

Claudio Stacchi, Tiziano Testori, Antonio Rapani, Yoshiaki Arai, Gustavo Avila-Ortiz, Juan Blanco-Carrión, Tiago Borges, Eriberto Bressan, Luigi Canullo, Pablo Galindo-Moreno, Carlos Garaicoa-Pazmiño, Guo-Hao Lin, Tomas Linkevičius, Nikos Mattheos, Krisztina Mikulás, Alberto Monje, Marta Muñoz, Miguel Padial-Molina, Andrea Ravidà, Rafael Siqueira, Sergio Spinato, Fernando Suárez-López del Amo, Cristiano Tomasi, Giuseppe Troiano, Hom-Lay Wang, Teresa Lombardi

Prevention of initial bone remodelling around dental implants: An international clinical consensus utilising the Delphi method

KEYWORDS

initial bone remodelling, marginal bone loss, peri-implant disease, peri-implantitis

ABSTRACT

Purpose: To establish an expert consensus on the definition, diagnostic boundaries and clinical interpretation of initial bone remodelling around dental implants and identify evidence-based strategies for its prevention and management.

Materials and methods: A three-round Delphi consensus process was conducted using an established methodology. Twenty-five internationally recognised experts in implant dentistry, identified through a structured literature search, participated anonymously. Fifteen statements were developed by a coordinating group to address the definition, clinical implications and aetiopathogenesis of initial bone remodelling. Agreement was rated on a 9-point Likert scale, with consensus defined as a mean score ≥ 7 and ≤ 1 outlier.

Results: All 25 experts completed each round. Of the 15 statements evaluated, 10 reached full consensus, one achieved near consensus and four did not reach the predefined threshold. No consensus was achieved regarding the definition, temporal reference or prognostic significance of initial bone remodelling, highlighting the persistent heterogeneity in terminology and diagnostic interpretation. In contrast, strong agreement was achieved on the biological and mechanical determinants of initial bone remodelling, including implant–abutment configuration, platform switching, peri-implant bone volume, insertion torque, soft tissue thickness and phenotype, abutment height, prosthetic emergence profile and the presence of undetected residual cement.

Conclusions: Initial bone remodelling remains variably defined but is increasingly recognised as a controllable rather than an inevitable process. A shared conceptual and diagnostic framework is needed to standardise clinical interpretation, guide preventive strategies and support more rigorous future research on peri-implant bone stability.

Conflict-of-interest statement: *The authors declare there are no conflicts of interest relating to this study.*

Introduction

Marginal bone loss (MBL) around dental implants remains one of the most widely assessed clinical parameters in implant dentistry and is a central indicator of long-term success.¹ Conceptually, it can be divided into two distinct phases: an early, non-infectious phase, often referred to as initial bone remodelling (IBR), which reflects the bone's adaptive response to surgical trauma, prosthetic rehabilitation and the onset of functional loading; and a late, pathological phase, which reflects the onset and progression of peri-implant disease, driven by infective, inflammatory and biomechanical conditions and further influenced by systemic or behavioural cofactors such as smoking and a history of periodontitis.² Although MBL and peri-implantitis represent distinct clinical entities, the latter invariably arises at sites where MBL has already occurred.

IBR represents the adaptive reshaping of the peri-implant crestal bone that occurs after implant placement and continues through the early functional phase, driven by surgical, prosthetic and patient-related factors.³⁻⁵ Although traditionally regarded as a physiological healing event,^{6,7} both the magnitude and timing of IBR vary widely. In some circumstances, it reaches the upper boundary of what is considered physiological, creating a grey zone in which an early transition towards peri-implant disease may be misinterpreted as normal adaptation.^{8,9} This suggests that part of what is currently classified as physiological remodelling may represent avoidable bone loss resulting from the multifactorial interplay of the aforementioned determinants.¹⁰⁻¹⁴ Growing evidence supports this view, indicating that IBR is not a biologically predetermined event but a controllable response that can be markedly reduced and, under certain circumstances, almost eliminated when influencing factors are managed appropriately.^{15,16}

However, the biological limits within which remodelling can still be regarded as adaptive have not been clearly defined, and the lack of shared diagnostic thresholds leads to heterogeneous interpretation in both research and clinical practice.¹⁷ At the same time, there is no consensus on how IBR itself should be defined, nor on when it ceases to

represent a physiological healing phenomenon and begins to predispose the site to peri-implant disease.^{18,19} Greater clarity on these fundamentals is required before the contribution of influencing factors and their potential interrelationships can be analysed with interpretative validity. Although the role of implant and site characteristics, surgical and prosthetic protocols and patient-related factors has been widely reported,²⁰⁻²⁴ their actual clinical weight is interpreted inconsistently, and no common criteria define when each variable becomes relevant. Consequently, the significance of early crestal changes cannot yet be interpreted uniformly or in a prognostically reliable manner.

In this context, a Delphi consensus may help clarify what should be considered IBR, what falls within an acceptable biological range and how the main influencing factors should be interpreted in a shared manner, thereby formalising a common ground for IBR clinical evaluation and management and providing a uniform starting point for future rigorous research.

Materials and methods

Development group

The present clinical consensus was designed following the Delphi methodology set out by Rosenfeld et al²⁵ and subsequently applied in implant dentistry by Testori et al.²⁶⁻²⁸ Once it was established that the prevention and management of IBR around dental implants represented an appropriate topic for a clinical consensus, a development group was formed. This group consisted of four chairs (TL, CS, TT and HLW), who coordinated the consensus process, and one assistant chair (AR), who was responsible for sending and collecting data from each participant and assisting with the formulation of the statements.

Expert identification and selection

Potential experts were identified through a structured search strategy focused on IBR around dental implants. An electronic search was conducted in MEDLINE (via PubMed) on 31 March 2025 using the following predefined search strategy:

((“marginal bone loss”[Title/Abstract] OR “crestal bone loss”[Title/Abstract] OR “marginal bone level”[Title/Abstract] OR “bone level change”[Title/Abstract] OR “bone resorption”[Title/Abstract] OR “bone remodeling”[Title/Abstract] OR “bone stability”[Title/Abstract] OR “crestal bone stability”[Title/Abstract] OR “marginal bone stability”[Title/Abstract] OR “crestal remodeling”[Title/Abstract]) AND (“dental implants”[All Fields] OR “oral implants”[All Fields]) AND (“early”[Title/Abstract] OR “initial”[Title/Abstract] OR “early phase”[Title/Abstract] OR “short-term”[Title/Abstract] OR “physiological”[Title/Abstract] OR “remodeling”[Title/Abstract] OR “adaptation”[Title/Abstract]) AND (review[pt] OR meta-analysis[pt] OR systematic review[pt]) NOT (peri-implantitis[Title])) AND (“2015/01/01”[Date - Publication] : “2025/03/31”[Date - Publication])).

A targeted manual search was also conducted across Q1-ranked journals in periodontology and implant dentistry (Periodontology 2000, Journal of Clinical Periodontology, Clinical Oral Implants Research, Journal of Periodontology, Clinical Implant Dentistry and Related Research, International Journal of Oral and Maxillofacial Implants, International Journal of Implant Dentistry and International Journal of Oral Implantology) for articles published up to 31 March 2025. Studies were included only if they met all the following criteria:

- original articles in English published in peer-reviewed journals;
- systematic reviews with meta-analysis that only included human studies that specifically addressed factors influencing IBR as a primary outcome;
- publication window 1 January 2015 to 31 March 2025;
- full text available.

Eight meta-analyses were identified through the database search, as detailed in Fig 1.²⁹⁻³⁶ From these reviews, 69 original clinical studies were extracted: of these, 24 duplicates were excluded, resulting in a final set of 45 unique studies. In addition, the targeted manual search across Q1-ranked journals identified 25 further relevant clinical trials, yielding a combined pool of 70 articles.^{4,10,12,13,16,20,33-35,37-97}

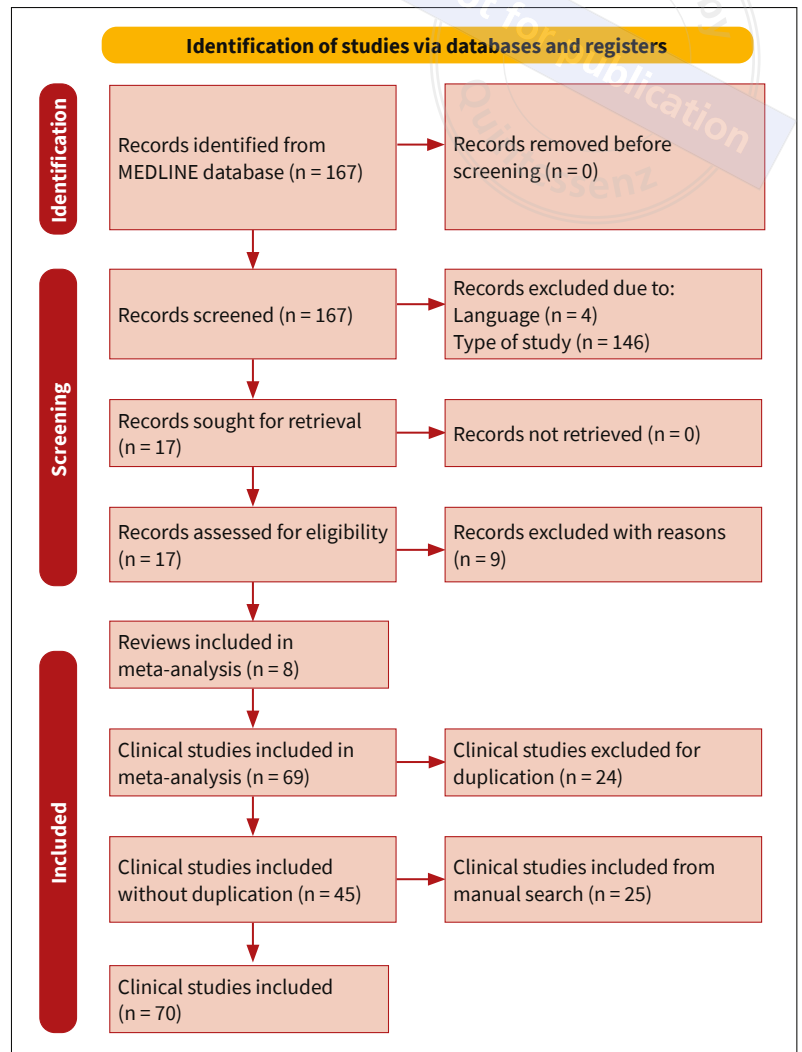


Fig 1 Flowchart illustrating the identification and selection of studies included in the review.

From this dataset, author lists were extracted and names were standardised to unify duplicates. Candidates had to meet the following criteria:

- repeated first authorship within the pooled set (used as a proxy for primary contribution and subject matter expertise);
- scientific/clinical activity directly related to peri-implant IBR (implant dentistry, periodontology, oral/maxillofacial surgery);
- availability to participate in all Delphi rounds.

Candidates were excluded if their contributions were not clinically orientated towards the topic (for example, basic science without clinical translatability to peri-implant bone remodelling), their primary

Table 1 List of experts enrolled in the Delphi consensus on the prevention and management of initial bone remodelling around dental implants, with their academic qualifications and institutional affiliations

Name and qualification suffixes	Affiliation
Yoshiaki Arai, DDS, PhD	Niigata University Medical and Dental Hospital, Niigata, Japan
Gustavo Avila-Ortiz, DDS, MS, PhD	University of Michigan, Ann Arbor, MI, USA
Juan Blanco-Carrión, MD, DDS, PhD	University of Santiago de Compostela, Santiago de Compostela, Spain
Tiago Borges, DDS, MSc, PhD	Universidade Católica Portuguesa, Viseu, Portugal
Eriberto Bressan, DDS, MSc, PhD	University of Padua, Padua, Italy
Luigi Canullo, DDS, PhD	Unicamillus, Rome, Italy
Pablo Galindo-Moreno, DDS, PhD	University of Granada, Granada, Spain
Carlos Garaicoa-Pazmiño, DDS, MS	University of Iowa, Iowa City, IA, USA
Guo-Hao Lin, DDS, MS	University of California San Francisco, San Francisco, CA, USA
Tomas Linkevičius, DDS, PhD	Lithuanian University of Health Sciences, Kaunas, Lithuania
Teresa Lombardi, DDS	University of Brescia, Brescia, Italy
Nikos Mattheos, DDS, MASC, PhD	Chulalongkorn University, Bangkok, Thailand
Krisztina Mikulás, DMD, PhD	Semmelweis University, Budapest, Hungary
Alberto Monje, DDS, MS, PhD	Universitat Internacional de Catalunya, Barcelona, Spain
Marta Muñoz, DDS, PhD	Universitat Internacional de Catalunya, Barcelona, Spain
Miguel Padial Molina, DDS, PhD	University of Granada, Granada, Spain
Andrea Ravidà, DDS, MS, PhD	University of Pittsburgh, Pittsburgh, PA, USA
Rafael Siqueira, DDS, MS, PhD	Virginia Commonwealth University, Richmond, VA, USA
Sergio Spinato, DDS, PhD	Private Practice, Sassuolo, Italy
Claudio Stacchi, DDS, MSc, FEBOS	LUM University, Casamassima, Italy
Fernando Suárez-López Del Amo, DDS, MS	University of Iowa, Iowa City, IA, USA
Tiziano Testori, MD, DDS, MSc, FICD	University of Milan, Milan, Italy
Cristiano Tomasi, DDS, PhD	University of Gothenburg, Gothenburg, Sweden
Giuseppe Troiano, DDS, PhD	LUM University, Casamassima, Italy
Hom-Lay Wang, DDS, MSD, PhD	University of Michigan, Ann Arbor, MI, USA

research field was unrelated or contact/a response could not be obtained.

Invitation and enrolment

Based on the above criteria, the 15 most frequently recurring first authors were invited. As three of them did not respond, the list was expanded by sequentially including the next ranked candidates to reach the required number of 15 respondents. In addition,

the corresponding authors of the two most recent systematic reviews on the topic and four internationally recognised experts were invited, yielding a final panel of 21 participants. All were contacted individually via a standardised invitation letter outlining the aims, workload (online surveys and review of the manuscript draft), voluntary participation and absence of financial compensation; authorship acknowledgment in the final manuscript was specified. Together with the four chairs, the final Delphi panel comprised 25 participants, as reported in Table 1.

Development of consensus statements

The development group (TL, CS, TT and HLW), with the support of the assistant chair (AR), reviewed the evidence that emerged from the selected literature and drafted an initial set of statements addressing the mechanisms influencing peri-implant IBR. These statements were specifically designed to reflect clinically relevant aspects and to be suitable for evaluation by an international panel of experts with diverse backgrounds in implant dentistry and maxillofacial surgery. Each statement was formulated to be concise, clear and evidence-based while allowing room for expert interpretation and comment. The draft list of statements was then incorporated into the first-round survey and distributed to all enrolled experts for their evaluation.

To ensure that all participants had access to the most recent and relevant scientific evidence on the topic, the development group compiled a reference package including a selection of key systematic reviews and meta-analyses on the initial bone remodelling around dental implants. These articles were shared with the panel members at the beginning of the Delphi process as background material to support their evaluations of the statements.

Delphi survey process

The list of preliminary statements was distributed to all panel members through an online survey (Google Forms, Google, Mountain View, CA, USA). Each participant was asked to rate their level of agreement with every statement on a 9-point Likert scale, where 1 corresponded to “strongly disagree”,

3 to “disagree”, 5 to “neutral”, 7 to “agree” and 9 to “strongly agree”. To ensure anonymity, each participant was assigned a random code known only to themselves and the assistant chair (AR). After each round, the mean and median score and the number of outliers (defined as responses differing from the mean score by ± 2 points) were calculated. Consensus thresholds were established a priori as follows²⁵:

- Consensus: mean score ≥ 7 with at most one outlier;
- Near consensus: mean score ≥ 6.5 with no more than two outliers;
- No consensus: statements that did not meet the above criteria.

Anonymous comments were mandatory for all responses that scored below 7 (1 to 6) and were not required when the score was ≥ 7 . These comments were reviewed by the development group and used to reformulate statements that did not reach consensus before resubmitting them in the following round. Three rounds were planned.

Data analysis

The assistant chair (AR) collected all anonymised responses and comments after each round of the survey. For each statement, the mean score, median score, number of outliers and overall level of consensus were calculated. After each round, a structured report summarising the data was prepared and circulated among the development group. Statements that failed to reach a consensus were reformulated based on the anonymised comments provided by the participants and resubmitted for evaluation in the next round.

Results

Participation was completed across all rounds (25/25 panellists). In Round 1, six statements reached consensus, two achieved near-consensus and seven fell below the predefined threshold; accordingly, nine reworded items were advanced to Round 2. In Round 2, three additional statements reached consensus, two achieved near-consensus and four

remained below the threshold, leaving six items for the final round. In Round 3, among the six items, one achieved consensus, one reached near-consensus and four did not meet the threshold.

The analysis of the three Delphi rounds resulted in different levels of agreement across the proposed statements. The final formulations are presented below, organised according to whether they reached full consensus, near-consensus or no consensus, and specifying the round in which the outcome was obtained. For each statement, the version that achieved the highest level of agreement was reported, as it represented the final wording evaluated by the panel. Descriptive statistics (mean, median and outliers) for all items are displayed in Table 2.

Statements that achieved full consensus

Round 1

The statements for which full consensus was achieved were as follows:

- Statement 6: Platform-switching is an effective strategy for preserving peri-implant marginal bone levels.
- Statement 7: Placing implants within an adequate bone envelope is a crucial factor in preventing IBR.
- Statement 11: When using an appropriate implant (conical connection or tissue-level), adapting the apico-coronal implant positioning to the thickness of the supracrestal tissue can be an effective strategy to prevent unwanted exposure of the micro-rough implant surface.
- Statement 12: After stabilisation and maturation of the supracrestal tissue height, the use of excessively short abutments may alter the established condition and lead to marginal bone resorption.
- Statement 14: Undetected cement remnants may trigger an inflammatory response, leading to marginal bone resorption.
- Statement 15: Crowns with a convex emergence profile and an emergence angle greater than 30 degrees may negatively affect marginal bone stability, particularly in bone-level implants with short abutments.

Table 2 Final median and mean agreement, number of outliers and level of consensus for all statements evaluated across the three Delphi rounds

#	Statement	Last round	Median agreement	Mean agreement	Total outliers	Level of agreement in the last round
1	IBR around healthy implants takes place primarily in the early months following functional loading and subsequently stabilises. The 12-month period defined by the American Academy of Periodontology/European Federation of Periodontology (AAP/EFP) should be viewed as a conventional reference rather than a strict biological timeframe.	3	9	7.7	4	No consensus
2	Although IBR of up to 1.5 mm was traditionally considered acceptable, current evidence indicates that microrough implant surface exposure coronal to the bone crest should be avoided and, if present, should not exceed 0.5 mm.	3	9	8.1	3	No consensus
3	During IBR, exposure of more than 0.5 mm of the microrough implant surface coronal to the bone crest may be associated with an increased risk of progressive crestal bone loss over time.	3	9	8.2	3	No consensus
4	Exposure of more than 0.5 mm of the microrough implant surface coronal to the bone crest during IBR may be associated with an increased risk of peri-implant pathologies over time.	3	9	8.1	4	No consensus
5	For implants placed at or below the crestal level, conical implant–abutment connections better preserve peri-implant marginal bone levels compared to flat-to-flat designs.	2	9	8.5	1	Consensus
6	Platform-switching is an effective strategy for preserving peri-implant marginal bone levels.	1	9	8.0	1	Consensus
7	Placing implants within an adequate bone envelope is a crucial factor in preventing IBR.	1	9	8.1	1	Consensus
8	At implant placement, a minimum bone thickness of 1.0 mm is recommended on both buccal and palatal/lingual aspects, with a buccal thickness of ≥ 1.5 mm being ideal.	2	9	8.0	1	Consensus
9	Excessive compression of the marginal bone caused by implants inserted with excessive torque may create cortical cracks and microfractures, triggering marginal bone resorption.	2	9	8.2	1	Consensus
10	Thin supracrestal mucosa (≤ 2 mm) may affect IBR during formation of the supracrestal tissue adhesion, which develops after uncovering in submerged implants or immediately after placement in non-submerged implants.	3	9	8.3	1	Consensus
11	When using an appropriate implant (conical connection or tissue-level), adapting the apico-coronal implant positioning to the thickness of the supracrestal tissue can be an effective strategy to prevent unwanted exposure of the microrough implant surface.	1	9	8.3	1	Consensus
12	After stabilisation and maturation of the supracrestal tissue height, the use of excessively short abutments may alter the established condition and lead to marginal bone resorption.	1	9	8.1	1	Consensus
13	Multiple abutment disconnections and reconnections may negatively affect short-term marginal bone stability in two-piece implants placed at or below the crestal level, with the extent of the effect influenced by peri-implant phenotype, timing relative to soft tissue healing and implant design.	3	9	8.1	2	Near-consensus
14	Undetected cement remnants may trigger an inflammatory response, leading to marginal bone resorption.	1	9	9.0	0	Consensus
15	Crowns with a convex emergence profile and an emergence angle greater than 30 degrees may negatively affect marginal bone stability, particularly in bone-level implants with short abutments.	1	9	8.3	1	Consensus

Round 2

The statements for which full consensus was achieved were as follows:

- Statement 5: For implants placed at or below the crestal level, conical implant–abutment connections better preserve peri-implant marginal bone levels compared to flat-to-flat designs.
- Statement 8: At implant placement, a minimum bone thickness of 1.0 mm is recommended on both the buccal and palatal/lingual aspects, with a buccal thickness of ≥ 1.5 mm being ideal.
- Statement 9: Excessive compression of the marginal bone caused by implants inserted with excessive torque may create cortical cracks and microfractures, triggering marginal bone resorption.

Round 3

The statements for which full consensus was achieved were as follows:

- Statement 10: Thin supracrestal mucosa (≤ 2 mm) may affect IBR during formation of the supracrestal tissue adhesion, which develops after uncovering in submerged implants or immediately after placement in non-submerged implants.

Statements that achieved near-consensus

Round 3

The statements for which near-consensus was achieved were as follows:

- Statement 13: Multiple abutment disconnections and reconnections may negatively affect short-term marginal bone stability in two-piece implants placed at or below the crestal level, with the extent of the effect influenced by the peri-implant phenotype, timing relative to soft tissue healing and implant design.

Statements that achieved no consensus

Round 3

The statements for which no consensus was achieved were as follows:

- Statement 1: IBR around healthy implants takes place primarily in the early months following functional loading and subsequently stabilises. The 12-month period defined by the American Academy of Periodontology/European Federation of Periodontology (AAP/EFP) should be viewed as a conventional reference rather than a strict biological timeframe.
- Statement 2: Although IBR of up to 1.5 mm was traditionally considered acceptable, current evidence indicates that microrough implant surface exposure coronal to the bone crest should be avoided and, if present, should not exceed 0.5 mm.
- Statement 3: During IBR, exposure of more than 0.5 mm of the microrough implant surface coronal to the bone crest may be associated with an increased risk of progressive crestal bone loss over time.
- Statement 4: Exposure of more than 0.5 mm of the microrough implant surface coronal to the bone crest during IBR may be associated with an increased risk of peri-implant pathologies over time.

Discussion

The statements developed through this Delphi process can be conceptually grouped into three domains:

- definition and temporal characterisation of IBR (Statement 1);
- clinical consequences of IBR on peri-implant bone stability and implant survival (Statements 2 to 4);
- aetiopathogenetic mechanisms underlying IBR (Statements 5 to 15).

Although agreement levels varied across domains, three main trends became apparent: definitions and temporal references of IBR remain heterogeneous

and lack standardisation, the long-term prognostic value of early marginal bone changes is still uncertain, and the biological and mechanical determinants of IBR are now largely established and consistently recognised. The following sections discuss these domains in detail, highlighting the areas of convergence, uncertainty and future research priorities.

Definition of IBR (Statement 1)

The absence of consensus on Statement 1 likely derives from the lack of uniformity in the definition and temporal framing of IBR across international guidelines and contemporary clinical literature.^{8,17,98,99} Although current definitions address the same biological process, namely the early adaptation of peri-implant bone following implant placement and loading, there is no agreement on its temporal boundaries, reference baseline or quantitative interpretation. International consensus documents (such as those by the AAP, EFP and Academy of Osseointegration) use similar terminology but differ substantially in how they delineate the timeframe of IBR. Some define it as the remodelling that occurs within the first 12 months after loading,⁹⁹ whereas others describe the process without clearly specifying its temporal limits.¹⁷ A similar inconsistency is evident in the scientific literature, where IBR has been variably assessed at 6 or 12 months after implant placement or loading, reflecting the absence of a standardised temporal reference across studies.^{8,37,98,100,101} Such definitional heterogeneity complicates the interpretation of clinical data and the comparison of study results, as investigators may report the same biological process under different methodological assumptions.

The absence of a clear and universally accepted definition of IBR therefore represents a major limitation for generating comparable evidence, establishing clinically meaningful thresholds for IBR and formulating consistent guidelines.

Clinical consequences of IBR (Statements 2 to 4)

Statements 2 to 4 addressed whether the extent of IBR, with particular attention to exposure of the

microrough implant surface coronal to the bone crest, may influence long-term marginal bone stability and the occurrence of peri-implant disease. The panel did not reach consensus on these items.

The traditional concept, derived from early implant survival criteria, considers marginal bone remodelling within approximately 1.5 mm during the first year as physiologically acceptable.^{6,7} Conversely, some recent clinical studies emphasise minimising exposure of rough implant surfaces because of their potential association with progressive bone loss^{8,16} and the onset of peri-implant diseases.^{18,38,102} However, other authors suggest that implant surface exposure may not have a significant impact on long-term clinical outcomes.¹⁰³ The experts involved in this Delphi process agreed that, despite several studies exploring the topic, the available evidence is still too limited to define a consistent or measurable link between the extent of IBR and the risk of progressive bone loss or peri-implant disease. This highlights the need for future prospective longitudinal studies based on standardised designs and shared reporting criteria. Clear baseline definitions, reproducible radiographic methods and consistent clinical endpoints, such as marginal bone stability, peri-implant tissue health and implant survival, are required to clarify whether IBR should be viewed as an early biological risk indicator or simply as a normal adaptive process without long-term consequences.

Aetiopathogenesis of IBR (Statements 5 to 15)

The third group of statements focused on the biological and mechanical determinants influencing IBR. This domain showed the highest level of convergence, with full consensus achieved for almost all statements, indicating that the aetiopathogenesis of IBR is well characterised and supported by coherent clinical and experimental evidence.

The panel agreed on the pivotal role of implant design, along with surgical and prosthetic variables, in shaping early crestal bone dynamics. Conical implant-abutment connections and platform switching were unanimously recognised as effective configurations for preserving the peri-implant bone crest, likely due to their favourable stress distribution and improved biological sealing.^{23,39,104}

The importance of maintaining sufficient buccal and palatal bone thickness during placement was also confirmed, supporting the concept that marginal bone stability strictly depends on the presence of an adequate bone envelope around the implant.^{105,106} Similarly, excessive insertion torque and bone compression during implant placement have been identified as mechanical risk factors capable of inducing cortical microfractures and subsequent marginal resorption.^{107,108}

Soft tissue characteristics have emerged as another consistent determinant. Thin supracrestal mucosa may condition early bone stability through its influence on the establishment of the supracrestal tissue adhesion after implant uncovering.^{10,31-33}

Accordingly, adapting the vertical position of the implant to the soft tissue phenotype and avoiding the use of excessively short abutments after tissue maturation were both associated with improved marginal bone stability.^{29,34,35,108} This relationship between soft-tissue morphology and apico-coronal implant positioning highlights the need to consider the peri-implant mucosal phenotype as an integrated component of the future supracrestal tissue complex, which plays a central role in the establishment of stable hard and soft tissue dimensions.^{109,110} Prosthetic design and restorative protocols also showed a strong and consistent influence on peri-implant marginal bone maintenance. Excessively convex emergence profiles of the crowns and emergence angles > 30 degrees were identified as unfavourable configurations, likely due to increased plaque retention and mechanical stress at the marginal interface.^{111,112}

Furthermore, the presence of residual cement is universally acknowledged as a preventable iatrogenic factor associated with marginal inflammation and bone resorption.^{113,114}

The only statement that did not reach full consensus, but rather near-consensus, concerned the effect of multiple abutment disconnections and reconnections during the prosthetic phase. The available literature on this topic remains heterogeneous and partially contradictory, with some studies reporting significant short-term changes in marginal bone levels and others showing no measurable effect.^{104,115-117}

Taken together, the high level of agreement across this group of statements confirms that the biological mechanisms governing peri-implant bone preservation are consistently understood. IBR appears to result from a multifactorial equilibrium among the surgical protocol, implant macro- and micro-design, soft tissue conditions and prosthetic control of the transmucosal environment. The convergence of expert opinion in this domain highlights that future research should move beyond the identification of individual factors and instead focus on their combined and interactive effects on maintaining marginal bone homeostasis over time.

Some limitations of this consensus must be acknowledged. By design, the Delphi methodology is grounded in expert opinion and, even when derived from a carefully selected and internationally representative panel, does not constitute the highest level within the hierarchy of evidence. In addition, several statements were intentionally formulated using cautious wording, such as “may”, reflecting the heterogeneity and current limitations of the available literature on the topic rather than a lack of expert insight. Finally, the strict predefined criteria for consensus favoured methodological rigour but classified statements with high mean agreement as “no consensus”, highlighting the persistent uncertainty surrounding specific clinical thresholds related to IBR.

Conclusion

This Delphi consensus underscores that, despite extensive research, IBR still lacks a unified definition, standardised timeframe and clear diagnostic criteria. Although strong agreement has emerged on the biological and mechanical determinants of peri-implant bone stability, uncertainty persists regarding the true boundaries and prognostic meaning of IBR. The panel agreed that IBR should be regarded as a controllable rather than an inevitable phenomenon, and that shared terminology and diagnostic standards are essential to guide clinical interpretation, prevention and future research on peri-implant bone stability over time.

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Claudio Stacchi

Claudio Stacchi, DDS, MSc, FEBOS

Associate Professor, Department of Medicine and Surgery, LUM University, Casamassima, Italy

Tiziano Testori, MD, DDS, MSc, FICD

Head, IRCCS Galeazzi-Sant'Ambrogio Hospital, Section of Implant Dentistry, Department of Biomedical, Surgical and Dental Sciences, University of Milan, Milan, Italy; Adjunct Clinical Associate Professor, Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI, USA; Lecturer, Harvard School of Dental Medicine, Boston, MA, USA

Antonio Rapani, DDS, MSc

Adjunct Professor, Department of Medical, Surgical and Health Sciences, University of Trieste, Trieste, Italy

Yoshiaki Arai, DDS, PhD

Associate Professor, Oral Implant and Temporomandibular Joint Clinic, Niigata University Medical and Dental Hospital, Niigata, Japan

Gustavo Avila-Ortiz, DDS, MS, PhD

Clinical Professor, Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI, USA

Juan Blanco-Carrión, MD, DDS, PhD

Full Professor, Department of Surgery and Medical-Surgical Specialties. School of Medicine and Dentistry, University of Santiago de Compostela, Santiago de Compostela, Spain

Tiago Borges, DDS, MSc, PhD

Assistant Professor, Faculty of Dental Medicine, Universidade Católica Portuguesa, Viseu, Portugal

Erierto Bressan, DDS, MSc, PhD

Associate Professor, Department of Neurosciences, School of Dentistry, University of Padua, Padua, Italy

Luigi Canullo, DDS, PhD

Associate Professor, Department of Prosthodontics, Unicamillus, Rome, Italy

Pablo Galindo-Moreno, DDS, PhD

Full Professor, Department of Oral Surgery and Implant Dentistry, University of Granada, Granada, Spain

Carlos Garaicoa-Pazmiño, DDS, MS

Clinical Associate Professor, Department of Periodontics, University of Iowa College of Dentistry and Dental Clinics, Iowa City, IA, USA

Guo-Hao Lin, DDS, MS

Associate Professor, Department of Orofacial Sciences, University of California San Francisco School of Dentistry, San Francisco, CA, USA

Tomas Linkevičius, DDS, PhD

Full Professor, Department of Prosthodontics, Lithuanian University of Health Sciences, Kaunas, Lithuania

Nikos Mattheos, DDS, MSc, PhD

Visiting Professor, Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand

Krisztina Mikulás, DMD, PhD

Associate Professor, Department of Prosthodontics, Semmelweis University, Budapest, Hungary

Alberto Monje, DDS, MS, PhD

Assistant Lecturer, Department of Periodontology, Universitat Internacional de Catalunya, Barcelona, Spain

Marta Muñoz, DDS, PhD

Assistant Professor, Department of Periodontology, Universitat Internacional de Catalunya, Barcelona, Spain

Miguel Padial-Molina, DDS, PhD

Associate Professor, Department of Oral Surgery and Implant Dentistry, University of Granada, Granada, Spain

Andrea Ravidà, DDS, MS, PhD

Programme Director, Department of Periodontics and Preventive Dentistry, University of Pittsburgh, School of Dental Medicine, Pittsburgh, PA, USA

Rafael Siqueira, DDS, MS, PhD

Assistant Professor, Department of Periodontics, Virginia Commonwealth University, Richmond, VA, USA

Sergio Spinato, DDS

Private Practice, Sassuolo, Italy

Fernando Suárez-López del Amo, DDS, MS

Visiting Professor, Department of Oral and Maxillofacial Surgery, University of Iowa College of Dentistry, Iowa City, IA, USA

Cristiano Tomasi, DDS, PhD

Associate Professor, Department of Periodontology, Institute of Odontology, The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden

Giuseppe Troiano, DDS, PhD

Full Professor, Department of Medicine and Surg, LUM University, Casamassima, Italy

Hom-Lay Wang, DDS, MSD, PhD

Full Professor, Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, Ann Arbor, MI, USA

Teresa Lombardi, DDS

Adjunct Professor, Department of Medical and Surgery Specialties, Radiological Sciences and Public Health, University of Brescia, Brescia, Italy

Correspondence to:

Dr Antonio Rapani, Clinica Odontoiatrica, Piazza Ospitale, 34129 Trieste, Italy. Email: rapani.antonio@gmail.com