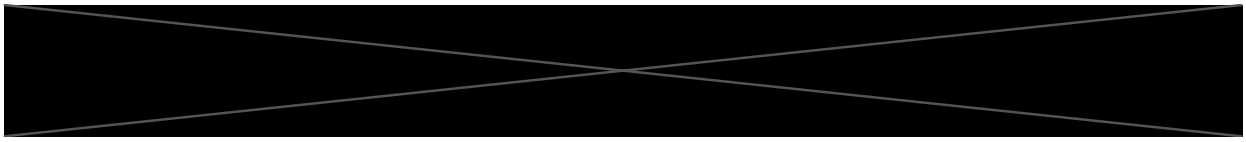
Study Code: NOVAMAG-2024

Alveolar ridge reconstruction in post-extraction sites using a magnesium resorbable membrane. An explorative study



Document: Study Protocol

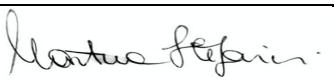
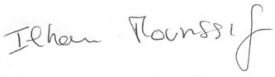
Version: 2

Date of approval 10/09/2025

Number of pages: 24

Signature page

Protocol code: NOVAMAG-2024

Author	Signature	Date
Martina Stefanini		**28/07/2025**
Ilham Mounssif		**28/07/2025**
Alexandra Rendon		**28/07/2025**
Valentina Bentivogli		**28/07/2025**
Claudio Mazzotti		**28/07/2025**
Bianchelli Diego		**28/07/2025**

Department of Biomedical and Neuromotor Sciences Bologna University, Periodontology Unit Via San Vitale 59Bologna 40125 Tel: 0512088125-0512088181
Martina.stefanini2@unibo.it claudio.mazzotti5@unibo.it

Diego.bianchelli2@unibo.it valentin.bentivogli3@unibo.it

Ilham.mounssif2@unibo.it

mayra.rendonmedina2@unibo.it

DECLARATION OF THE PRINCIPAL INVESTIGATOR:

Protocol code: NOVAMAG-2024

I declare that I have read the protocol and agree to conduct this clinical study in agreement with all the protocol requirements and according to the Good Clinical Practices Guidelines and the principles of the Helsinki declaration.

Signature (Principal investigator)

Martina Stefanini

Date 28/07/2025

TABLE OF CONTENTS

1. Abbreviations

BOP	Bleeding on probing
CRF	Case Report Form
KM	Keratinized mucosa
MR	Mucosal recession
PD	Pocket probing depth
SAP	Statistical analysis Plan
ABC	Alveolar bone changes
STT	Soft tissue thickness
ARH	alveolar bone changes in height
ARW	alveolar bone changes in width
ARR	alveolar ridge reconstruction
AE	Adverse event
ADR	Adverse device reaction
WHI	Wound healing index

2. Introduction

2.1. Background

Alveolar ridge atrophy is the unavoidable hard and soft tissue remodeling that takes place as a consequence of tooth loss [1]. The sequence of biological events related to the wound-healing cascade in fresh extraction sites results in variable horizontal and vertical alveolar ridge resorption, both at the buccal and palatal/lingual aspects. This phenomenon is more evident when the baseline conditions are associated with significant bone loss or in cases of traumatic dental extractions. This can give rise to esthetic, functional, and prosthodontic challenges and interfere with ideal implant placement for tooth replacement. To minimize the extent of bone resorption, and hence the probability of needing bone augmentation at the time of implant placement, a wide variety of alveolar ridge preservation (ARP) and reconstruction (ARR) techniques have been described in the literature. ARP aims to attenuate post-extraction dimensional changes in intact or mostly intact post-extraction sites, while ARR is indicated in extraction sites presenting extensive alveolar bone damage [2]. Different techniques and materials can be used for this intervention; some of the commonly used materials include resorbable and non-resorbable barrier membranes, particulate bone replacement graft materials sourced from various origins, and autologous bone blocks.[2] Although bone preservation and augmentation protocols have succeeded in many investigations [3-6], they have certain drawbacks and limitations. These may include complications such as infections during the healing phase, delayed healing of the extraction site, and reduced amount of new bone formation.

Regarding ARR, according to the most recent evidence, the best biomaterials to be used are bone grafts covered by resorbable membranes to seal the socket [7,8]. However, in cases involving extensive damage to the alveolus's bony walls, non-resorbable membranes are preferred due to their more rigid characteristics and their ability to maintain the bone substitute in place throughout a more extended period. The drawbacks are a higher risk of infection and the need for a second surgical step for their removal, rendering the procedure more invasive [9].

To address these concerns, a new Magnesium metal membrane, already established for orthopedic and cardiovascular uses [10], has been recently developed for application in regenerative dentistry, gaining CE approval for its first two medical devices in 2021 [11,12]. Magnesium possesses unique characteristics, being synthetic, mechanically robust yet malleable, and entirely resorbable [13]. Upon degradation, it transforms into magnesium ions integral to various bodily functions,

particularly bone maintenance, growth, and regeneration [14]. These ions stimulate cortical bone growth through periosteal stem cells, releasing calcitonin gene-related peptide (CGRP) from sensory nerve endings [15].

Once implanted, magnesium metal gradually degrades, eliminating the need for subsequent surgeries for its removal. The degradation yields magnesium salts and a minimal volume of hydrogen gas. The salt composition mirrors elements in the bone matrix, exhibiting good biocompatibility and integrating into new bone [17]. The salts maintain the original membrane shape until resorption, while the released hydrogen gas provides slight tenting of the soft tissues, sustaining separation of soft and hard tissues [11,17,18]. As reported for other magnesium implants, once the magnesium metal has completely degraded, no more hydrogen gas is released and the space created by the gas spontaneously resorbs [19,20].

Magnesium implants have already been proven to provide excellent biocompatibility in applications such as cardiovascular stents [21,22] and orthopedic screws [23,24]. In a performance study on Beagle dogs, the magnesium membrane proved comparable to a collagen membrane in augmenting four-wall defects with bovine bone graft. Both membranes exhibited similar ratios of new bone to soft tissue volume over time, indicating the magnesium membrane's efficacy in maintaining a barrier and enabling bone regeneration. Notably, neither group showed signs of chronic inflammation reactions. Although the magnesium membrane initially caused a slightly higher inflammatory reaction, it subsided quickly, aligning with the collagen membrane's response by week 8. [18]

The magnesium membrane's mechanical strength [11] allows it to potentially function as a cortical plate, offering clinical manageability through cutting and bending to match defect contours. Once in place, the membrane acts as a barrier between soft and hard tissues, its gradual degradation ensures defect stability during critical healing, facilitating new bony tissue infiltration [5,18] and fully resorbing after the critical healing period [18] as the complete degradation occurs after 16 weeks.

2.2. Clinical relevance

This study explores the use of a magnesium membrane to reconstruct the alveolar ridge after tooth extraction in cases where the bony wall is moderately or severely damaged. The dimensions of the alveolar ridge are crucial for maintaining overall aesthetics, and its proper reconstruction is essential for ideal dental implant placement when substituting missing dentition. The magnesium membrane combines the rigidity of non-resorbable membranes with its own biocompatible and osteogenic properties, in addition to the advantage of being resorbable but it remains stable for the critical healing period as the complete degradation occurs after 16 weeks; this makes it a promising alternative to biomaterials currently in use. This innovative patient-friendly approach could improve the efficiency of post-extraction alveolar ridge reconstruction techniques. The findings from this

study may not only advance dental implantology in terms of implant site development but also contribute to enhanced patient outcomes by reducing invasiveness and avoiding further surgical augmentation procedures before or during implant installation.

3. Study objectives

3.1 Primary objective:

The primary objective is to investigate alveolar bone dimensional changes in post-extraction sites with Class III-IV sockets [25] after alveolar ridge reconstruction using bone substitutes in combination with a resorbable magnesium membrane and a collagen membrane as an occlusal seal.

3.2 Secondary objectives:

The secondary objectives are to evaluate adverse events (medical device-related and procedure-related), patient-reported outcomes, soft tissue volumetric changes, and new bone formation in the socket site

3.3 Outcome measures

The **primary objective** (alveolar bone changes in height and width) will be measured in mm through the following outcomes:

- alveolar bone changes in height (ARH) and width (ARW)[25a] will be assessed through bucco-lingual and apico-coronal measurements at the treated site using CBCT scans taken before extraction and 6 months following ARR. A radiographic reference, such as sinus floor, lower border of the mandible or nasal floor, will be used to align baseline and 6-month CBCT scans in three planes. The sagittal and coronal planes will be rotated to ensure that the long axis of the extraction site is duplicated in the 6-month scan, reproducing the same points of measurement. ARH will be measured from midpoint of a horizontal line connecting the buccal and lingual/palatal crestal bone to a chosen reference point. ARW will be measured at 1, 3, and 5 mm apical to the midpoint of the same line that connects buccal and lingual/palatal crestal bone.
  CBCT examination represents a standard of care.
  A single investigator (A.R) will perform all the radiographic measurements.

The calibration process will include a training session in which one investigator (A.R) will be trained by a senior clinician (C.M.) through the examination of 10 CBCT scans. After achieving 90% agreement, the same investigator (A.R) will measure five CBCT scans on separate occasions with a two-week interval to assess the intra-examiner reproducibility.

The **secondary objectives** will be measured through the following outcomes:

- soft tissue volumetric changes through the superimposition of digital impressions (3D scan) of buccal and occlusal soft tissue volume at different time points. An intraoral optical scanner will be used to generate a digital model of the upper or lower arch according to the location of the region of interest. The region of interest (ROI) will be defined as one tooth mesial and one tooth distal to the target site. The resulting STL files will be imported in an image analysis software and a best-fit algorithm will be used to superimpose the STL files [26-28]. The volumetric outcomes of interest will be:

  (a) volume change in mm3 (Vol), (b) the mean distance between the surface/mean thickness of the reconstructed volume in mm (ΔD), and (c) linear dimensional (LD) changes from 1 to 7 mm from the soft tissue margin. The digital impressions will be performed at:
  -baseline
  -6 months after the surgical procedure and before implant installation.
  These measurements will be performed by the same trained investigator (AR). These evaluations are part of the standard of care.

- The **new bone formation** will be evaluated through histomorphometric analysis in terms of the percentage of new bone formation, percentage of bone substitute proportion, and connective tissue formation. This is a study-specific evaluation.

Patient morbidity evaluated by patient-reported outcomes (Proms) questionnaire: Visual analogue scale [29]and OHIP-14 [30] after 7 days. All of the above-mentioned questionnaires are validated and used in daily practice.

- **Adverse device reaction** ADRs: (study-specific): **any adverse event in** tissue wound healing (i.e. dehiscences, inflammation, swelling, infection, membrane loss) considered related to the device included in the CRF.

- **Wound healing index** (WHI) (study-specific): The Landry WHI [31] will be used to evaluate the extraction region based on tissue color, response to touch, the marginality of the incision line, and the extent of the area. The rating is from 1 = very poor to 5 = excellent

Healing index	Tissue color	Bleeding on palpation	Granulation tissue	Incision margin	Suppuration
1—very poor Two or more signs are present	≥ 50% of red gingiva	Yes	Yes	Not epithelized, with loss of epithelium beyond incision margin	Yes
2—poor	≥ 50% of red gingiva	Yes	Yes	Not epithelized, with exposed connective tissue	No
3—good	25–50% of red gingiva	No	No	No exposed connective tissue	No
4—very good	< 25% of red gingiva	No	No	No exposed connective tissue	No
5—excellent	All pink tissues	No	No	No exposed connective tissue	No

4. Methods

4.1 Study design

This will be a no-profit pilot clinical interventional study with post-marketing medical device, prospective monocenter, to investigate alveolar bone dimensional changes after alveolar ridge reconstruction using a resorbable magnesium membrane (Novamag, Botiss, Germany in post-extraction sites with Class III-IV sockets [25] in patients referred to the Periodontal Unit, Dental Clinic, Dibinem, Bologna University, Italy.

The materials/equipment needed for this study will be donated/loaned free of cost by the Botiss company* (Botiss, Berlin, Germany) for the duration of the study and will be used solely as per the manufacturer's instructions.
The Botiss company* (Botiss, Berlin, Germany) will cover the insurance fee for the study participants for the duration of the study.

The histological and histomorphometric analysis will be performed at the Berlin Analytix GmbH laboratory headed by Dr Mike Barbeck and will be loaned free of cost and covered by The Botiss company*

*Agreement has been attached.

4.2 Study population

All patients who will be seen at the Periodontal Unit (Dental Clinic, Bologna University) and have a compromised tooth (from second premolar to second premolar) that requires extraction and

subsequent implant restoration will be eligible for this study and enrolled based on the following inclusion criteria. After verifying the exclusion criteria, patients will be enrolled and confirmed during the intraoperative phase. As this study is exploratory in nature, 10 patients will be consecutively enrolled.

4.2.1. Inclusion Criteria

- Patients agreeing to participate in the study
- Age 18 years or older
- Periodontally healthy (including patients currently in supportive periodontal maintenance therapy) or patients with ongoing periodontal treatment
- Compromised tooth because of severe periodontitis or root fracture
- full mouth plaque score < 20% and full-mouth bleeding score < 20% at the time of alveolar bone reconstruction

4.2.2. Exclusion criteria

- Heavy smokers (≥10 cigarettes/day)
- Patients with a history of malignancy, radiotherapy, or chemo-therapy for malignancy.
- Pregnant patients or nursing during the past 6 months.
- Patients taking medications or having treatments with an effect on mucosal healing in general (e.g.steroids, large doses of anti- inflammatory drugs)
- Uncontrolled medical conditions, presence of systemic diseases or consumption of medications known to alter bone metabolism
- allergic reactions to bovine bone substitute
- patients that do not comply with the oral hygiene maintenance program and follow-up visits

4.2.3 Sample size and statistic power

This pilot monocenter study will be analyzed in an exploratory way by analyzing summary measures using descriptive statistics. Due to the novelty of the intervention, statistical sample size considerations are neither reasonable nor feasible. A sample size of 10 is considered large enough to allow a safety analysis and a first quantitative statement about the proposed treatment.

4.3 Duration of the study

The comprehensive duration of the study will be 24 months.

4.3.1 Duration of the Enrollment Phase

The enrollment phase will last 4 months.

4.3.2 Duration of the study

The study will last 19 months, following the patient for 1 year after the implant insertion. One additional month will be needed for statistical analysis and final report preparation.

4.4 Treatment, visit e follow-up

4.4.1 Baseline (the following phase is performed according to daily clinical practice)

All eligible patients will undergo cause-related therapy, including motivation and oral hygiene instructions until high standards of oral hygiene (FMPS and FMBS <20%) are achieved before proceeding to enrollment.
Preoperative treatment for inflammation and infection control will be performed after the first screening visit. This treatment involves subgingival scaling/root planning, an oral hygiene session, and motivation. After enrolling the patient, they must undergo a CBCT and 3D intraoral scan of the target site. Enrolled patients will receive extraction and reconstruction of the alveolar ridge using xenogenic bone, a resorbable magnesium membrane, and a collagen membrane to seal the entire reconstructed site.

The diseased tooth will be extracted during the procedure, and the buccal/lingual flap will be elevated as necessary. Thorough curettage of granulation tissue will be performed in the extraction socket so as to expose the bony surface in all regions of the socket. The Novamag® will then be shaped and trimmed to match the dimension of the bony deficiency. The magnesium membrane should fully cover the bone plate, and the dimensions may vary on a case-by-case basis.
Afterwards, the extraction socket will be filled with xenogenic bone substitute (Cerabone plus, Botiss, Germany) up to the crestal border of the alveolar bone walls. Then, the site will be covered coronally with a collagen membrane (Mucoderm, Botiss, Germany) to seal the socket and prevent

exposure of the bone graft and the magnesium membrane. The collagen membrane will be fixed to the adjacent crestal soft tissues with a cross-mattress suture (6.0 PGA sutures).

The following intra-surgical clinical measurements will be recorded according to daily practice procedures:

- Alveolar bone dehiscence in height (ABDH) and width (ABDW) measured using a periodontal probe
- Soft tissue thickness at the central aspect on the side of the missing bone wall, measured 1mm apical to the soft tissue margin using a tissue caliper.

After 6 months, a second CBCT and intraoral scan will be performed, as per clinical practice, for implant planning. During implant surgery, a bone core biopsy sample will be obtained from each patient before implant positioning by collecting the bone removed during drilling for implant site preparation. The drilled bone represents the core biopsies, which create the implant site; therefore, this bone is usually discarded. The biopsies will be taken and transferred to a 4% formalin solution. Afterwards, routine histological evaluation will be performed at the internal laboratory of Botiss (Berlin, Germany). Please see the attached letter of collaboration.

Histological evaluation

The explants will be embedded in the polymer embedding system Technovit 9100 (Technovit 9100, Kulzer GmbH, Hanau, Germany). After initial dehydration, stepwise immersion at 4 ◦C with Technovit 9100 medium using specific infiltration solutions (following the manufacturer's instructions) will be conducted. Afterward, the tissue blocks will be trimmed into a diamond shape using a grinding machine (EcoMet 30, Bühler, Esslingen, Germany) and sectioned at 7 µm using a specialized rotation microtome for hard tissue samples (CUT4060E, microTec GmbH, Walldorf, Germany). Finally, the slides will be histochemically stained with hematoxylin and eosin (H&E) and Movat Pentachrome staining.

To enable histomorphometry, total scans will be generated using a scanning microscope (M8, PreciPoint, Munich, Germany). The histomorphometry will be achieved by means of image analyses via the software ImageJ v 1.53 (National Institutes of Health, Bethesda, MD, USA) [32]. To determine the different parameters within the specific areas of the implantation beds, the margins will be manually integrated to separate the different compartments after determining the total implantation area (TIA).

Postoperative care (according to daily practice procedures)

Patients will be instructed to abstain from brushing the treated area before suture removal and to rinse with a chlorhexidine mouthwash 3 times a day for the said period. Sutures will be removed at 14 days. All patients will be prescribed Amoxicillin 1 gr as an antibiotic therapy, to be taken twice a day for 6 days and starting the day before the scheduled extraction. If the patient has an allergy to Amoxicillin, an alternative therapy will be provided.

4.4.2 Follow-up visits and timing:

After 7 days patients will be recalled to evaluate:

-wound healing index (filling the specific table)

-adverse events occurrence by means visual inspection and patient interviewing

Vas and OHIP-14 questionnaires will be collected; intraoral pictures will be taken.

After suture removal (14 days), patients will be enrolled in a tailored hygiene recall program until the final examination at 1- year after implant placement

Wound healing index and adverse events will be evaluated, as described above, at:

-2 weeks

-1 month

-3 months

-6 months

The above-mentioned follow-ups (wound healing index and adverse events) are study- specific

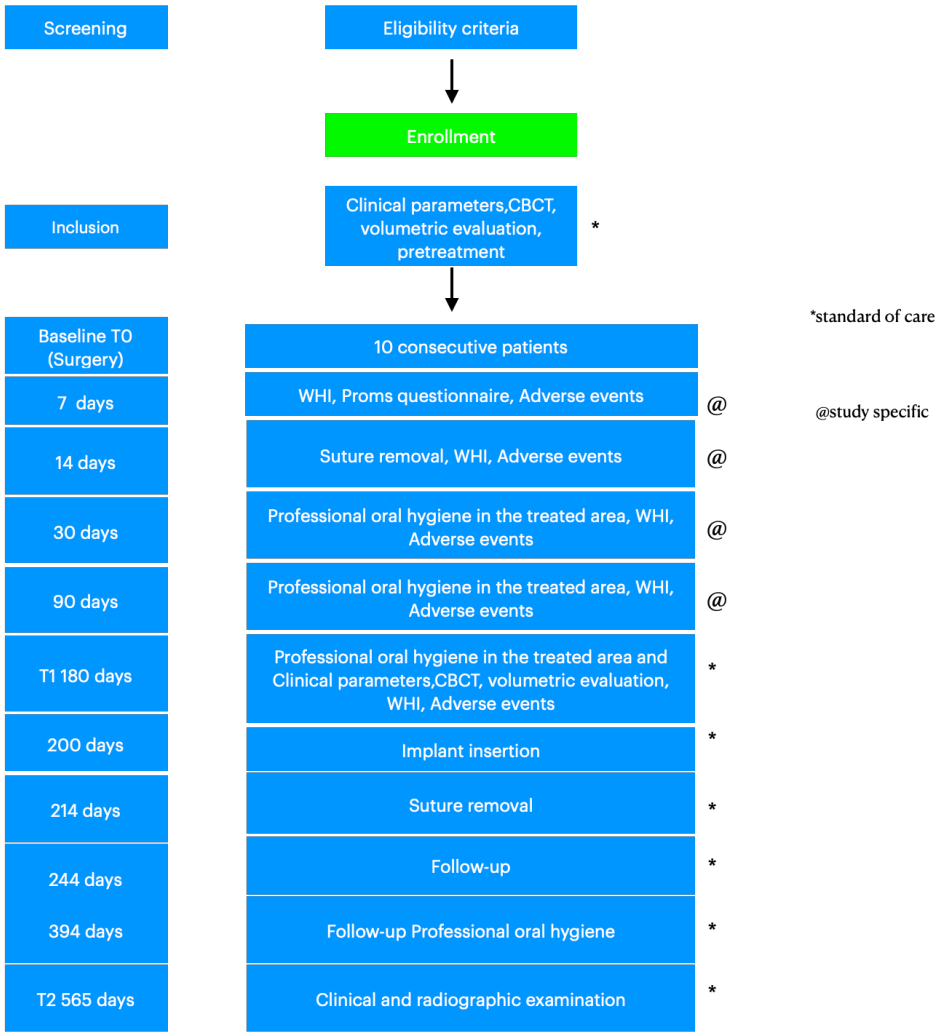
After 6 months from extraction and alveolar ridge reconstruction, a CBCT (standard of care) will be performed to evaluate the alveolar reconstruction and digitally plan the future implant-guided installation (standard of care). The patients will undergo the implant insertion procedure as routine practice and will be followed up for one year after implant insertion.

Patient-reported outcomes (using validated questionnaires**)**:

To assess morbidity: 10mm Visual analogue questionnaire and OHIP-14 after 7 days

The patients will be asked to record any adverse event they encounter in the first six months after the alveolar bone reconstruction using the Adverse events diary (see the attached file).

4.4.3. Study timeline



4.5. Medical device

4.5.1. Medical device

NOVAMag® membrane is a medical device regulated according to EC-Guidelines. Manufacturing of NOVAMag® membrane is subject to a quality control system based on international standards (e.g., EN ISO 13485), and is regularly audited by the notified body and authorities. This medical device is not used for standard care.
The NOVAMag® membrane is produced from pure magnesium metal. Magnesium is a biodegradable metal that is resorbed by the human body without toxic residuals. Magnesium ions (Mg^{2+}) released during the degradation process are a naturally occurring component in the human body and are responsible for many physiological processes. Due to the inherent properties of magnesium metal, the NOVAMag® membrane provides a mechanically strong yet degradable material option for bone augmentation surgeries.

4.5.2 Intended use

NOVAMag® is ideal for protecting bone defect voids during bone regeneration and maintaining the positioning of autologous bone and bone augmentation materials. For more indications, please see the attached instructions for use.

For this study, the use of the NOVAMag® membrane will comply with the intended use described by the manufacturer.

4.5.3 Adverse reactions

No known sensitivity reactions to the NOVAMag® membrane exist. However, rare cases of hypersensitivity to any of the trace elements cannot be ruled out. Dehiscences cannot be excluded, as in all GBR treatments. Degradable biomaterials can induce local inflammatory tissue reactions. Usually, these inflammations dissolve over time and do not interfere with the regenerative process. For more indications, please see the attached instructions for use.

4.6. Treatment discontinuation

Every patient will be able to discontinue their participation in the study at any time. Furthermore, the researcher can interrupt patient participation whenever it is considered beneficial to their health.

4.7. Security evaluation

The medical device's security evaluation will consist of monitoring and registering unexpected events (adverse events). Information regarding these incidents, acknowledged by the patient or the researcher, will be registered in the CRF and followed up accordingly.

4.8. Statistical analysis plan (SAP)

Due to the exploratory nature of the statistical analysis, no formal inference on the population will be drawn. Quantitative variables are summarized by mean, standard deviation, median, minimum, maximum, and the first and third quartile, and qualitative variables by means of absolute and relative counts. The secondary endpoint parameters concerning tissue thickness will be compared in descriptive statistics.

All non-missing data will be analyzed.

4.8.1. Study population and statistic power

This pilot monocenter study will be analyzed in an exploratory way by analyzing summary measures using descriptive statistics. Due to the novelty of the intervention, statistical sample size considerations are neither reasonable nor feasible. A sample size of 10 is considered large enough to allow a safety analysis and a first quantitative statement about the proposed treatment.

4.8.2. Methods of analysis

Due to the exploratory nature of the statistical analysis, no formal inference on the population will be drawn. Statistical analysis will be performed using IBM SPSS Statistics v20 software (IBM Corp, USA). Descriptive statistics of initial bone level, alveolar bone changes in height (ARH) and width (ARW), soft tissue changes (linear and volumetric), and alveolar bone dehiscence will be described by mean, standard deviation, standard error of mean, median, minimum and maximum values.

5. DATA MANAGEMENT

Pseudonymization will be used by the personnel designated by the Principal Investigator to collect the clinical data required by the protocol in case report forms (CRF; electronic and hardcopy). The bone sample will be sent to the histological laboratory in a pseudo-anonymized way.

6. ADMINISTRATIVE PROCEDURES AND DECLARATIONS

6.1. Informed consent and Consent to process personal data

The present research protocol, any amendment, the informed consent, the consent to process personal data, or any other patient information must be approved by the Ethics committee.
In order to participate in this study, every patient must give written consent including consenting to handling of their personal data.

6.2. Study-specific insurance

Given the interventional nature of the study, a specific insurance agreement will be drafted.

6.3. Amendments to the protocol and modifications to the execution of the study

Any modification to the study protocol will be submitted to the ethics committee as an amendment.

No other modalities are consented to modify the protocol during the study period. Any unforeseen changes will be registered in the "Clinical Study Report".

6.4. Termination of the study

The principal investigator commits to communicating the end of the study and sending at least an abstract or publication derived from it to anyone it may concern.

6.5. Publication of results

At the end of the study, the principal investigator commits to making its results public. Any formal presentation or publication of the data deriving from this study should be considered a publication from the principal investigator. Even if the outcome is negative, publication of the results will still be ensured.

6.6. Storage of the documentation

The principal investigator is responsible for the storage and conservation of the essential study documents before, during, and after the completion or interruption of the study, in agreement with the current regulations and good clinical practices.
The data gathered in the CRF will be rigorously pseudonymized, and the participants will only be identified with a number/code
The principal investigator will keep the patients' original data and signed written informed consent in a secure place to ensure privacy and confidentiality.

6.7. Inspections/verifications

The principal investigator must immediately inform the ethics committee if a regulating authority requires an inspection.

6.8. Contact persons

The contact persons' phone numbers and e-mails for the study's conduction are reported in the Investigator Folder at the study center.

7. References

1. *Araujo, M.G.; Lindhe, J. Dimensional ridge alterations following tooth extraction. An experimental study in the dog. J. Clin Periodontol. 2005, 32, 212–218.*
2. *Suarez-L.pez del Amo, F, Monje A. Efficacy of biologics for alveolar ridge preservation/reconstruction and implant site development: An American Academy of Periodontology best evidence systematic review. JPeriodontol. 2022;93:1827–1847. https://doi.org/10.1002/JPER.22-0069*
3. *Araujo MG, da Silva JCC, de Mendonca AF, Lindhe J. Ridge alterations following grafting of fresh extraction sockets in man. A randomized clinical trial. Clin Oral Implants Res 2015;26:407-412.*
4. *Lee JS, Shin HK, Yun JH, Cho KS. Randomized clinical trial of maxillary sinus grafting using deproteinized porcine and bovine bone mineral. Clin Implant Dent Relat Res 2017;19:140-150.*
5. *Mendoza-Azpur G, de la Fuente A, Chavez E, Valdivia E, Khouly I. Horizontal ridge augmentation with guided bone regeneration using particulate xenogenic bone substitutes with or without autogenous block grafts: a randomized controlled trial. Clin Implant Dent Relat Res 2019;21:521-530.*
6. *Urban IA, Lozada JL, Jovanovic SA, Nagursky H, Nagy K. Vertical ridge augmentation with titanium-reinforced, dense-PTFE membranes and a combination of particulated autogenous bone and anorganic bovine bone-derived mineral: a prospective case series in 19 patients. Int J Oral Maxillofac Implants 2014;29:185-193.*
7. *Avila-Ortiz G, Elangovan S, Kramer KW, Blanchette D, Dawson DV. Effect of alveolar ridge preservation after tooth extraction: a systematic review and meta-analysis. J Dent Res 2014: 93: 950–958.*
8. *Chappuis V, Araújo MG, Buser D. Clinical relevance of dimensional bone and soft tissue alterations post-extraction in esthetic sites. Periodontol 2000. 2017 Feb;73(1):73-83. doi: 10.1111/prd.12167. PMID: 28000281.*
9. *Cucchi A, Vignudelli E, Napolitano A, Marchetti C, Corinaldesi G.Clin Implant Dent Relat Res. 2017 Oct;19(5):821-832. Evaluation of complication rates and vertical bone gain after guided bone regeneration with non-resorbable membranes versus titanium meshes and resorbable membranes. A randomized clinical trial. G.Clin Implant Dent Relat Res. 2017 Oct;19(5):821-832.*
10. *Zheng, Y.F.; Gu, X.N.;Witte, F. Biodegradable metals. Mater. Sci. Eng. R Rep. 2014, 77, 1–34.*

11. *Rider, P.; Kačarević, Ž.P.; Elad, A.; Tadic, D.; Rothamel, D.; Sauer, G. Biodegradable magnesium barrier membrane used for guided bone regeneration in dental surgery. Bioact. Mater. 2022, 14, 152–168.*
12. *Kačarević, Ž.P.; Rider, P.; Elad, A.; Tadic, D.; Rothamel, D.; Sauer, G. Biodegradable magnesium fixation screw for barrier membranes used in guided bone regeneration. Bioact. Mater. 2022, 14, 15–30.*
13. *Azadani, M.N.; Zahedi, A.; Bowoto, O.K.; Oladapo, B.I. A review of current challenges and prospects of magnesium and its alloy for bone implant applications. Prog. Biomater. 2022, 11, 1–26.*
14. *Glenske, K.; Donkiewicz, P.; Köwitsch, A.; Milosevic-Oljaca, N.; Rider, P.; Rofall, S. Applications of metals for bone regeneration. Int. J. Mol. Sci. 2018, 19, 826*
15. *Wang, L.; Luo, Q.; Zhang, X.; Qiu, J.; Qian, S.; Liu, X. Co-implantation of magnesium and zinc ions into titanium regulates the behaviors of human gingival fibroblasts. Bioact. Mater. 2021, 6, 64–74.*
16. *Jung, O.; Hesse, B.; Stojanovic, S.; Seim, C.; Weitkamp, T.; Batinic, M. Biocompatibility analyses of hf-passivated magnesium screws for guided bone regeneration (Gbr). Int. J. Mol. Sci. 2021, 22, 12567.*
17. *Atrens, A.; Song, G.L.; Liu, M.; Shi, Z.; Cao, F.; Dargusch, M.S. Review of recent developments in the field of magnesium corrosion. Adv. Eng. Mater. 2015, 17, 400–453.*
18. *Rider, P.; Kačarević, Ž.P.; Elad, A.; Rothamel, D.; Sauer, G.; Bornert, F.; Witte, F. Analysis of a Pure Magnesium Membrane Degradation Process and Its Functionality When Used in a Guided Bone Regeneration Model in Beagle Dogs. Materials 2022, 15, 3106.*
19. *Biber, R.; Pauser, J.; Brem, M.; Bail, H.J. Bioabsorbable metal screws in traumatology: A promising innovation. Trauma Case Rep. 2017, 8, 11–15.*
20. *Atkinson, H.D.; Khan, S.; Lashgari, Y.; Ziegler, A. Hallux valgus correction utilising a modified short scarf osteotomy with a magnesium biodegradable or titanium compression screws—A comparative study of clinical outcomes. BMC MusculoskeletDisord. 2019, 20, 334.*
21. *Haude, M.; Ince, H.; Kische, S.; Abizaid, A.; Tölg, R.; Alves Lemos, P. Safety and clinical performance of a drug eluting absorbable metal scaffold in the treatment of subjects with de novo lesions in native coronary arteries: Pooled 12-month outcomes of BIOSOLVE-II and BIOSOLVE-III. Catheter. Cardiovasc. Interv. 2018, 92, E502–E511.*
22. *Sotomi, Y.; Onuma, Y.; Collet, C.; Tenekecioglu, E.; Virmani, R.; Kleiman, N.S.; Serruys, P.W. Bioresorbable scaffold: The emerging reality and future directions. Circ. Res. 2017, 120, 1341–1352.*

23. *Willbold, E.;Weizbauer, A.; Loos, A.; Seitz, J.M.; Angrisani, N.;Windhagen, H.; Reifenrath, J. Magnesium alloys: A stony pathway from intensive research to clinical reality. Different test methods and approval-related considerations. J. Biomed. Mater. Res.—Part A 2017, 105, 329–347.*
24. *Seitz, J.M.; Lucas, A.; Kirschner, M. Magnesium-Based Compression Screws: A Novelty in the Clinical Use of Implants. JOM 2016, 68, 1177–1182.*
25. *Cardaropoli D, Nevins M, Casentini P. A Clinical Classification System for the Treatment of Postextraction Sites. Int J Periodontics Restorative Dent. 2021 Mar-Apr;41(2):227-232. doi: 10.11607/prd.*
26. *Atieh, M. A., Al-Ali, B., Shah, M., Amir-Rad, F., Baqain, Z. H., Al-Suwaidi, S., & Alsabeeha, N. H.M. (2023). Enamel matrix derivative for alveolar ridge preservation: A randomized controlled trial. Clinical Oral Implants Research, 34, 802–812. https://doi.org/10.1111/clr.14108*
27. *Tavelli L, Barootchi S, Vera Rodriguez M, et al. Early soft tissue changes following implant placement with or without soft tissue augmentation using a xenogeneic crosslink collagen scaffold: A volumetric comparative study. J Esthet Restor Dent. 2021;1-7. doi:10.1111/jerd.12856*
28. *Tavelli L, Barootchi S, Majzoub J, Siqueira R, Mendonca G, Wang HL. Volumetric changes at implant sites: a systematic appraisal of traditional methods and optical scanning-based digital technologies. J Clin Periodontol. 2021;48(2):315-J Periodontol*
29. *Seymour RA. The use of pain scales in assessing the efficacy of analgesics in postoperative dental pain. Eur J Clin Pharmacol. 1982;23(5):441–444. doi: 10.1007/BF00605995.*
30. *Corridore D, Campus G, Guerra F, Ripari F, Sale S, Ottolenghi L. Validation of the Italian version of the Oral Health Impact Profile-14 (IOHIP-14) Ann Stomatol. 2014;4(3–4):239–243.*
31. *Landry RG, Turnbull RS, Howley T. Effectiveness of benzydamine HCl in the treatment of periodontal postsurgical patients. Research in Clinic Forums 1988;10:105–118*
32. *Hita-Iglesias P, Torres-Lagares D, Flores-Ruiz R, Magallanes-Abad N, Basallote-Gonzalez M, Gutierrez-Perez JL. Effectiveness of chlorhexidine gel versus chlorhexidine rinse in reducing alveolar osteitis in mandibular third molar surgery. J Oral Maxillofac Surg. 2008 Mar;66(3):441-5. doi: 10.1016/j.joms.2007.06.641. PMID: 18280375.*