone Loss Concepts or Crestal Bone Stability (ZBLC), a multifactorial, evidence-based approach designed to attain and preserve long-term crestal bone stability with low to no marginal bone loss over prolonged durations.

Materials and Methods: ZBLC combines surgical and prosthetic approaches, with a minimum vertical soft tissue thickness of 3 mm as the essential requirement to avert biological width-related remodeling. Additional considerations encompass platform switching, subcrestal or supracrestal implant positioning, the avoidance of polished collars beneath bone level, screw-retained restorations to eradicate subgingival cement leftovers, and enhanced abutment designs. Clinical experiments, systematic reviews, and long-term observations substantiate these factors, showing diminished or little bone loss when utilized synergistically.

Results: Clinical studies indicate that sufficient vertical soft tissue thickness substantially reduces early marginal bone loss (about 0.5 mm less than thin biotypes), whereas prosthetic enhancements further improve stability. Long-term follow-up statistics demonstrate consistent bone preservation exceeding 5–10 years in complying instances.

Conclusions: ZBLC contests the notion of unavoidable peri-implant bone resorption, providing clinicians with a proactive framework for enhanced implant durability, peri-implant health, and aesthetic results by meticulous regulation of biological and biomechanical variables.

KEYWORDS: Zero Bone Loss Concepts, Crestal bone stability, Vertical soft tissue thickness, Peri-implant marginal bone loss, Platform switching, Dental implants, Screw-retained restorations.

INTRODUCTION

The Zero Bone Loss Concept (ZBLC) was initially presented in 2019 by Professor Tomas Linkevičius. Zero bone loss denotes the preservation of the initial bone level surrounding a dental implant throughout time, with no further bone deterioration. Excessive bone loss is critical for the long-term effectiveness of dental implants, as it may result in implant failure. Factors associated with minimal bone loss in dental implants encompass precise implant placement, suitable implant diameter and length, sufficient bone quality and quantity, utilization of implant surfaces that enhance osseointegration, and effective implant management. [1] Dental implants have emerged as a fundamental aspect of contemporary restorative dentistry, providing reliable long-term replacements for missing teeth with elevated survival rates. Nonetheless, peri-implant marginal bone loss continues to be a significant concern, conventionally regarded as an unavoidable outcome of implant insertion and prosthetic loading. Traditional success criteria, as delineated by Albrektsson et al. in 1986,

allowed for a maximum of 1.5 mm of crestal bone loss in the initial year, followed by ≤ 0.2 mm per year subsequently. This paradigm has shaped treatment expectations for decades; however, growing data suggests that bone remodeling is not inevitable and can frequently be averted with focused multifactorial therapies. [2]

The Zero Bone Loss Concept (ZBLC) signifies a transformative approach in implant dentistry. This evidence-based treatment procedure combines surgical and prosthetic approaches to attain and preserve long-term crestal bone stability, characterized by minimum to no marginal bone loss years following prosthetic implementation. The concept contests the idea of unavoidable bone resorption by examining essential biological and biomechanical factors, notably the significant influence of vertical soft tissue thickness (≥ 3 mm as a prerequisite), implant design features (e.g., platform switching, stable connections), accurate implant placement depth, and enhanced prosthetic materials and techniques (e.g., screw-retained restorations to eradicate subgingival cement residues). [3]

The basis of ZBLC arises from clinical findings and peer-reviewed research indicating that narrow vertical soft tissues (< 2 mm) initiate the creation of biological width, resulting in crestal bone remodeling irrespective of advantageous implant designs. Conversely, sufficiently thick tissue acts as a protective barrier, facilitating therapies like platform swapping and subcrestal insertion to successfully reduce or eradicate bone loss. This method optimizes implant durability and peri-implant tissue health while simultaneously improving aesthetic results and patient satisfaction through the preservation of soft tissue architecture. The subsequent sections examine the surgical and prosthetic principles that form the foundation of ZBLC, substantiated by clinical evidence. [4, 5] An optimal clinical scenario may exist with adequate bone height and width, at least 2 mm of connected tissues, and precise 3D positioning of the implant, yet crestal bone loss can nonetheless transpire. This problem can be mitigated by implementing the 'zero bone loss idea'.

METHODOLOGY

Search Protocol

This methodology outlines a systematic framework for the analysis and implementation of the zero bone loss concept in implant dentistry, highlighting its importance in preventing marginal crestal bone loss around a dental implant from the onset of prosthetic loading and by safeguarding the biological width and peri-implant soft tissue seal.

We utilized the keywords "zero bone loss concepts," "crestal bone stability," "vertical soft tissue thickness," "peri-implant marginal bone loss," "platform switching," "dental implants," and "screw-retained restorations," employing databases including Google Scholar, Science Direct, Scopus, Wiley Online Library, PubMed, Web of Science, and EBSCOhost. The search targeted papers published from January 2010 to December 2025.

Criteria for eligibility

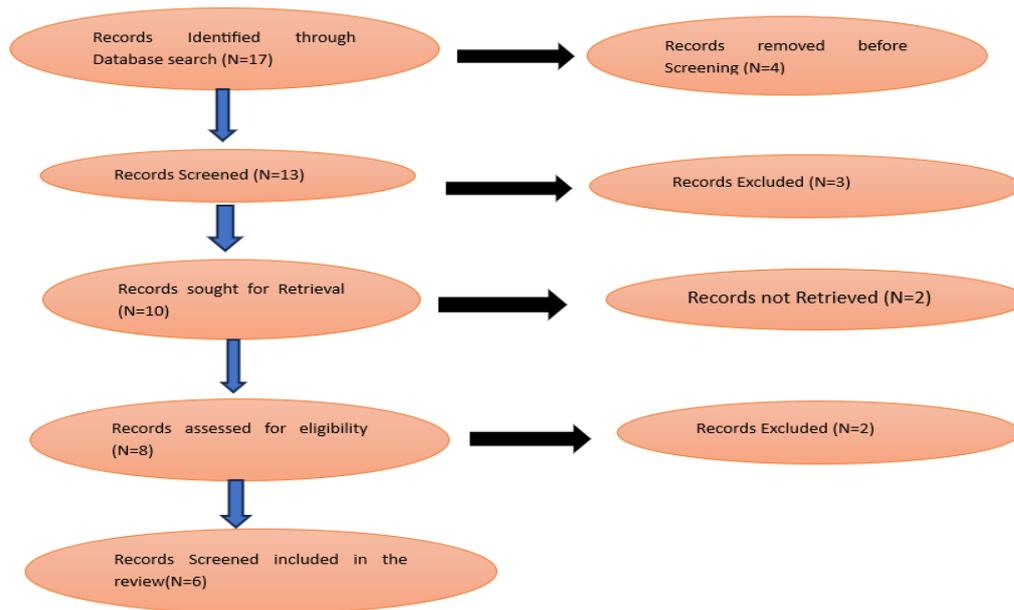
We exclusively examined full-text articles in English that satisfied the following criteria: relevance to the aforementioned keywords and availability of the complete text. The analysis omitted papers not authored in English, those comprising solely abstracts, and those originating from restricted investigations.

Extracting data

We perused the entire article to obtain the required knowledge. The data extraction approach analyzed the evaluation of ZBLC's role in implant dentistry. Seventeen manuscripts were identified in the literature search; however, only six satisfied the inclusion requirements.

[Figure-1: Flow Chart]

Figure -1 PRISMA flow chart for the selection of Articles



DISCUSSION

The objective of Zero Bone Loss Concepts (ZBLC) is to avert peri-implant bone resorption, augment implant longevity, enhance aesthetics through stable soft tissue levels, and provide both the patient and doctor with increased predictability and reassurance. Zero Bone Loss Concepts (ZBLC) denotes a clinical approach in dental implantology designed to secure long-term crestal bone stability surrounding implants, hence limiting or eradicating marginal bone resorption. Conceived by Prof. Tomas Linkevičius, it underscores accurate implant positioning at a minimum depth of 4 mm from the gingival edge, sufficient soft tissue thickness (generally exceeding 2 mm), and particular prosthetic configurations like as screw-retained restorations with titanium and zirconia bases. [6, 7]

Key Aspects of the Zero Bone Loss Concept

Preventive Approach: In contrast to conventional treatments that see a degree of bone resorption as acceptable, whereas ZBLC aspires to achieve zero millimeters of crestal bone loss over time.

Critical Determinants of Success: The notion underscores that success relies on a confluence of precise surgical, prosthetic, and biomechanical elements rather than a singular aspect.

Soft Tissue Stability: A significant observation is that when the vertical soft tissue thickness is 2 mm or less, there is a likelihood of 1.5 mm of crestal bone resorption; therefore, augmenting this tissue thickness is a main objective.

Prosthetic Options: It is advisable to utilize screw-retained restorations and zirconia materials to mitigate biological problems.

The methodologies, encompassing particular implant configurations, provide enhanced and more reliable long-term results, hence augmenting aesthetic outcomes and patient contentment. These protocols have become essential instruments for dental practitioners, offering a systematic method to avert bone resorption and improve the success rates of implant procedures. [3,6,7]

Why is bone loss still common?

Despite adequate bone volume, optimal 3D placement, and sufficient connected gingiva, crestal bone loss frequently transpires due to a confluence of factors:

- a. Implant configuration (polished neck, micro-gap)

b. Inadequate vertical soft tissue thickness

c. Inadequate prosthetic selections (cement residues, insecure attachments, subgingival substances)

ZBLC considers bone loss to be preventable rather than inevitable. Linkevičius asserts that vertical soft tissue thickness, measured from the bone crest to the gingival edge, is the paramount prerequisite for preventing bone loss. [3,4,6]

Vertical soft tissue thickness of > 3 mm indicates a high probability of bone integrity, serving as a protective barrier. Thin tissue (< 2–2.5 mm) → increased risk of bone resorption. Thin tissue prompts bone remodeling to establish biological width, resulting in crestal bone loss. [6,7]

Key Surgical Factors in Zero Bone Loss Concepts

The primary principles frequently highlighted are:

1. Sufficient Vertical Soft Tissue Thickness (the foundation)

If slender, enhance vertically prior to or during implant insertion.

2. Techniques for augmenting vertical soft tissue (Puisys & Linkevičius algorithm):

Subcrestal implant insertion (regulated remodeling) Reduction of the alveolar crest Tent-pole technique. Vertical soft tissue grafts and augmentation (connective tissue and replacements)

3. Considerations for Implant Design:

Avoid or minimize polished (smooth) necks; micro-threaded or roughened necks up to the crest exhibit superior performance. Reliable implant-abutment interface (internal preferred, minimal micro-gap). Switching platforms frequently aids in mitigating bone loss.

4. Implant Placement Depth:

Determined by the implant design and the thickness of the soft tissue. Bone-level implants are frequently positioned somewhat subcrestally when the tissue is sufficient.

5. Attached Keratinized Mucosa:

A minimum of 2 mm is advised surrounding implants for enduring stability.

Key Prosthetic Factors in Zero Bone Loss Concepts

Screw-retained restorations are favored over cement-retained options. No possibility of subgingival cement residues. Titanium bases featuring pronounced gingival emerging and polished zirconia in the subgingival region. Enhances epithelial adherence. Appropriate emergence profile (concave/convex configuration). Facilitates soft tissue scalloping and enhances stability. [3,6,8]

Principles for attaining minimal bone loss

A). Vertical Soft Tissue Thickness

A fundamental principle in attaining zero bone loss is maintaining adequate vertical soft tissue thickness (generally ≥ 3 mm) above the implant site. Thin soft tissues (<2 mm) result in crestal bone resorption as the body seeks to establish a biological width. The enhancement of thin tissues inhibits this remodeling, hence fostering long-term bone stability. Methods encompass connective tissue grafts or allogenic membranes utilized during implant surgery. [8]

B). Platform Transition

Platform switching entails employing an abutment with a diameter smaller than that of the implant platform, thereby relocating the implant-abutment interface inward. This alleviates tension on the crestal bone and diminishes the inflammatory effects of the micro-gap, resulting in reduced bone loss. It is especially efficacious when paired with sufficient soft tissue thickness. [4,9]

C). Subcrestal Implant Placement

Positioning the implant marginally beneath the crestal bone level (subcrestal) facilitates regulated bone remodeling and enhances soft tissue integration. This treatment, applied in areas with enough soft tissue, facilitates bone outgrowth and stability, mitigating possible loss. The depth is generally 1-2 mm subcrestal, contingent upon the implant type. [7,8]

D). Techniques for Soft Tissue Thickening (e.g., Tent-Pole and Bone Flattening)

Methods such as the tent-pole technique (utilizing healing abutments or grafts to elevate the tissue) and alveolar crest reduction enhance vertical dimension. Allogenic membranes or connective tissue grafts are employed to augment thin biotypes, mitigating bone loss by establishing a protective barrier. [11, 12]

E). Prosthetic Considerations (Screw-Retained Restorations and Abutment Configuration)

Screw-retained prosthetics eliminate cement residues that might lead to irritation and osseous resorption. The height of the abutment (e.g., increased transmucosal heights) and the use of materials (polished zirconia subgingivally) guarantee secure connections and appropriate emergence profiles, hence promoting soft tissue health and bone maintenance. [7, 13]

F). Attached Keratinized Mucosa

Preserving or increasing ≥ 2 mm of keratinized mucosa surrounding implants improves plaque management and diminishes inflammation, hence promoting bone integrity. Insufficient keratinized tissue heightens vulnerability to peri-implantitis and ensuing bone resorption. [14, 15]

Within the Zero Bone Loss Concepts (ZBLC) paradigm, no singular concept is deemed the definitive "most important" or exclusively accountable for attaining zero (or near-zero) crestal bone loss. ZBLC asserts that the stability of crestal bone is derived from the synergistic interplay and integration of various surgical and prosthetic elements. [3-5]

Vertical soft tissue thickness (≥ 3 mm preferred, ideally 4 mm) is often emphasized as a critical precondition and fundamental biological element among the concepts. Thin tissues (< 2 mm) consistently result in bone resorption during biological width creation, even with advantageous implant designs (e.g., platform switching does not prevent loss in thin biotypes). Dense vertical soft tissue serves as a protective barrier, allowing additional factors (such as platform switching, subcrestal implantation, or screw-retained restorations) to successfully enhance bone stability. [3-5, 16]

Indications for ZBLC

ZBLC is approved in several therapeutic situations aimed at preventing or reducing peri-implant marginal bone loss, particularly when long-term stability, aesthetics, and functionality are paramount. Principal indications comprise: [3-6]

Voluntary implant implantation in healthy individuals: Optimal for single or multiple dental restorations in individuals with robust systemic health, satisfactory oral hygiene, and enough bone volume (or locations suitable for augmentation). It is especially advantageous in the aesthetic zone (e.g., anterior maxilla) to preserve soft tissue architecture and prevent gingival recession. Instances involving slender soft tissue biotypes: When vertical soft tissue augmentation (e.g., through connective tissue grafts or tent-pole procedures) can achieve ≥ 3 mm, facilitating bone preservation despite initial inadequacies.

Protocols for immediate or early loading: Applicable in post-extraction locations or urgent instances, contingent upon the resolution of contraindications such as infection or thin buccal plates by methods such bone augmentation beneath the implant or directed bone regeneration. Patients with a history of periodontitis should be handled with thick keratinized mucosa (≥ 2 mm) and stringent maintenance to mitigate inflammatory risks.

Short implants or compromised ridges: When utilized alongside vertical augmentation to guarantee effective platform changeover and stable connections.

These indications correspond with ZBLC's emphasis on proactive bone preservation, rendering it appropriate for the majority of conventional implant cases when augmentation is viable and patient adherence is elevated.

Contraindications for ZBLC

Although ZBLC can be modified for various complex scenarios, there exist relative and absolute contraindications that may render its complete implementation impractical or inadvisable, possibly resulting in poor results or heightened hazards.

These comprise: [7-10]

Severe systemic conditions: Uncontrolled diabetes, extensive smoking (>10 cigarettes/day), immunosuppression, or bisphosphonate medication, which hinder healing and elevate the risk of bone loss, superseding ZBLC's preventive mechanisms.

Inadequate bone or tissue lacking augmentation potential: Severe vertical or horizontal bone atrophy where grafting is contraindicated (e.g., due to vascular compromise or patient refusal), or enduring thin biotypes that cannot be thickened, as this undermines the essential requirement of ≥ 3 mm vertical soft tissue.

Active peri-implant or periodontal disease: Unmanaged infections or inflammation, as these may aggravate bone loss despite ZBLC treatments.

Suboptimal patient adherence: Inability to sustain oral hygiene or attend follow-up appointments, elevating the risk of peri-implantitis.

Specific immediate contraindications include acute infections, insufficient apical bone stability, or inadequate buccal plate thickness without corrective interventions; however, ZBLC provides solutions to address these issues in certain patients. Relative contraindications in complex restorations include full-arch instances subjected to high loading or bruxism, wherein certain bone adaptation may be inevitable. In these situations, modified or alternative methods (e.g., stepwise approaches with permissible low loss) are favored to guarantee implant viability.

How ZBLC Distinct from Other Concepts

Conventional implant paradigms, such as Branemark's osseointegration principles and Albrektsson's success criteria, recognize a degree of crestal bone loss as standard and inevitable, attributing it to several factors including occlusal overload, microbiological contamination, and deficiencies in implant design. Success is defined as survival with minimal loss (≤ 1.5 mm in the first year post-loading, ≤ 0.2 mm yearly thereafter), emphasizing mitigation over elimination.

Paradigm Shift: ZBLC refutes inevitability, perceiving loss as avoidable through biological requirements (e.g., soft tissue thickness as the "keystone" superseding design). Conventional methods emphasize implant hardware (e.g., textured necks, micro-threads) or surgical sequencing (two-stage submerged healing) to minimize loss (~ 0.3 – 1 mm), yet neglect soft tissue biology, resulting in variable outcomes in slender biotypes.

Biological versus Mechanical Emphasis: Traditional techniques such as platform switching (launched about 2006) or subcrestal insertion alone mitigate loss by approximately 0.3 – 0.7 mm through biomechanical and microbiological regulation, although are ineffective in thin tissues (e.g., approximately 1.17 mm loss despite switching). ZBLC incorporates these as supplementary elements, but requires tissue augmentation initially, resulting in nearly negligible loss (e.g., 0.21 mm in thick tissues).

Prosthetic Focus: Conventional cement-retained restorations pose a risk of irritation due to residual materials; ZBLC requires screw-retained and polished components to ensure zero tolerance.

Outcomes: Traditional methods exhibit inconsistent loss (e.g., greater in short implants or aesthetic zones, increasing the risk of peri-implantitis); ZBLC enhances predictability, facilitates bone growth, and diminishes problems such as aesthetic recession. ZBLC is proactive and biology-driven, contrasting with standard reactive, design-centric solutions by addressing resorption at its molecular origin. [2-6]

The Zero Bone Loss Concepts (ZBLC), developed by Prof. Tomas Linkevičius, constitute a transformative, multifactorial protocol designed to attain and maintain long-term crestal bone

stability around dental implants, thereby reducing or eradicating marginal bone loss (MBL) beyond conventional thresholds (e.g., ≤ 1.5 mm in the first year and ≤ 0.2 mm annually). In contrast to previous methods that considered a certain level of crestal remodeling unavoidable, ZBLC asserts that bone loss can be predominantly averted by the synergistic enhancement of surgical and prosthetic factors. [2, 3, 5]

At the core of ZBLC is the acknowledgment that vertical soft tissue thickness during implant placement is an essential biological need. Clinical and systematic review research consistently indicates that thin peri-implant mucosa (< 2 mm) predisposes individuals to increased early marginal bone loss (MBL) due to the physiological establishment of biological width, regardless of advantageous implant designs such as platform switching. Conversely, substantial vertical soft tissue (≥ 3 mm, preferably ≥ 4 mm) serves as a protective barrier, markedly diminishing remodeling and allowing additional elements to contribute effectively to bone preservation. Meta-analyses have established that implants situated in thicker mucosa demonstrate roughly 0.5–0.54 mm reduced marginal bone loss in the near term, with trial-sequential analyses reinforcing the reliability of this correlation despite study heterogeneity. [17,18]

Platform switching, subcrestal placement, micro-threaded necks, and the avoidance of polished collars or subgingival cement remains are beneficial adjuncts; nevertheless, their effectiveness is significantly reduced or nullified in thin tissue biotypes. For example, platform-switched implants in thin mucosa may demonstrate around 1.17 mm of bone loss after one year, but the same design in thick tissue results in nearly negligible remodeling (approximately 0.21 mm). Prosthetic factors, such as screw-retained restorations, elevated titanium bases with polished zirconia subgingivally, and concave emerging profiles, enhance epithelial adhesion and reduce inflammation; nevertheless, these advantages depend on sufficient vertical tissue dimension. [19, 20]

CONCLUSION

The Zero Bone Loss Concepts (ZBLC), developed by Prof. Tomas Linkevičius, signify a paradigm shift in implant dentistry from the acceptance of marginal bone loss as a foregone conclusion to the proactive prevention of such loss using rigorous, evidence-based surgical and prosthetic methodologies. By emphasizing vertical soft tissue thickness (≥ 3 mm) as the essential biological criterion, and incorporating additional factors such as platform switching, optimal implant placement depth, the exclusion of polished collars beneath the bone level, screw-retained restorations, and meticulous subgingival material selection, ZBLC empowers clinicians to attain and maintain negligible or zero crestal bone loss over prolonged durations, frequently recorded beyond 5–10 years in clinical practice.

A surgeon devoid of prosthetic expertise and a prosthodontist lacking surgical insight may fail to achieve optimal outcomes, as both components are equally crucial for bone stability. The integration of information from both professions is crucial for all implantologists. Zero Bone Loss Concepts (ZBLC) does not possess specific randomized controlled trials (RCTs) or double-blind studies that directly validate the complete methodology established by Prof. Tomas Linkevičius.

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