The role of minimally invasive non-surgical therapy (MINST) in regenerating intrabony defects

MINST is a precision-driven non-surgical approach designed to manage intrabony defects while minimising trauma to the surrounding tissues.

Learning outcomes:

- to present the classification of infrabony defects;
- to discuss the biological concepts for successful regeneration of intrabony defects;
- to demonstrate the concept of MINST; and,
- to outline the clinical research supporting MINST as a treatment approach in the management of intrabony defects.

Introduction

An infrabony defect is a periodontal lesion characterised by the localised loss of bone "below the crest of bone". Clinically, it presents as a pocket that is apical to the residual alveolar crest.[1] Teeth with deep pockets and extensive infrabony defects present a significant clinical challenge as they are often complicated by limited residual periodontal attachment and sometimes residual tooth mobility. Such teeth are often classified as having a questionable or unfavourable prognosis. These elements collectively contribute to the complexity of managing these cases, which is why such defects are considered as complexity factors when staging a periodontitis case.[2]

Improving the prognosis of such teeth could provide substantial benefits for both clinicians and patients. Achieving this shift would not only support long-term tooth retention but also improve periodontal stability, enhancing patient comfort and functional outcomes. Thus, the potential to restore lost periodontal architecture represents a critical step in preserving natural dentition and maintaining oral health over time.

Classification of infrabony defects

Infrabony defects can be classified into those affecting one tooth or two adjacent teeth.

Affecting primarily one tooth:

- intrabony defects – a defect that is defined as 'within or inside the bone' and can be further classified based on several characteristics (see below); and,
- furcation defects – affecting the root separation areas of multi-rooted teeth.

Affecting two adjacent teeth (inter-root):[3]

- crater – a bowl-shaped defect with loss of interproximal bone between two adjacent teeth but the buccal and lingual alveolar crest is more coronal;
- ramp – interproximal bone loss between two adjacent teeth and buccal/lingual bone loss (so the buccal and lingual alveolar crest are not at the same levels); and,
- plane – interproximal bone loss between two adjacent teeth with buccal and lingual bone loss (so the buccal and lingual alveolar crest are at the same levels) – this is usually defined as a zero-wall defect, as there are no bony walls coronal to the defect.

Intrabony defects are classified using the following:

Number of bony walls housing the defect (Figure 1):

- one-wall;
- two-wall;
- three-wall; or,
- combinations.

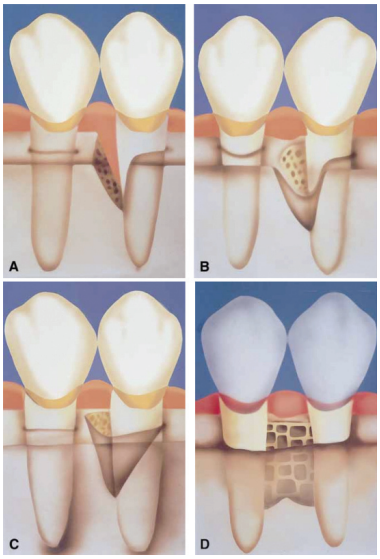

Figure 1: Schematic diagram describing the number of walls in intrabony defects. A: one-wall intrabony defect; B: two-wall intrabony defect; C: three-wall intrabony defect; D: interproximal crater. (Figure reproduced with permission.)[14]

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Extension of the defect around the surfaces of the tooth:

- interproximal only;
- trench – the defect extends to the buccal and/or lingual/palatal surfaces of the same tooth but there is still an outer bony wall;
- dehiscence – extends to the buccal and/or lingual/palatal surface of the tooth with complete loss of bone over the respective root surface; or,
- moat – the defect extends circumferentially around the whole tooth.

Width – the width of the defect based on the long axis of the tooth

It is important to note that different thresholds have been used in the literature:

- narrow – ≤25°;
- average – 26°-36°; and,
- wide – ≥37°.

Depth:

- shallow – <3mm; and,
- deep – ≥3mm.

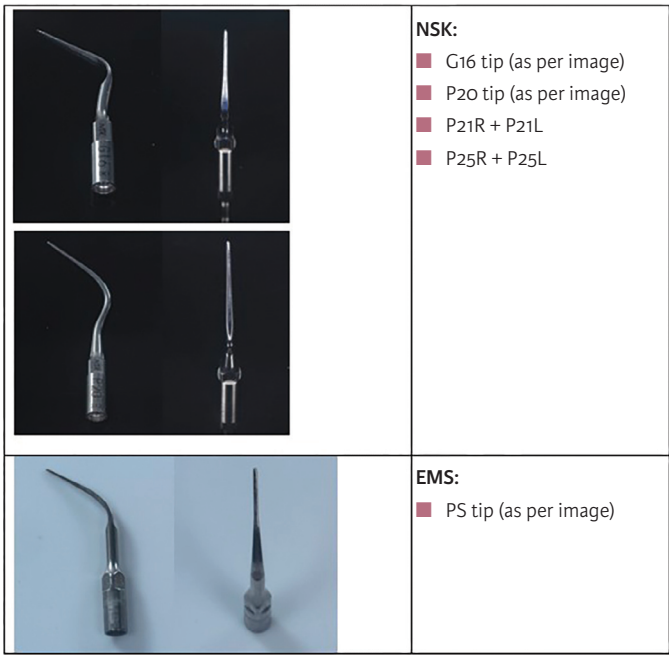
Intrabony defects and regenerative surgery

Surgical regenerative techniques aim to restore the attachment apparatus lost as a consequence of periodontitis (alveolar bone, periodontal ligament and cementum) and form part of the third step of periodontal therapy.[4] These approaches typically incorporate biomaterials, such as enamel matrix derivative (EMD), bone replacement grafts (BRGs) and barrier membranes, to enhance outcomes.[5] Regenerative procedures rely heavily on the stability of the blood clot within the defect, as it serves as the foundation for new tissue formation and successful healing. This stability is influenced by the containment provided by sufficient bony walls and an intact overlying soft tissue profile. Bony walls act as a natural scaffold to support the blood clot, ensuring that it remains stable within the effect, while the soft tissue compartment helps to protect the clot from external disturbances and promotes primary intention healing. Together, these factors create a conducive microenvironment for cellular proliferation, angiogenesis, and tissue regeneration.[6,7] Therefore, defects with adequate containment (increasing number of walls, minimal extension, narrow width, and adequate depth) are more likely to achieve predictable regenerative outcomes.

To optimise blood clot containment, there is growing emphasis on the importance of preserving and optimising both the hard and soft tissue architecture during surgical procedures. Consequently, surgical techniques have evolved with a growing emphasis on papilla preservation techniques. They prioritise maintaining the soft tissue compartment surrounding the defect to provide stability to the flap and aid primary intention healing – principles that are fundamental in regeneration. With this in mind, avoiding incisions or flap elevation, such as in minimally invasive non-surgical therapy (MINST), theoretically creates the most favourable soft tissue environment to naturally support and enhance the regenerative process.

MINST

MINST is a precision-driven non-surgical approach designed to manage intrabony defects while minimising trauma to the surrounding tissues. MINST is particularly effective for deep intrabony defects with favourable bony wall configurations, as it enhances healing through minimally invasive means while leveraging the body's natural regenerative capacity. This approach represents a shift towards preserving and utilising the intrinsic healing potential of periodontal tissues. Research detailing MINST consistently highlights core principles:[8-10]



NSK:

- G16 tip (as per image)
- P20 tip (as per image)
- P21R + P21L
- P25R + P25L

EMS:

- PS tip (as per image)

Figure 2: Examples of delicate tips for piezon handpieces.

- incorporating magnification, such as loupes, to enhance precision;
- the use of ultrasonic devices (with a particular focus on piezons) ± mini-curettes with fine and delicate tips (**Figure 2**);
- thorough root surface debridement of the affected areas, ensuring effective biofilm removal; and,
- exercising care to preserve soft tissue stability and minimise trauma to the soft tissue.

To reduce the risk of damage to the soft tissue, it is advisable to utilise subpapillary access with a focus on minimising trauma to the most coronal part of the interdental papilla.[11] The use of a local anaesthetic without a vasoconstrictor has been advocated, to encourage the defect to fill with blood following the procedure and support a stable blood clot.[11] However, the relative importance of sub-papillary access and anaesthetic without a vasoconstrictor has not been specifically investigated.

MINST has emerged as a promising approach for the management of intrabony defects. It is noteworthy that regeneration in these cases has been assessed clinically and radiographically, without histological confirmation. Therefore, true tissue regeneration cannot be guaranteed. However, this limitation also applies to most commonly performed regenerative procedures in clinical practice.

Across various studies (**Table 1**), MINST has consistently demonstrated its ability to promote periodontal regeneration while preserving soft tissue stability. Randomised controlled trials (RCTs) and retrospective studies highlight MINST's effectiveness in reducing probing pocket depths (PPDs) and improving clinical attachment levels (CALs). For instance, studies have reported PPD reductions and CAL gains comparable to surgical techniques, over follow-up periods of 12 to 24 months, with some improvements sustained for up to five years. The

Table 1: Summary of clinical parameters assessed in various MINST-related studies.

Study (study design)	Intervention	Sample defects (patients' age)	Instruments used	SPC intervals (final follow-up)	PPD at baseline (mm)	PPD reduction (mm)	CAL gain (mm)	Recession (mm)	Chair time (mins)
Ribeiro *et al.* (2011)[8] (RCT)	Intrabony defects T: MINST C: MIST	T: 13 (13; 45.31 ± 7.57) C: 14 (14; 45.43 ± 6.79)	Microscope, microsurgical instruments, mini-curettes, USS	Monthly (12 months)	T: 6.35 ± 0.92 C: 7.07 ± 1.13	T: 3.19 ± 0.71 C: 3.50 ± 0.87 (Δ baseline – 12 months)	T: 2.58 ± 1.13 C: 2.80 ± 1.14 (Δ baseline – 12 months)	T: 0.58 ± 0.83 C: 0.59 ± 0.60 (Δ baseline – 12 months)	T: 29.15 ± 4.30 C: 60.71 ± 9.41
Nibali et al. (2015, 2018)[9,10] (Retrospective study)	MINST of intrabony defects	35 defects (23; 51 ± 10 years old) 21 defects (14) – 5-year follow-up	Loupes, piezo-electric devices with specific thin tip, mini-curettes	Three-monthly (12 months; five years)	7.1 ± 2.2	3.1 (Δ baseline – 12 months) 3.6 (Δ baseline – five years)	2.8 (Δ baseline – 12 months) 3.5 (Δ baseline – five years)	0.3 (Δ baseline – 12 months) 0.1 (Δ baseline – five years)	–
Aimetti *et al.* (2017)[13] (RCT)	Intrabony defects T: MINST + EMD C: M-MIST/SFA + EMD	T: 15 (15; 44.3 ± 8.1) C: 15 (15; 42.2 ± 6.1)	Microscope, microsurgical instruments, mini-curettes, USS	First month: weekly First year: two-monthly Second year: three-monthly (24 months)	T: 7.5 ± 0.9 C: 7.3 ± 0.8	T: 3.6 ± 1.0 C: 3.7 ± 0.6 (Δ baseline – 24 months)	T: 3.2 ± 1.1 C: 3.6 ± 0.9 (Δ baseline – 24 months)	T: 0.4 ± 0.7 C: 0.1 ± 0.5 (Δ baseline – 24 months)	T: 23.5 ± 2.8 C: 54.9 ± 7.1
Anoixiadou *et al.* (2022)[15] (RCT)	Intrabony defects T: MINST + EMD C: MINST	T: 18 (18; 49.8 ± 10.2) C: 18 (18; 54.9 ± 8.2)	Loupes + fibre-optic lighting, piezo-electric devices with thin tip, mini-curettes	Two weeks, one, two, three, six, 12 months (12 months)	T: 7.7 ± 1.6 C: 8.0 ± 1.9	T: 4.2 ± 1.7 C: 4.0 ± 1.4 (Δ baseline – 12 months)	T: 3.4 ± 1.6 C: 3.5 ± 1.4 (Δ baseline – 12 months)	T: 0.7 ± 0.8 C: 0.5 ± 1.2 (Δ baseline – 12 months)	–
Mehta *et al.* (2024)[12] (Multi-centre prospective cohort)	MINST of intrabony defects	100 defects (100; 53 ± 10)	Loupes, non-adrenaline -containing LA, sub-papillary access, piezo-electric devices with thin tips	Three-monthly (12 months)	8.40 ± 1.65	4.17 ± 1.96 (Δ baseline – 12 months)	3.70 ± 2.06 (Δ baseline – 12 months)	0.48 ± 1.21 (Δ baseline – 12 months)	10 minutes

Abbreviations: C – control; EMD – enamel matrix derivative; LA – local anaesthetic; M-MIST – modified-minimally invasive surgical technique; SFA – single flap approach; T – test.

incorporation of adjunctive treatments, such as EMD, has shown comparable outcomes to utilising minimally invasive techniques alone, further supporting MINST's versatility. A key advantage of MINST is its ability to achieve these outcomes with minimal soft tissue recession (0.1-0.7mm) and significantly reduced chair time, ranging from 10 to 29 minutes, compared to 55-61 minutes for traditional minimally invasive surgical techniques.[8,12,13] Collectively, these findings position MINST as an effective and efficient, albeit not always predictable, technique for intrabony defect management, emphasising its long-term stability and patient-centred advantages. Direct comparisons with other versions of non-surgical therapy are still lacking in the literature.

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