

## Review

# 10 Years of Convergent Neck Implants: A Systematic Review of Clinical Outcomes, Initial Original Concepts, and Changes in Surgical and Prosthetic Protocols

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**Abstract:** The study reviewed the state of the art of the clinical use of a convergent-neck-designed Prama implant. This implant was introduced approximately 10 years ago and was characterized by a specific and unique convergent neck with a microtextured surface (UTM surface) and Zirconium Titanium (ZirTi) implant body surface. The neck design was developed to adopt the biologically oriented preparation technique (BOPT). A critical analysis of the published clinical studies and an evaluation of the adopted clinical protocols were performed. A total of forty-six articles were eligible to be reviewed. Only sixteen clinical studies reported clinical outcomes on Prama implants, and nine of these were selected having the longest follow-up from different research groups. The clinical follow-up/duration of the studies ranged from 12 months to 6 years. The initially proposed protocols explored neck supracrestal–transmucosal placement and gained interest due to its minimally invasive concept and the ability to proceed without a pre-prosthesis second surgery. The following investigations dedicated attention to the subcrestal or equicrestal implant placement with the conventional flap approach. The clinical studies characterized by the transmucosal exposed neck approach reported high survival rates with a stable bone morphology and reduced bone loss during the follow-up. Further recent implementations included the introduction of different convergent neck heights that need to be evaluated. The use of intraoral scanner technologies and digital workflow resulted in a simpler methodology with control of the marginal crown morphology. The studies support the concept that the hard tissue parameters (such as marginal bone level, MBL) and soft tissue parameters (such as pink esthetic score, PES) were stable or improved during the follow-up. Definitive crowns, designed with low invasiveness for soft tissues, were possible thanks to the morphology of the neck. The clinical studies support the use of the Prama implant with the different neck positions, demonstrating hard tissue preservation and optimal esthetic results in the first years following insertion. However, the current body of evidence is not robust enough to draw definitive conclusions, especially in the long term, and further high-quality research (long-term randomized trials) is required to consolidate these early observations.

**Keywords:** convergent neck implants; flapless technique; two-piece implant; MBL; esthetic results; dental implants; digital intraoral scanners



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## 1. Introduction

Non-submerged implants characterized by innovative neck designs are gaining increased attention among clinicians. A number of clinical studies and different reviews analyzed and compared the validity of different approaches on submerged, transmucosal, tissue-level, or bone-level techniques of neck implant placement [1–3]. Some limits and some advantages emerged, suggesting that major attention must be dedicated to the posi-

tion of the neck, its configuration, and the consequent effectiveness on mucosal healing and on the prosthetic procedures (i.e., intraoral scan 3D impression) [1–4].

A two-piece implant, characterized by a 2.8 mm convergent neck with a microtextured surface, was developed and proposed in 2014. The implant enabled tailored insertion (supracrestal level, crestal level, or subcrestal level) depending on several clinical protocols or clinical situations.

Additionally, the implant neck was conceived to comply with the biologically oriented preparation technique (BOPT) concepts [5]. The technique involves a vertically prepared prosthodontic protocol without a distinct finish line, enabling the mucosa to adapt to the prosthetic profile determined by the crown. Consequently, by adjusting the crown contours, clinicians can manage and modify the peri-implant soft tissues [5]. Recently, histological studies on animals demonstrated the stable morphology of bone tissues around implants with the neck designed following the BOPT [6] and following the same preparation concepts of teeth prepared using a prosthetic preparation with no finishing line [7].

The neck surface has been analyzed by both morphological [8] and histological studies [6,9]. The morphological environmental scanning electron microscope and energy-dispersive X-ray spectroscopy (ESEM-EDX) study revealed a homogeneous micro-threaded neck surface with a 60  $\mu\text{m}$  roughness (Ultrathin Threaded Microsurface, UTM) [8]. The UTM surface enabled the excellent adhesion of the collagen fibers and consequently a healthy supracrestal peri-implant mucosa, characterized by a barrier epithelium of variable length and connective tissue in tight apposition with the transmucosal implant components with no signs of inflammation [6]. As well as other surfaces, the endosseous implant surface (ZirTi—Zirconium Sand-Blasted Acid-Etched Titanium) is moderately rough ( $S_a = 1.4 \mu\text{m}$ ) according to a previous widely accepted classification [10]. Histological studies and animal models demonstrated thigh bone tissue formed on this surface within 6–8 weeks following the implant insertion [11–13]. The ZirTi surface enabled early cell adhesion, widespread cell-to-cell contact, stimulated an increase in the primary osteoblast cell differentiation, high cytocompatibility, and can precociously activate the cell growth and adhesion [14].

The use of such a two-piece implant with a convergent neck configuration and the application of the BOPT were expanded during the last 10 years, as confirmed by several clinical studies [15–17]. Different techniques and modifications have been proposed and introduced with the consequent modification of the clinical protocols. In particular, the use of this implant has been implemented for both non-submerged and submerged approaches.

Finally, the implementation of digital scanner technologies and new materials to accomplish prosthetic rehabilitation workflows also led to some variations in the original prosthetic rehabilitation protocol [18], with the need to re-think some procedures and re-evaluate the great possibilities proposed by the neck configurations and the BOPT [16].

The present study aimed to systematically review the use of the Prama implant in clinical practice to establish some concepts for using this implant in several clinical applications.

## 2. Materials and Methods

### 2.1. Analysis of the Scientific Evidence Concerning Prama Implant

The present systematic review was conceived to analyze the current scientific literature, clinical protocols, and concepts available on Prama implants. Moreover, it was also performed to assess the soft and hard tissue parameters around Prama implants placed in a healthy population requiring dental implant rehabilitation. The study was performed following PRISMA guidelines. The study protocol has been submitted and registered in PROSPERO database (CRD42024579114).

An electronic search on Web of Science, Pubmed, Scopus, and Google Scholar databases was performed to find scientific articles on Prama implants from 2014 (introduction of Prama implant) to the present date (March/June 2024).

The terms “Prama implant”, “Convergent neck”, “Hyperbolic neck”, “Nonsubmerged insertion”, “Dental implant”, “Equicrestal placement”, “Subcrestal placement”, “Supracre-

stal placement”, “Bone level”, and “Tissue level” were used. Boolean operators (AND OR) were also used to improve the search strategy.

The electronic search was also implemented by a manual search of the current top journals in Implantology, oral surgery, and prosthodontics (Clinical Oral Implant Research, Clinical Implant Dentistry and Related Research, Journal of Oral and Maxillofacial Implants, Implant Dentistry, Oral Maxillofacial Surgery, and Journal of Prosthodontics).

Two independent reviewers screened the retrieved studies (F.Z. and A.S.), assessed their eligibility based on the inclusion criteria, and extracted data using a standardized data extraction template. Reviewers were trained and calibrated at the start by performing ‘test’ literature research with a different number of keywords several times to check if comparable hits resulted. All files screened in the study were stored in an Excel spreadsheet. Duplicates were manually removed.

Clinical cohort studies were reviewed to assess the following data:

Number of patients, type of surgery, average follow-up, type of prosthetic approach, hard tissue analysis, soft tissue analysis, survival, success, and presence of external source of funding.

Case series and case reports were not included in the review but were analyzed to describe and report the different operative protocols around Prama implants and different innovations introduced over time.

## 2.2. Inclusion and Exclusion Criteria

Articles were selected according to the following inclusion criteria:

Inclusion criteria:

- Rehabilitations with Prama implants;
- Human studies (partially or completely edentulous);
- Publication in English;
- Randomized controlled clinical trial (RCT), or cohort prospective or retrospective study;
- Minimum period of follow-up must include definitive crown cementation;
- Study evaluating the survival or success rate and level of marginal bone resorption around osseointegrated implants.

Exclusion criteria:

- Animal studies;
- Case series and case reports;
- Patients undergoing radiotherapy, chemotherapy, or those making use of bisphosphonates;
- Patients with systemic diseases including autoimmune diseases, syndromes, and osteoporosis;
- Implants placed in areas of bone regeneration;
- Patients under the age of 18 years;
- Patients with periodontitis without previous treatment.

## 2.3. Assessment of Methodological Quality of the Included Studies

The quality assessment of the included studies was conducted using the modified Downs and Black checklist. The checklist comprised 27 questions covering various aspects: reporting (questions 1 to 10), external validity (questions 11 to 13), internal validity—bias (questions 14 to 20), internal validity (questions 21 to 26), and power (question 27). The maximum achievable score was 25 for non-randomized comparative clinical studies and 28 for randomized clinical studies. Studies were categorized based on their score as excellent (26–28), good (20–25), fair (15–19), or poor ( $\leq 14$ ) quality.

## 2.4. Grading of Recommendations Assessment, Development, and Evaluation (GRADE)

The certainty of the body of evidence for each evaluated outcome was assessed using Grading of Recommendations Assessment, Development, and Evaluation (GRADE) and classified into four categories: high, moderate, low, and very low. Observational studies

started at a low level of evidence (randomized trials from high level) and from there were rated up or down based on serious or very serious concerns in any of the following five domains: risk of bias, the directness of the evidence, the consistency of the results, the precision of the estimates, and the risk of publication bias within the included studies.

### 3. Results and Discussion

#### 3.1. State of the Art Regarding This Implant

A total of forty-nine articles were found in scientific databases fulfilling the inclusion criteria. An additional fourteen files were found through a manual search. After excluding nineteen duplicates, twelve papers not analyzing Prama implants, three conference abstracts, and one paper with inaccessible data (closed access), a total of twenty-eight papers were screened.

Of these, twelve were not analyzed because they were not clinical studies (six were laboratory studies, and six were case reports/case series). Among the remaining sixteen studies [8,17,19–32], we selected only the most recent investigations from each research group, resulting in a final analysis of nine studies (Table 1) [17,20–22,25,27,28,30].

**Table 1.** Clinical studies published in the period 2014–2024. When multiple studies by the same research group included the same population sample but with different follow-up durations, only the study with the longest follow-up was considered.

| Current Clinical Evidence of Prama Implants Published Up to June 2024 |                           |               |                                            |                        |           |                     |          |                                           |
|-----------------------------------------------------------------------|---------------------------|---------------|--------------------------------------------|------------------------|-----------|---------------------|----------|-------------------------------------------|
| Reference                                                             | Type of the Study         | N Implants    | Surgery and Insertion                      | Implant Type           | Follow-Up | Prosthetic Approach | Survival | Funding                                   |
| Agustín-Panadero et al., 2021 [30]                                    | Prospective               | 120 (60/60)   | Flap supracrestal crestal                  | Prama RF Premium Kohno | 1 year    | Screw retained      | 100%     | No external funding                       |
| Cabanes Gumbau et al., 2019 [28]                                      | Pilot study               | 32            | Flap supracrestal non-submerged            | Prama                  | 13 months | Cemented            | 100%     | No external funding                       |
| Canullo et al., 2021 [25]                                             | Retrospective             | 48 (27/21)    | Flap crestal                               | Prama Premium Kohno    | 5 years   | Cemented            | 100%     | No external funding                       |
| Castillo et al., 2022 [31]                                            | Retrospective             | 30 (10/10/10) | Flap supracrestal /crestal/ infracrestal   | Prama, Shelta, Premium | 1 year    | Screw retained      | 100%     | No external funding                       |
| Ceruso et al., 2022 [27]                                              | Prospective Case-Control  | 30 (15/15)    | Flap, crestal insertion + healing abutment | Prama Nobel            | 1 year    | Screw retained      | 100%     | No external funding                       |
| Mandillo-Alonso et al., 2022 [20]                                     | Ambispective              | 32            | Flap Bone level Subcrestal                 | Prama Shelta           | 16 months | Screw retained      | 100%     | No external fundings                      |
| Morón-Conejo et al., 2022 [21]                                        | Randomized Clinical Trial | 29 (15/14)    | Flap non-submerged/ submerged              | Prama Premium          | 1 year    | Cemented            | 100%     | Partially supported by Sweden and Martina |
| Prati et al., 2024 [17]                                               | Prospective               | 67            | Flapless Tissue level/Exposed              | Prama                  | 6 years   | Cemented            | 100%     | No external fundings                      |
| Pera et al., 2023 [22]                                                | Retrospective             | 156 (80/76)   | Flap Bone level Tissue level               | Shelta, Syra Prama     | 2 years   | Screw retained      | 97.37%   | No external fundings                      |

Due to the limited presence of prospective case control studies with comparable outcome measures (only three papers were eligible), it was not possible to perform a meta-analysis of the current evidence.

The majority of these studies had a prospective design, two being ambispective studies, one being a pilot study, and one being a randomized clinical trial. The studies included a total of 538 implants. The follow-up ranged from 1 to 6 years.

### 3.1.1. Outcome Analyses (Survival Rates and Hard and Soft Tissues Parameters)

Table 1 reports the nine clinical studies published so far with the longest follow-up available. The follow-up ranged from 1 year to 6 years. Most of the studies reported no implant loss. Only one study reported a 97% survival rate, but it considered multiple abutments performing an immediate load [22]. It should be noted that the clinical data available in the literature on Prama implants were mostly attributable to four European research groups.

Concerning the surgical techniques, a flap approach was mostly used (eight out of nine studies), while a flapless technique was performed in only one study.

Interestingly, variations in the implant placement height and neck position were proposed with different clinical approaches. One study placed the neck at the subcrestal level, while it was placed at the crestal and midcrestal levels in three studies and five studies supracrestal level.

Concerning the prosthetic interventions, screw-retained rehabilitations were performed in 6/9 studies, while the other studies used cemented rehabilitation.

As regards the outcome measures, marginal bone loss (MBL) was reported in all the studies (Table 2), alongside the pink esthetic score (PES) (3/9) and other parameters related to implant stability and soft tissue changes (bleeding on probing, papilla index, soft tissue thickness changes, and recessions) (Table 3).

**Table 2.** Clinical studies analyzing crestal bone levels around Prama implants. When multiple studies by the same research group included the same population sample but with different follow-up durations, only the study with the longest follow-up was considered.

| Reference                          | Type of the Study            | N Implants     | Surgery and Insertion                           | Implant Type               | Follow-Up | Endpoint Outcome Value                                        |
|------------------------------------|------------------------------|----------------|-------------------------------------------------|----------------------------|-----------|---------------------------------------------------------------|
| Agustín-Panadero et al., 2021 [30] | Prospective                  | 120 (60/60)    | Flap<br>supracrestal<br>crestal                 | Prama RF<br>Premium Kohno  | 1 year    | MBL<br>0.31 mm<br>supracrestal<br>0.97 mm crestal             |
| Canullo et al., 2021 [25]          | retrospective                | 48 (27/21)     | Flap<br>crestal                                 | Prama<br>Premium Kohno     | 5 years   | MBL<br>0.38 mm Prama<br>0.83 mm Premium<br>Kohno              |
| Castillo et al., 2022 [31]         | Retrospective                | 30 (10/10/10)  | Flap<br>Supracrestal<br>Crestal<br>Infracrestal | Prama<br>Shelta<br>Premium | 1 year    | MBL<br>Prama 0.12 mm,<br>Shelta 1.04 mm<br>Premium<br>0.27 mm |
| Ceruso et al., 2022 [27]           | Prospective<br>Case-Control  | 30<br>(15/15)  | Flap,<br>crestal insertion<br>+healing abutment | Prama<br>Nobel             | 1 year    | MBL<br>0.65 mm Prama<br>0.99 mm Nobel                         |
| Mandillo-Alonso et al., 2022 [20]  | Ambispective                 | 32             | Flap<br>Bone level<br>Subcrestal                | Prama<br>Shelta            | 2 years   | MBL<br>85.7% stable<br>14.3% gain                             |
| Morón-Conejo et al., 2022 [21]     | Randomized<br>Clinical Trial | 29<br>(15/14)  | Flap<br>non-submerged/<br>submerged             | Prama<br>Premium           | 1 year    | MBL<br>0.16 mm Prama<br>0.45 mm Premium                       |
| Prati et al., 2024 [17]            | Prospective                  | 67             | Flapless<br>Tissue<br>level/Exposed             | Prama                      | 6 years   | MBL<br>0.91 mm                                                |
| Pera et al., 2023 [22]             | Retrospective                | 156<br>(80/76) | Flap<br>Bone level<br>Tissue level              | Shelta, Syra<br>Prama      | 2 years   | MBL<br>1.324 mm Bone<br>Level<br>1.194 mm Tissue<br>Level     |

MBL = marginal bone level.

**Table 3.** Clinical studies analyzing soft tissues around Prama implants. When multiple studies by the same research group included the same population sample but with different follow-up durations, only the study with the longest follow-up was considered.

| Reference                          | Type of the Study         | N Implants  | Surgery and Insertion                     | Implant Type        | Follow-Up | Soft Tissue Parameter | Endpoint Outcome Value                                                                          |
|------------------------------------|---------------------------|-------------|-------------------------------------------|---------------------|-----------|-----------------------|-------------------------------------------------------------------------------------------------|
| Cabanes Gumbau et al., 2019 [24]   | Pilot study               | 32          | Flap supracrestal non-submerged           | Prama               | 13 months | Soft tissue variation | Soft tissue variation 64.7 mm <sup>3</sup> peri-implant mucosal volume increase after 16 months |
| Canullo et al., 2021 [25]          | Retrospective             | 48 (27/21)  | Flap crestal                              | Prama Premium Kohno | 5 years   | Modified PES, WES     | PES<br>8.59 Prama<br>8.14 Premium<br>WES<br>9.59 Prama<br>8.14 Premium                          |
| Ceruso et al., 2022 [27]           | Prospective Case-Control  | 30 (15/15)  | Flap crestal insertion + healing abutment | Prama Nobel         | 1 year    | Modified PES, PI, BoP | PES<br>10.46 mm Prama<br>9.79 mm Nobel                                                          |
| Mandillo-Alonso, et al., 2021 [20] | Ambispective              | 26          | Flap Bone level Subcrestal                | Prama Shelta        | 2 years   | Soft tissue changes   | Soft tissue changes<br>8.06 mm for Prama<br>8.42 mm for Shelta                                  |
| Morón-Conejo et al., 2022 [21]     | Randomized Clinical Trial | 29 (15/14)  | Flap non-submerged/submerged              | Prama Premium       | 1 year    | soft tissue thickness | Soft tissue thickness<br>1.96 mm increase Prama<br>0.65 mm increase Premium                     |
| Prati et al., 2024 [17]            | Prospective               | 67          | Flapless Tissue level/Exposed             | Prama               | 6 years   | PES                   | PES<br>11.86                                                                                    |
| Pera et al., 2023 [22]             | Retrospective             | 156 (80/76) | Flap Bone level Tissue level              | Shelta, Syra Prama  | 2 years   | BoP, PI, PPD          | Bone-level BoP 0.905, PI 1.892, PPD 2.155 mm<br>Tissue-level BoP 1.7, PI 1.938, PPD 2.066 mm    |

PES = pink esthetic score; WES = white esthetic score; PI = papilla index; BoP = bleeding on probing.

### 3.1.2. Assessment of Methodological Quality of the Included Studies

The quality assessment of the studies is summarized in Table 4. Retrospective, ambispective studies could not be analyzed, leading to the assessment of five studies. The studies showed good/fair methodological quality. The variability in the intervention and unclear sampling of the total number of participants enrolled were some of the causes that lowered the methodological quality.

**Table 4.** Modified Downs and Black checklist for assessment of methodological quality.

| Reference                          | Score | Methodological Quality |
|------------------------------------|-------|------------------------|
| Agustín-Panadero et al., 2021 [30] | 18    | Fair                   |
| Cabanes Gumbau et al., 2019 [28]   | 15    | Fair                   |
| Ceruso et al., 2022 [27]           | 16    | Fair                   |
| Morón-Conejo et al., 2022 [21]     | 25    | Good                   |
| Prati et al., 2024 [17]            | 20    | Good                   |

### 3.1.3. Grading of Recommendations Assessment, Development, and Evaluation (GRADE)

The GRADE analysis concerning hard and soft tissues is reported in Tables 5 and 6, respectively. Retrospective and ambispective studies were excluded from the recommenda-

tions assessment, leading to a total of four studies analyzed for both crestal bone levels and soft-tissue-level analysis.

**Table 5.** Grade recommendations according to crestal bone levels around Prama implants.

| References                         | Study Design              | Downgrade    |               |                          |             |                  | Upgrade      |                            | Certainty of Evidence (Grade)         |
|------------------------------------|---------------------------|--------------|---------------|--------------------------|-------------|------------------|--------------|----------------------------|---------------------------------------|
|                                    |                           | Risk of Bias | Inconsistency | Indirectness of Evidence | Imprecision | Publication Bias | Large Effect | Dose–Response Relationship | Confounding Only Reducing Size Effect |
| Agustín-Panadero et al., 2021 [30] | Prospective               | X **         |               |                          |             |                  |              |                            |                                       |
| Ceruso et al., 2022 [27]           | Prospective Case-Control  | X **         |               |                          |             |                  |              |                            |                                       |
| Morón-Conejo et al., 2022 [21]     | Randomized Clinical Trial |              |               |                          |             |                  |              |                            |                                       |
| Prati et al., 2024 [17]            | Prospective               |              |               |                          |             |                  |              |                            |                                       |

\*\* high variability.

**Table 6.** Grade recommendations according to soft tissues around Prama implants.

| References                       | Study Design              | Downgrade    |               |                          |             |                  |              | Upgrade                    |                                       | Certainty of Evidence (Grade) |
|----------------------------------|---------------------------|--------------|---------------|--------------------------|-------------|------------------|--------------|----------------------------|---------------------------------------|-------------------------------|
|                                  |                           | Risk of Bias | Inconsistency | Indirectness of Evidence | Imprecision | Publication Bias | Large Effect | Dose-Response Relationship | Confounding Only Reducing Size Effect |                               |
| Cabanes Gumbau et al., 2019 [24] | Pilot study               | X **         |               |                          |             |                  |              |                            |                                       | ⊕○○○<br>very low              |
| Ceruso et al., 2022 [27]         | Prospective Case-Control  | X **         |               |                          |             |                  |              |                            |                                       | ⊕○○○<br>very low              |
| Morón-Conejo et al., 2022 [21]   | Randomized Clinical Trial |              |               |                          |             |                  |              |                            |                                       | ⊕⊕⊕⊕<br>high                  |
| Prati et al., 2024 [17]          | Prospective               |              |               | X *                      |             |                  |              |                            |                                       | ⊕○○○<br>very low              |

\* Soft tissue analysis was not the primary investigation outcome; \*\* high variability.

Regarding crestal bone stability, two studies demonstrated a very poor recommendation due to the high variability in the cases. One prospective study demonstrated a poor recommendation but low variability in the cases and protocols performed. Conversely, the randomized clinical study was well designed and enabled providing solid evidence of the results (Table 5).

Regarding the soft tissue stability, three studies demonstrated a very poor recommendation due to the high variability in the cases or because soft tissue analysis was not the primary investigation outcome. Conversely, the randomized clinical study was well designed and enabled providing solid evidence of the results (Table 6).

All the studies obtained great bone stability (evidenced by stable MBL values at the ending) and soft tissue improvement/stability, evidenced by satisfactory PES/WES values and low BoP, plaque score, pocket depth, soft tissue thickness, and soft tissue recessions. These values were generally better when the Prama implant was compared to implants with other neck morphology that were placed at the crestal or subcrestal levels.

### 3.2. Factors Influencing Bone Tissues around Prama Implant according to Literature

Peri-implant mucosal connective tissue attachment has clinical and histological features similar to those of teeth. However, the main difference lies in the cellular composition and fiber orientation. The connective tissue surrounding the dental implant is in direct contact with the titanium dioxide surface and contains a dense network of collagen fibers. These fibers, primarily originating from the periosteum of the alveolar bone crest, extend to the mucosal margin. Notably, the fibers are oriented parallel to the implant/abutment surface [33].

The gingival biotype is a critical factor influencing MBL. Studies have shown that a thicker biotype (equal to or more than 2 mm) is associated with greater MBL stability, whereas a thin biotype (less than 2.0 mm) results in more pronounced marginal bone loss [34,35]. Thicker gingival tissue around implants with a convergent neck provides a more stable marginal bone tissue, as previously demonstrated by various investigations [8,17,24].

The positioning of the implant neck, whether supragingival (above the soft tissues) or subgingival (below the soft tissues), may affect the MBL. Implants with a supragingival neck positioning tend to have better maintenance of the marginal bone levels due to less mechanical and bacterial stress compared to subgingival placements [8,17,21,30,32].

The timing of the implant placement is also a significant factor associated with early bone loss. The initial “pre-loading” bone/remodeling can be dependent on the preoperative status of the bone tissue. Histological and micromorphological scanning electron microscope studies demonstrated very different bone mineralization areas in relation to the initial bone density and structure independent of the type of implant surface proposed [36–38]. Different bone remodeling patterns can also be observed after loading procedures [39–41], which can result in a more dense and mineralized bone structure after several years of implant loading [42].

### 3.3. Factors Influencing Soft Tissues around Prama Implant according to Literature

The PES values generally improved from the moment of crown cementation to the subsequent follow-up studies, suggesting the ongoing remodeling of the gingival-connective tissue. In particular two studies also showed marked improvements in the soft tissue thickness at after 1 year [21] and 2 years [20] in comparison to platform switch implants with the same ZirTi implant surface. A six-year study on Prama implants demonstrated the morphological stability of the soft tissues as indicated by the PESs [17]. The PESs improved over a 6-year evaluation period, showing that the gingival tissues (e.g., papilla and gingival architecture) adapted well to the neck and crown finishing line, independent of the MBL and gingival biotype. However, the 6-year PES values were slightly higher in those implants placed in healed crests (early and delayed groups) compared to those placed immediately after extraction, likely due to the soft tissue contraction in the immediate post-extraction sites [17].

Hard tissue variation after several years from loading was not related to the timing of the implant placement. Bone maturation and crestal morphology stability were observed 2–3 years following placement, likely due to higher bone mineralization, widely demonstrated in several clinical studies [8,26,27,29].

### 3.4. Initially Proposed Protocols (2014–2015)

Immediately after the introduction of Prama, a university group proposed the application of a transmucosal implant with the neck exposed for approximately 1.0 mm. This group usually placed implants with flapless approaches. The clinical data from the first published prospective cohort studies on Prama implants proposed a supracrestal/exposed protocol [8,32]. The biological rationale of the current implant placement consists of placing the endosseous ZirTi surface in full contact with the bone tissue and the transmucosal neck at soft tissues. This approach supports early tissue healing without further trauma or interventions in the intramucosal portion (Figure 1).



**Figure 1.** Minimally invasive protocol performed in 2014–2015. Implant insertion in different scenarios. (a) Implant positioned with neck partially exposed (transmucosal insertion technique); (b) in post-extractive areas; (c) in healed crests. Note the different neck heights, decided on the basis of the soft tissue thickness.

The stability of the soft tissues around the exposed neck was immediately evident. The specific morphology of the neck and its design (hyperbolic/convergent neck) modified the approach of the crown design. Different morphologies were prepared, and different provisional crowns were adapted to comply with the tissues' response to the neck and to the crown itself [8,32]. The neck design was very similar to a conventional tooth preparation with a sort of chamfer that guided the crown finishing line.

The transmucosal neck constituted a large part of the abutment. The Prama abutment was shorter than a conventional abutment, with the implant–abutment connection positioned away from the gingival tissue, avoiding immersion in soft tissues or contact with crevicular fluids [8,17].

#### 3.4.1. Exposed Neck Protocol

Several research groups proposed the supracrestal positioning of the implant neck, with partial exposition of the neck above the tissue levels, supported by case reports [43,44] and clinical studies [29–32] and also considering multiple insertion and an immediate protocol [45]. The neck exposition for approximately 1.0 mm (and the flapless procedure) avoided the use of a second surgery to expose the neck. No healing screws have been used in accordance with the initial protocol.

A preliminary study was dedicated to the anterior rehabilitation of elderly patients partially affected by periodontal disease [46]. The implants were placed with the flapless technique, and the implant neck profile (i.e., implant neck with 1.0 mm cover screw) was left exposed for 1.0–1.5 mm, and prosthetic phases were performed after 3 months and a cemented provisional, followed by a definitive crown, was fixed on customized abutments with no proper finishing line. By performing such a minimally invasive rehabilitation protocol, the use of a Prama implant was proposed for elderly patients [46] to reduce discomfort and rehabilitation time.

To support the use of the neck position being exposed, a recent histological study demonstrated effectively that Prama implants placed subcrestally showed greater bone loss and were afflicted with greater soft tissue recessions [9]. In agreement with this, a recent randomized 1-year clinical trial reported markedly higher MBL stability when convergent neck implants were placed with a non-submerged approach in comparison to platform switch submerged implants [21]. Both implants have different neck morphologies but the same surface texture, so they were rather comparable. Altogether, the 1–3 year MBL ranged from 0.12 mm to 0.44 mm [8,29–32]. Interestingly, only marked MBL variations were observed after 6 years of loading; the MBL was 0.91 mm [17].

The study demonstrated that the exposed/transmucosal protocol is particularly useful when in the presence of aging patients, thus requiring only limited and low-invasiveness interventions. The elderly population (>65 years) is a widespread patient population that may benefit due to the presence of systemic diseases (cardiovascular disease, diabetes mel-

litus, osteoporosis, rheumatic diseases, and poor nutrition), which could lead to worse oral health conditions, including aggressive dental decay and periodontal compromise [47].

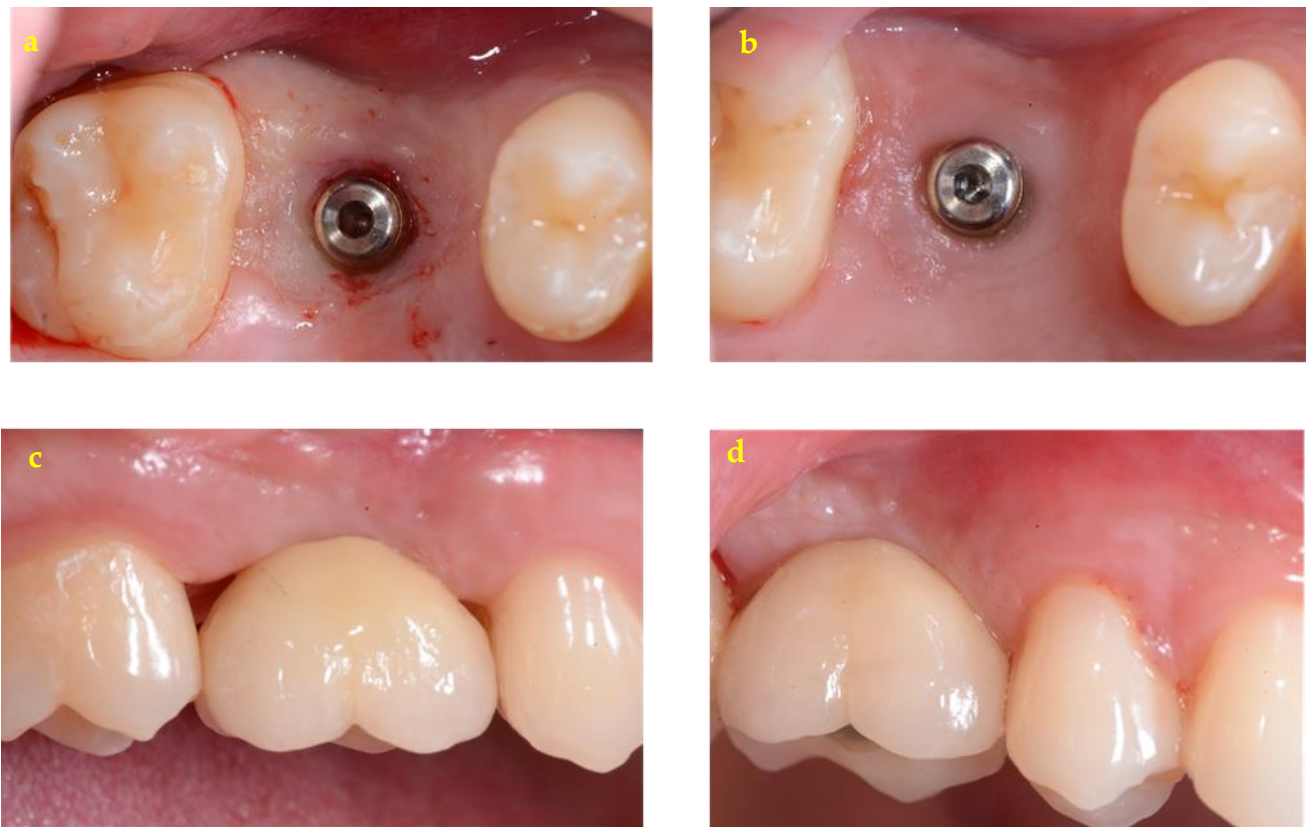
In this way, it was possible to restore single edentulism in the esthetic areas without complex and invasive surgeries. Moreover, the transmucosal exposition of the neck can be tailored according to the clinical scenario (Figure 1).

The concept of placing the implant with the neck exposed at the tissue level implies that the neck is just exposed and positioned approximately at the papilla level, with a “half-moon” gingival exposure. The larger part of the neck profile is situated just beneath the gingival contour, making it not visible but detectable with a probe [29–32,46]. No-flap elevation was performed in some cases [17,32,46]. In such cases, the implant impression phases after a 3-month healing period were more easily performed as no surgical exposition of the neck was required. In addition, the implant abutment connection was internal to the prosthetic rehabilitation (Figure 2).



**Figure 2.** Minimally invasive protocol performed in 2014–2015 on 3 elderly patients (Patient 1 images (a,d,g); Patient 2 images (b,e,h); Patient 3 images (c,f,i)). Implant impression protocol with customized pick-up transfer impressions on customized trays after 3 months from impressions (a–c). Customized abutment application (d–f) and cementation of definitive crowns designed with different designs and soft tissue compressions (g–i). Note the different abutment heights and crown profiles, which were designed in accordance with the thickness of the soft tissues. In all cases, the implant abutment connection was internal to the crown, leading to lower chance of bacterial contamination.

The implant–abutment connection is described as a critical area susceptible to bacterial contamination [48], tissue inflammation [49,50], mechanical stress [51], and bone loss [52]. An internal connection far from the bone tissues led to a lower risk of the contamination of the implant inner portion and the decreased risk of connection screw loosening [53–55]. The application of these protocols enabled having soft tissues at long follow-up in accordance with a recent 6-year study, where the recorded mean PES value was 11.86 [17]. Longer follow-up clinical examinations have been performed and demonstrated soft tissue stability at the 10-year follow-up (Figure 3).



**Figure 3.** Minimally invasive protocol performed in 2014–2015. (a) Clinical view of convergent neck implant placed with a flapless technique immediately after flapless surgeries, (b) after 3 months, (c) after definitive crown cementation, and (d) after 10-year follow-up. Soft tissue stability and optimal results were observed.

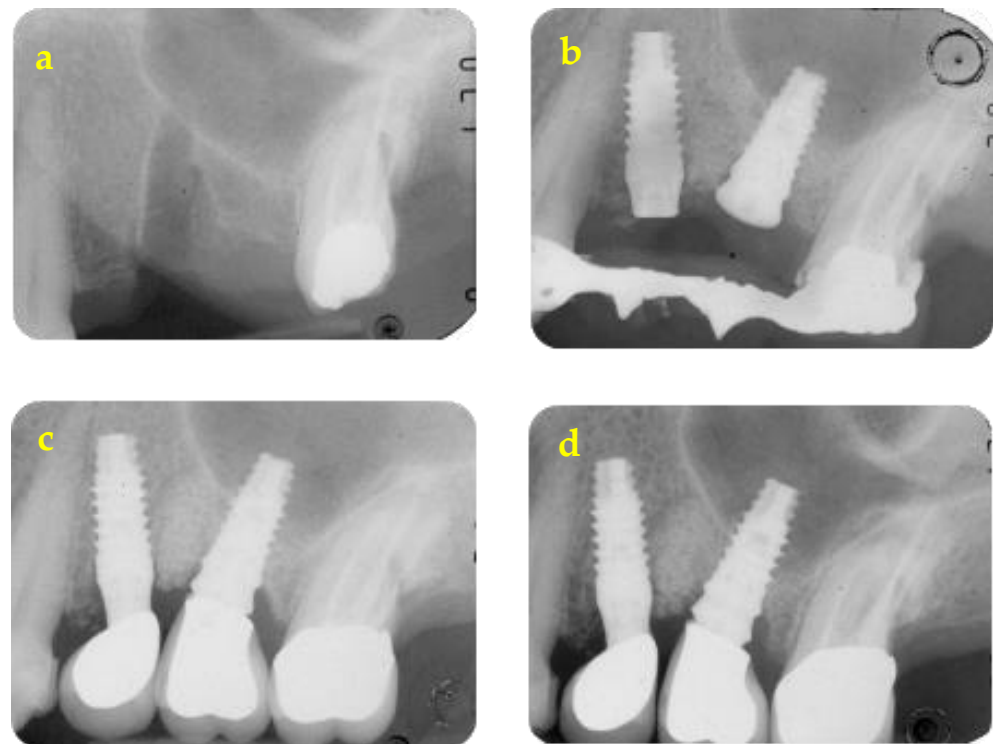
#### 3.4.2. Submerged Neck Protocol

Some research groups proposed the implant placement with the neck partially/completely submerged. These studies proposed this placement following the concept of submerged healing [23,28]. The convergent neck was positioned along the soft tissues but still became completely immersed in the soft tissues. Using this protocol, a second surgery to expose the neck was necessary to proceed with the prosthetic phases. Some further investigations used healing abutments to avoid surgeries and bone loss [26,27]. The prosthetic phases were performed with open custom tray impressions and the preparation of screw-retained provisional and definitive rehabilitations. High survival rates and reduced bone loss were observed in 1- to 3-year clinical studies, with the MBL ranging from 0.09 mm to 0.65 mm [19,20,23–27]. Some limitations, however, should be considered. The implant insertion at the crestal or deep crestal level implies the formation of a transmucosal tunnel and an implant abutment connection closer to the bone tissues. The transmucosal tunnel could be susceptible to bacterial infections [55,56]. A large number of histological and clinical studies revealed that the implant–abutment connection suffers from high strains and is a critical area when marginal bone remodeling events start after the loading phases [53,57].

#### 3.4.3. Design of Prosthetic Crowns and Soft Tissue Compression

The convergent neck profile introduces innovative concepts in implant prosthetic protocols for crown preparation. The presence of a smoother transition due to the absence of a proper finishing line between the crown and the implant can promote better oral hygiene and overall patient outcomes (see Figure 4). In contrast, other configurations (such

as Platform Switch necks) involve the crown preparation ending above the implant level, resulting in a prosthetic step or ledge at the implant–abutment connection.



**Figure 4.** Clinical case performed in 2015–2016. (a) Post-extractive insertion of a Prama implant (#25) and (b) delayed insertion of a Premium SP implant (#26). Both implants were placed submerged with no exposition of the neck. A cover screw was placed on the Prama implant, while a healing screw was immediately placed on the Premium SP implant to avoid second surgeries during the subsequent prosthetic phases. (c) Periapical X-rays at 1-year follow-up bone stability around Prama implant and slight cervical bone loss around Premium implant. (d) The MBL was stable at the 8-year follow-up.

It is also possible to more freely design the crown margin at the implant neck, in particular when a transmucosal/exposed protocol is performed. The provisional crown could guide soft tissue healing, enabling the formation of thick and non-inflamed tissue [8,17] (Figures 2 and 3). In this situation, after at least one month of stabilization, impressions of the soft tissues were taken around the new emergence profile formed by the temporary restorations, and the definitive restorations were fabricated according to a defined laboratory protocol. Creating a new emergence profile with the restoration helps the soft tissue to adapt, increasing its thickness and stabilizing the gingival margin.

The BOPT concepts have been applied to Prama implant-supported restorations, featuring a convergent transmucosal neck that extends to the abutments without a distinct finishing line. This approach aligns with a published guideline for managing implant restorations, which recommends a subcritical contour that is as convergent (concave) as possible [58].

The important concept is mainly that the convergent transmucosal neck creates space for the soft tissues and provides a regenerative space that leads to a stable coagulum, which potentially will turn into soft tissue, increasing the peri-implant tissue thickness. This is one of the reasons to obtain different neck heights, recently available in the market (Prama Short neck or Long neck).

The design of the crown, specifically the soft tissue margin, follows the contour of the gum tissue without forming a gingival tunnel. The connective fibers ensure a perfect seal around the convergent neck, as demonstrated by some histological studies [6], and they are not altered by the presence of intramucosal abutments. Indeed, the convergent

neck associated with the UTM micromorphology demonstrated faster fibroblast adhesion and proliferation when compared to divergent neck implants with the standard (smooth) micromorphology, as demonstrated in a recent histomorphological human study [59].

### 3.5. Recent Clinical Innovations and New Clinical Protocols (2020–2024)

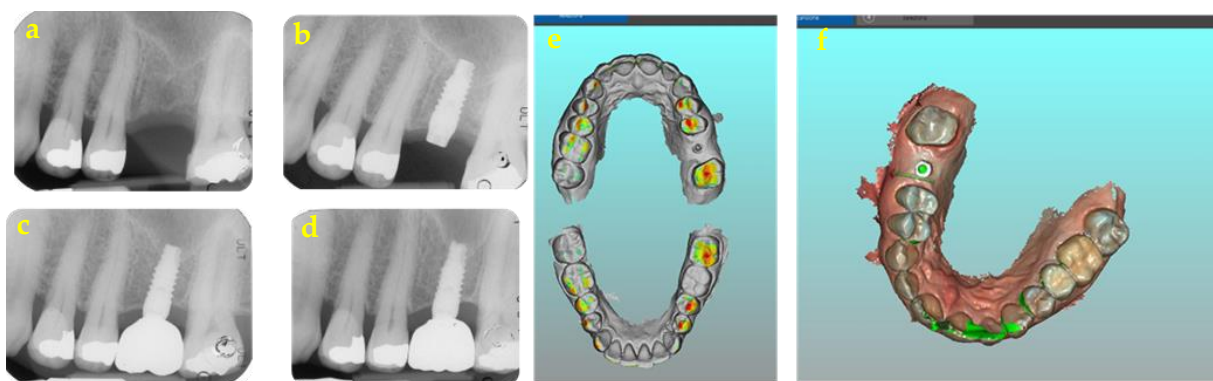
The recent innovations in implant dentistry and prosthetic rehabilitation have influenced the clinical protocols related to Prama implants, impacting both the surgical and prosthetic phases.

#### Digital Intraoral Scanner Workflow

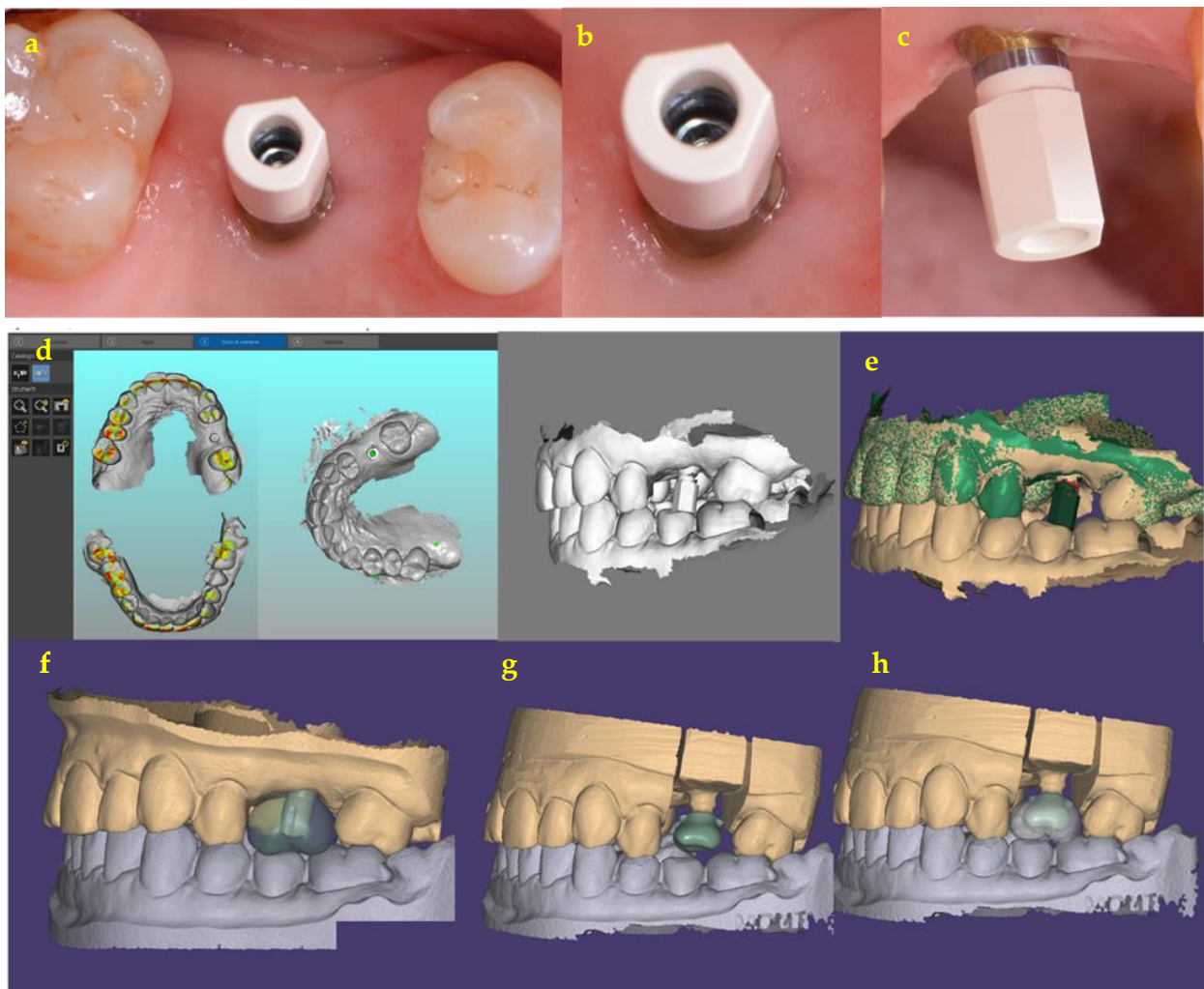
The recent innovations and advances regarding digital intraoral scanners enabled their use for dental implant rehabilitation. High levels of accuracy and precision regarding the digital intraoral scanners, in particular when dealing with partial edentulous areas, have recently been reported [16,60]. In these areas, the differences are very minimal, around 8  $\mu\text{m}$  when considering the digital impressions taken on single implants and around 18  $\mu\text{m}$  regarding two adjacent implants [60]. A different context could be when in the presence of total edentulous areas [61] with markedly higher trueness values (from 96  $\mu\text{m}$  to 140  $\mu\text{m}$ ) [60].

Different from traditional analogic impression, the digital impressions were well-tolerated by the patients since they do not require the use of conventional materials and involve a technically simpler process for trained professionals [60]. The quality of the digital impression can be immediately visualized and verified through computer-assisted software without producing a physical model/cast [18], saving additional time. The impressions can also be directly sent to the dental laboratory by e-mail or by dedicated software. The use of a digital workflow could support clinicians in replicating the previous anatomic characteristics of a hopeless tooth and studying/analyzing the correct occlusal function [62]. Some research groups combined the digital impression mesh with the CBCT data to design a surgical guide to place implants in a prosthetically driven way [63].

The application of a digital workflow with a Prama transmucosal implant led to the possibility to perform a prosthetic rehabilitation using a minimally invasive concept. Indeed, the supracrestal position of the Prama implant enables a simpler way to acquire the scan body and limits the possibility of scan body misplacement or incorrect reading (Figures 5 and 6).



**Figure 5.** Clinical case performed in 2021. Single edentulous area due to the extraction of an upper left molar with recurrent endodontic pathology (a). Typical morphology of Prama neck (b) and prosthetic crown placed with the margin at gingival level (c). Note the integrity of cortical bone and its stability during time (follow-up at 3 years from insertion) (d). The implant abutment connection was internal to the crown, leading to decreased possibility of bacterial infections and also decreased chance of screw loosening. Digital impression images before and after scan body positioning and analysis of the occlusal contacts (e,f).



**Figure 6.** Digital acquisition of scan body (Carestream CS) (a–e) of Prama implant and prosthetic workflow of provisional (e,f) and definitive restoration (metal and ceramic structure) (g,h).

The possibility to design provisional crowns and definitive crowns through a digital workflow also allows us to perform all the steps using one digital impression (Figure 7).



**Figure 7.** Digital workflow around Prama Short neck implant. (a) The implant has a shorter convergent neck compared to traditional Prama implant. (b,c) Provisional crown was designed with graphene-reinforced resin. (d) Full monolithic zirconia definitive crown was subsequently digitally designed and cemented.

The acquisition of the subgingival portion of the Prama implant is much easier compared to other dental implants with an intramucosal implant abutment connection (such as platform switch or external hex implants). The possibility to end the crown at the Prama implant neck enables a more predictable procedure as the dental technician possesses all

the required information about the implant neck morphology. However, difficulties may arise with excessive soft tissue overgrowth or when the Prama implant neck is placed in a more submerged manner. It is important to always check and control the soft tissue compression with the provisional crown morphology.

The analysis of the literature on Prama implants suggests a cautious interpretation of the findings due to several limitations. Although the included studies generally report favorable outcomes, such as high survival rates and stable marginal bone levels, the presence of bias and variability across the studies weakens the overall certainty of the evidence. Most of the studies were conducted by a limited number of research groups, raising concerns about the generalizability of the results. Moreover, the methodological quality varied, with some studies receiving only “fair” ratings due to issues such as unclear sampling and inconsistent interventions. Future randomized clinical studies should demonstrate the long-term stability of this implant placed with the neck exposed.

#### 4. Conclusions

After a decade since its introduction, the use of a convergent neck implant demonstrated significant performance in clinical practice, resulting in solid and well-designed techniques. The initial protocols, whether involving subcrestal or equicrestal placement, have been refined and adapted over time. Notably, the protocol advocating for the exposure of the implant neck above the tissue level has gained traction due to its minimally invasive nature and the facilitation of prosthetic procedures without the need for additional surgeries. The prosthetic advantage offered by convergent neck/abutment was evident. The versatility and high adaptability of soft tissues to the crown contour offer a great change/approach for cemented prosthetic rehabilitations.

The combination of the well-known ZirTi surface and UTM convergent neck design may support the biological and clinical performances. However, the current body of evidence is not robust enough to draw definitive conclusions, especially in the long term, and further high-quality research (long-term randomized trials) is required to consolidate these early observations.

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#### References

1. Buser, D.; Janner, S.F.M.; Wittneben, J.-G.; Brägger, U.; Ramseier, C.A.; Salvi, G.E. 10-Year Survival and Success Rates of 511 Titanium Implants with a Sandblasted and Acid-Etched Surface: A Retrospective Study in 303 Partially Edentulous Patients. *Clin. Implant Dent. Relat. Res.* **2012**, *14*, 839–851. [[CrossRef](#)] [[PubMed](#)]
2. Sanz, M.; Ivanoff, C.J.; Weingart, D.; Wiltfang, J.; Gahlert, M.; Cordaro, L.; Ganeles, J.; Bragger, U.; Jackowski, J.; Martin, W.C.; et al. Clinical and Radiologic Outcomes after Submerged and Transmucosal Implant Placement with Two-Piece Implants in the Anterior Maxilla and Mandible: 3-Year Results of a Randomized Controlled Clinical Trial. *Clin. Implant Dent. Relat. Res.* **2015**, *17*, 234–246. [[CrossRef](#)] [[PubMed](#)]
3. Paul, S.; Petsch, M.; Held, U. Modeling of Crestal Bone after Submerged vs Transmucosal Implant Placement: A Systematic Review with Meta-Analysis. *Int. J. Oral Maxillofac. Implant* **2017**, *32*, 1039–1050. [[CrossRef](#)]

4. Giacomel, M.C.; Camati, P.; Souza, J.; Deliberador, T. Comparison of Marginal Bone Level Changes of Immediately loaded Implants, Delayed Loaded Nonsubmerged Implants, and Delayed Loaded Submerged Implants: A Randomized Clinical Trial. *Int. J. Oral Maxillofac. Implant* **2017**, *32*, 661–666. [[CrossRef](#)] [[PubMed](#)]
5. Loi, I.; Di Felice, A. Biologically oriented preparation technique (BOPT): A new approach for prosthetic restoration of periodontically healthy teeth. *Eur. J. Esthet. Dent.* **2013**, *8*, 10–23. [[PubMed](#)]
6. Palombo, D.; Rahmati, M.; Vignoletti, F.; Sanz-Esporrin, J.; Haugen, H.J.; Sanz, M. Hard and soft tissue healing around implants with a modified implant neck configuration: An experimental in vivo preclinical investigation. *Clin. Oral Implants Res.* **2021**, *32*, 1127–1141. [[CrossRef](#)] [[PubMed](#)]
7. Palombo, D.; Rahmati, M.; Vignoletti, F.; Sanz-Esporrin, J.; Salido, M.P.; Haugen, H.J.; Sanz, M. Hard and soft tissue healing around teeth prepared with the biologically oriented preparation technique and restored with provisional crowns: An in vivo experimental investigation. *J. Clin. Periodontol.* **2023**, *50*, 1217–1238, Epub 2023 May 30. [[CrossRef](#)] [[PubMed](#)]
8. Prati, C.; Zamparini, F.; Canullo, L.; Pirani, C.; Botticelli, D.; Gandolfi, M.G. Factors Affecting Soft and Hard Tissues Around Two-Piece Transmucosal Implants: A 3-Year Prospective Cohort Study. *Int. J. Oral Maxillofac. Implant* **2020**, *35*, 1022–1036. [[CrossRef](#)]
9. Mainetti, T.; Bengazi, F.; Velez, J.U.; De Rossi, E.F.; Sakaguchi, R.; Botticelli, D. Subcrestal Positioning of Implants with a Convergent Hyperbolic Collar Profile: An Experimental Study in Dogs. *Int. J. Oral Maxillofac. Implant* **2022**, *37*, 1160–1168. [[CrossRef](#)]
10. Wennerberg, A.; Albrektsson, T. Effects of titanium surface topography on bone integration: a systematic review. *Clin. Oral Implants Res.* **2009**, *20* (Suppl. S4), 172–184. [[CrossRef](#)]
11. Rossi, F.; Lang, N.P.; De Santis, E.; Morelli, F.; Favero, G.; Botticelli, D. Bone-healing pattern at the surface of titanium implants: An experimental study in the dog. *Clin. Oral Implants Res.* **2014**, *25*, 124–131. [[CrossRef](#)]
12. Caneva, M.; Salata, L.; Scombatti de Souza, S.; Bressan, E.; Botticelli, D.; Lang, N.P. Hard tissue formation adjacent to implants of various size and configuration immediately placed into extraction sockets. An experimental study in dogs. *Clin. Oral Implants Res.* **2010**, *21*, 885–890. [[CrossRef](#)]
13. Baffone, G.M.; Botticelli, D.; Pantani, F.; Carvalho Cardoso, L.; Schweikert, M.T.; Lang, N.P. Influence of various implant platform configurations on peri-implant tissue dimensions. An experimental study in the dog. *Clin. Oral Implants Res.* **2011**, *22*, 438–444. [[CrossRef](#)]
14. Passeri, G.; Cacchioli, A.; Ravanetti, F.; Galli, C.; Elezi, E.; Macaluso, G.M. Adhesion pattern and growth of primary human osteoblastic cells on five commercially available titanium surfaces. *Clin. Oral Implants Res.* **2010**, *21*, 756–765. [[CrossRef](#)] [[PubMed](#)]
15. Ceruso, F.M.; Ottria, L.; Martelli, M.; Gargari, M.; Barlattani, A., Jr. Transgingival implants with a convergent collar (PRAMA); surgical and screwed prosthetic approach. A case report. *J. Biol. Regul. Homeost. Agents* **2020**, *34* (Suppl. S1), 71–77. [[PubMed](#)]
16. Canullo, L.; Di Domenico, A.; Marinotti, F.; Menini, M.; Pesce, P. Soft Tissue Contour Impression with Analogic or Digital Work Flow: A Case Report. *Int. J. Environ. Res. Public Health* **2018**, *15*, 2623. [[CrossRef](#)]
17. Prati, C.; Zamparini, F.; Spinelli, A.; Lenzi, J.; Gandolfi, M.G. The Use of Two-Piece Transmucosal Implants Designed with a Convergent Neck: A 6-Year Clinical Prospective Cohort Study Evaluating the Impact on Soft and Hard Tissues. *Int. J. Oral Maxillofac. Implant* **2024**, *21*, 396–408. [[CrossRef](#)]
18. Mangano, F.; Gandolfi, A.; Luongo, G.; Logozzo, S. Intraoral scanners in dentistry: A review of the current literature. *BMC Oral Health* **2017**, *17*, 149. [[CrossRef](#)] [[PubMed](#)]
19. Mandillo-Alonso, V.; Cascos-Sánchez, R.; Antonaya-Martín, J.L.; Laguna-Martos, M. Soft tissue thickness evaluation in screw-retained crowns by the biologically oriented preparation technique (BOPT). *J. Clin. Exp. Dent.* **2021**, *13*, e1209–e1215. [[CrossRef](#)]
20. Mandillo-Alonso, V.; Cascos-Sánchez, R.; Antonaya-Martín, J.L.; Laguna-Martos, M. Evaluation of peri-implant soft and hard tissues behavior in screw-retained crowns by the biologically oriented preparation technique (BOPT): Ambispective longitudinal analytical study. *J. Clin. Exp. Dent.* **2022**, *14*, e64–e71. [[CrossRef](#)]
21. Morón-Conejo, B.; Sanz-Sánchez, I.; Salido, M.P.; Martínez-Rus, F.; Pradies, G. The effect of a convergent transmucosal neck on soft tissues and radiographic outcomes: A 1-year follow-up randomized controlled trial. *Clin. Oral Investig.* **2023**, *27*, 2923–2933. [[CrossRef](#)] [[PubMed](#)]
22. Pera, F.; Carossa, M.; Bagnasco, F.; Crupi, A.; Ambrogio, G.; Isola, G.; Menini, M.; Pesce, P. Comparison between Bone-Level and Tissue-Level Implants in Immediate-Loading Full-Arch Rehabilitations: A Retrospective Multi-Center 1-Year Follow-Up Study. *Prosthesis* **2023**, *5*, 1301–1311. [[CrossRef](#)]
23. Canullo, L.; Tallarico, M.; Pradies, G.; Marinotti, F.; Loi, I.; Cocchetto, R. Soft and hard tissue response to an implant with a convergent collar in the esthetic area: preliminary report at 18 months. *Int. J. Esthet. Dent.* **2017**, *12*, 306–323.
24. Canullo, L.; Menini, M.; Covani, U.; Pesce, P. Clinical outcomes of using a prosthetic protocol to rehabilitate tissue-level implants with a convergent collar in the esthetic zone: A 3-year prospective study. *J. Prosthet. Dent.* **2020**, *123*, 246–251. [[CrossRef](#)] [[PubMed](#)]
25. Canullo, L.; Menini, M.; Bagnasco, F.; Di Tullio, N.; Pesce, P. Tissue-level versus bone-level single implants in the anterior area rehabilitated with feather-edge crowns on conical implant abutments: An up to 5-year retrospective study. *J. Prosthet. Dent.* **2022**, *128*, 936–941. [[CrossRef](#)]

26. Ceruso, F.M.; Ieria, I.; Martelli, M.; Lumbau, A.I.; Xhanari, E.; Gargari, M. New Generation of Fixture-Abutment Connection Combining Soft Tissue Design and Vertical Screw-Retained Restoration: 1-Year Clinical, Aesthetics and Radiographic Preliminary Evaluation. *Dent. J.* **2021**, *24*, 35. [\[CrossRef\]](#)
27. Ceruso, F.M.; Ieria, I.; Tallarico, M.; Meloni, S.M.; Lumbau, A.I.; Mastroianni, A.; Zotti, A.; Gargari, M. Comparison between Early Loaded Single Implants with Internal Conical Connection or Implants with Transmucosal Neck Design: A Non-Randomized Controlled Trial with 1-Year Clinical, Aesthetics, and Radiographic Evaluation. *Materials* **2022**, *15*, 511. [\[CrossRef\]](#)
28. Cabanes-Gumbau, G.; Pascual-Moscardó, A.; Peñarrocha-Oltra, D.; García-Mira, B.; Aizcorbe-Vicente, J.; Peñarrocha-Diogo, M.A. Volumetric variation of peri-implant soft tissues in convergent collar implants and crowns using the biologically oriented preparation technique (BOPT). *Med. Oral Patol. Oral Cir. Bucal.* **2019**, *24*, 643–651. [\[CrossRef\]](#)
29. Agustín-Panadero, R.; Martínez-Martínez, N.; Fernandez-Estevan, L.; Faus-López, J.; Solá-Ruiz, M.F. Influence of Transmucosal Area Morphology on Peri-Implant Bone Loss in Tissue-Level Implants. *Int. J. Oral Maxillofac. Implant* **2019**, *34*, 947–952. [\[CrossRef\]](#)
30. Agustín-Panadero, R.; Bermúdez-Mulet, I.; Fernández-Estevan, L.; Fernanda Solá-Ruiz, M.; Marco-Pitarch, R.; García-Selva, M.; Zubizarreta-Macho, Á.; León-Martínez, R. Peri-Implant Behavior of Tissue Level Dental Implants with a Convergent Neck. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5232. [\[CrossRef\]](#)
31. Costa Castillo, M.; Laguna Martos, M.; Marco Pitarch, R.; García Selva, M.; Del Cid Rodríguez, S.; Fons-Badal, C.; Agustín Panadero, R. Analysis of Peri-Implant Bone Loss with a Convergent Transmucosal Morphology: Retrospective Clinical Study. *Int. J. Environ. Res. Public Health* **2022**, *19*, 3443. [\[CrossRef\]](#) [\[PubMed\]](#) [\[PubMed Central\]](#)
32. Prati, C.; Zamparini, F.; Pirani, C.; Montebugnoli, L.; Gandolfi, M.G. Multifactorial statistical analysis toward evaluation of MBL, PES and PI of a novel nonsubmerged implant to restore a single tooth: A 1-year prospective cohort study. *J. Oral Sci. Rehabil.* **2017**, *3*, 32–41.
33. Ivanovski, S.; Lee, R. Comparison of peri-implant and periodontal marginal soft tissues in health and disease. *Periodontology* **2000**, *2018*, *76*, 116–130. [\[CrossRef\]](#) [\[PubMed\]](#)
34. Linkevicius, T.; Puisys, A.; Steigmann, M.; Vindasiute, E.; Linkeviciene, L. Influence of Vertical Soft Tissue Thickness on Crestal Bone Changes Around Implants with Platform Switching: A Comparative Clinical Study. *Clin. Implant Dent. Relat. Res.* **2015**, *17*, 1228–1236. [\[CrossRef\]](#)
35. Spinelli, A.; Zamparini, F.; Romanos, G.; Gandolfi, M.G.; Prati, C. Tissue-Level Laser-Lok Implants Placed with a Flapless Technique: A 4-Year Clinical Study. *Materials* **2023**, *16*, 1293. [\[CrossRef\]](#)
36. Botticelli, D.; Berglundh, T.; Lindhe, J. Hard-tissue alterations following immediate implant placement in extraction sites. *J. Clin. Periodontol.* **2004**, *31*, 820–828. [\[CrossRef\]](#) [\[PubMed\]](#)
37. Degidi, M.; Scarano, A.; Piattelli, M.; Perrotti, V.; Piattelli, A. Bone remodeling in immediately loaded and unloaded titanium dental implants: A histologic and histomorphometric study in humans. *J. Oral Implantol.* **2005**, *31*, 18–24. [\[CrossRef\]](#) [\[PubMed\]](#)
38. Shah, F.A.; Ruscsák, K.; Palmquist, A. 50 years of scanning electron microscopy of bone—A comprehensive overview of the important discoveries made and insights gained into bone material properties in health, disease, and taphonomy. *Bone Res.* **2019**, *7*, 15. [\[CrossRef\]](#) [\[PubMed\]](#)
39. Romanos, G.; Zamparini, F.; Spinelli, A.; Prati, C.; Gandolfi, M.G. ESEM-EDX Microanalysis at Bone-Implant Region on Immediately Loaded Implants Retrieved Postmortem. *Int. J. Oral Maxillofac. Implant* **2022**, *37*, e51–e60. [\[CrossRef\]](#)
40. Zamparini, F.; Gandolfi, M.G.; Spinelli, A.; Ferri, M.; Iezzi, G.; Botticelli, D.; Prati, C. Mineralization and morphology of peri-implant bone around loaded and unloaded dental implants retrieved from the human mandible. *Oral Maxillofac. Surg.* **2024**, *28*, 623–637. [\[CrossRef\]](#)
41. Imai, H.; Prati, C.; Zamparini, F.; Iezzi, G.; Botticelli, D.; Gandolfi, M.G.; Baba, S. ESEM-EDX Mineralization and Morphological Analysis of Human Retrieved Maxillary Sinus Bone Graft Biopsies before Loading. *J. Funct. Biomater.* **2023**, *14*, 391. [\[CrossRef\]](#) [\[PubMed\]](#)
42. Gandolfi, M.G.; Zamparini, F.; Iezzi, G.; Degidi, M.; Botticelli, D.; Piattelli, A.; Prati, C. Microchemical and Micromorphologic ESEM-EDX Analysis of Bone Mineralization at the Thread Interface in Human Dental Implants Retrieved for Mechanical Complications After 2 Months to 17 Years. *Int. J. Periodontics Restor. Dent.* **2018**, *38*, 431–441. [\[CrossRef\]](#) [\[PubMed\]](#)
43. Barlattani, A., Jr.; Martelli, M.; Ceruso, F.M.; Gargari, M.; Ottria, L. Convergent implant transmucosal collar and healing abutment: Aesthetics influence on soft tissues. A clinical study. *J. Biol. Regul. Homeost. Agents* **2020**, *34* (Suppl. S1), 63–69.
44. Carossa, M.; Alovise, M.; Crupi, A.; Ambrogio, G.; Pera, F. Full-Arch Rehabilitation Using Trans-Mucosal Tissue-Level Implants with and without Implant-Abutment Units: A Case Report. *Dent. J.* **2022**, *10*, 116. [\[CrossRef\]](#) [\[PubMed\]](#) [\[PubMed Central\]](#)
45. Celletti, R.; Fanali, S.; Laici, C.U.; Santori, C.; Pignatelli, P.; Sinjari, B. Instant loading with intraoral welding technique and PRAMA implants: A new prosthetic approach. *J. Biol. Regul. Homeost. Agents* **2017**, *31*, 1127–1131.
46. Zamparini, F.; Pirani, C.; Chavarria-Bolanos, D.; Gandolfi, M.G.; Prati, C. Rehabilitation of anterior maxilla with a novel hyperbolic profile transmucosal implant in elderly patients. *Minerva Stomatol.* **2019**, *68*, 249–258. [\[CrossRef\]](#)
47. Sato, Y.; Kitagawa, N.; Isobe, A. Implant treatment in ultra-aged society. *Jpn. Dent. Sci. Rev.* **2018**, *54*, 45–51. [\[CrossRef\]](#)
48. Broggini, N.; McManus, L.M.; Hermann, J.S.; Medina, R.; Schenk, R.K.; Buser, D.; Cochran, D.L. Peri-implant inflammation defined by the implant-abutment interface. *J. Dent. Res.* **2006**, *85*, 473–478. [\[CrossRef\]](#)
49. Barone, A.; Orlando, B.; Cingano, L.; Marconcini, S.; Derchi, G.; Covani, U. A randomized clinical trial to evaluate and compare implants placed in augmented versus non-augmented extraction sockets: 3-year results. *J. Periodontol.* **2012**, *83*, 836–846. [\[CrossRef\]](#)

50. Crespi, R.; Capparè, P.; Gherlone, E. Immediate loading of dental implants placed in periodontally infected and non-infected sites: A 4-year follow-up clinical study. *J. Periodontol.* **2010**, *81*, 1140–1146. [[CrossRef](#)]
51. Ausiello, P.; Tribst, J.P.M.; Ventre, M.; Salvati, E.; di Lauro, A.E.; Martorelli, M.; Lanzotti, A.; Watts, D.C. The role of cortical zone level and prosthetic platform angle in dental implant mechanical response: A 3D finite element analysis. *Dent. Mater.* **2021**, *37*, 1688–1697. [[CrossRef](#)] [[PubMed](#)]
52. Göthberg, C.; Gröndahl, K.; Omar, O.; Thomsen, P.; Slotte, C. Bone and soft tissue outcomes, risk factors, and complications of implant-supported prostheses: 5-Years RCT with different abutment types and loading protocols. *Clin. Implant Dent. Relat. Res.* **2018**, *20*, 313–321. [[CrossRef](#)] [[PubMed](#)]
53. Peñarrocha-Diogo, M.A.; Flichy-Fernández, A.J.; Alonso-González, R.; Peñarrocha-Oltra, D.; Balaguer-Martínez, J.; Peñarrocha-Diogo, M. Influence of implant neck design and implant-abutment connection type on peri-implant health. *Radiol. Study Clin. Oral Implants Res.* **2013**, *24*, 1192–1200. [[CrossRef](#)] [[PubMed](#)]
54. Piattelli, A.; Scarano, A.; Paolantonio, M.; Assenza, B.; Leghissa, G.C.; Di Bonaventura, G.; Catamo, G.; Piccolomini, R. Fluids and microbial penetration in the internal part of cement-retained versus screw-retained implant-abutment connections. *J. Periodontol.* **2001**, *72*, 1146–1150. [[CrossRef](#)] [[PubMed](#)]
55. Assenza, B.; Tripodi, D.; Scarano, A.; Perrotti, V.; Piattelli, A.; Iezzi, G.; D’Ercole, S. Bacterial leakage in implants with different implant-abutment connections: An in vitro study. *J. Periodontol.* **2012**, *83*, 491–497. [[CrossRef](#)]
56. Chan, D.; Pelekos, G.; Ho, D.; Cortellini, P.; Tonetti, M.S. The depth of the implant mucosal tunnel modifies the development and resolution of experimental peri-implant mucositis: A case-control study. *J. Clin. Periodontol.* **2019**, *46*, 248–255. [[CrossRef](#)]
57. Galindo-Moreno, P.; León-Cano, A.; Ortega-Oller, I.; Monje, A.; Suárez, F.; ÓValle, F.; Spinato, S.; Catena, A. Prosthetic abutment height is a key factor in peri-implant marginal bone loss. *J. Dent. Res.* **2014**, *93*, 80–85. [[CrossRef](#)]
58. González-Martín, O.; Lee, E.; Weisgold, A.; Veltri, M.; Su, H. Contour Management of Implant Restorations for Optimal Emergence Profiles: Guidelines for Immediate and Delayed Provisional Restorations. *Int. J. Periodontics Restor. Dent.* **2020**, *40*, 61–70. [[CrossRef](#)]
59. Canullo, L.; Giuliani, A.; Furlani, M.; Menini, M.; Piattelli, A.; Iezzi, G. Influence of abutment macro- and micro-geometry on morphologic and morphometric features of peri-implant connective tissue. *Clin. Oral Implants Res.* **2023**, *34*, 920–933. [[CrossRef](#)] [[PubMed](#)]
60. Pesce, P.; Bagnasco, F.; Pancini, N.; Colombo, M.; Canullo, L.; Pera, F.; Bressan, E.; Annunziata, M.; Menini, M. Trueness of Intraoral Scanners in Implant-Supported Rehabilitations: An In Vitro Analysis on the Effect of Operators’ Experience and Implant Number. *J. Clin. Med.* **2021**, *10*, 5917. [[CrossRef](#)]
61. Nedelcu, R.; Olsson, P.; Thulin, M.; Nyström, I.; Thor, A. In vivo trueness and precision of full-arch implant scans using intraoral scanners with three different acquisition protocols. *J. Dent.* **2023**, *128*, 104308. [[CrossRef](#)] [[PubMed](#)]
62. Choi, J.W.; Choi, G.J.; Kim, Y.S.; Kyung, M.H.; Kim, H.K. A digital workflow for pair matching of maxillary anterior teeth using a 3D segmentation technique for esthetic implant restorations. *Sci. Rep.* **2022**, *12*, 14356. [[CrossRef](#)] [[PubMed](#)]
63. Gómez-Polo, M.; Ballesteros, J.; Padilla, P.P.; Pulido, P.P.; Revilla-León, M.; Ortega, R. Merging intraoral scans and CBCT: A novel technique for improving the accuracy of 3D digital models for implant-supported complete-arch fixed dental prostheses. *Int. J. Comput. Dent.* **2021**, *24*, 117–123. [[PubMed](#)]

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