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Original Article

Case Series on Clinical and Radiographic Assessment of a New Triangular Implant Neck Design

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ABSTRACT

This investigation examined the clinical and radiographic outcomes of a newly designed triangular-neck implant in patients with partial tooth loss. Sixteen participants, averaging 58.3 years of age, received a total of 25 implants placed in healed sites of both the maxilla and mandible, with diameters of 3.3 mm and 3.9 mm. Evaluations were performed at the time of prosthetic placement, serving as baseline, and repeated after an average follow-up of 15.6 months. The main focus was on interproximal peri-implant bone changes, with mesial and distal measurements averaged for analysis, while secondary assessments included peri-implant probing depth (PPD) and bleeding on probing (BoP). Statistical comparison using paired t-tests showed no significant differences in bone levels from baseline (mesial: 0.45 ± 0.47 mm, distal: 0.57 ± 0.69 mm) to follow-up (mesial: 0.59 ± 0.42 mm, distal: 0.78 ± 0.59 mm). Likewise, PPD and BoP values remained stable over time. These findings suggest that the triangular-neck bone-level implant can be effectively used in partially edentulous patients, though larger and controlled studies are needed to corroborate these preliminary clinical and radiographic observations.

Keywords: Implant design, Dental implants, Marginal bone loss, Clinical study

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Introduction

In recent years, the field of dental implantology has advanced considerably due to improved standardized protocols, innovative technologies, and a deeper understanding of the biological processes surrounding implant integration [1]. Osseointegration, defined as the direct contact between living bone and a functioning implant surface, remains a cornerstone of implant success and can be evaluated microscopically [2]. Dental implants aim not only to restore chewing function but also to enhance aesthetics, ultimately improving the quality of life for patients with partial or complete tooth loss [3, 4]. Modern implant procedures have become increasingly predictable, allowing for less invasive approaches while providing durable clinical outcomes [5–8].

Implant stability is influenced by both micro- and macro-design characteristics. Micro-design elements, such as surface topography, can enhance cell attachment, proliferation, and the recruitment of proteins and growth factors [8, 9–11], whereas macro-design features—including implant body and neck geometry, thread patterns, and pitch—affect primary mechanical stability and load distribution [12]. Studies have shown that implants with straight or convergent necks generate lower insertion stress compared to implants with divergent or wider neck designs [13, 14]. Ongoing innovation from implant manufacturers continues to introduce designs that improve treatment predictability and long-term outcomes [15–17].

Equally important are appropriate patient selection, careful management of hard and soft tissues during surgery, accurate three-dimensional implant placement, platform-switching or conical abutment connections, and meticulous prosthetic planning, all of which contribute to successful implant restorations [18–25].

Among recent innovations is a triangular-neck implant design, which has gained attention for its potential to improve primary stability, promote osseointegration, and support peri-implant tissue health [26–29]. Clinical evidence has shown promising results: Li Manni *et al*. [28] reported reduced proximal bone loss with triangular-neck implants compared to circular-neck designs after one year, while Eshkol-Yogev *et al*. [27] observed that although initial ISQ values were lower than circular-neck controls, the difference disappeared after six weeks. Retrospective analyses in the esthetic zone have also demonstrated preservation of hard and soft tissue architecture using this design [30], and Nevins *et al*. [31] confirmed that minor gaps between the implant and buccal cortical bone in the triangular configuration were fully bridged with new bone after six months.

The present study primarily aimed to investigate peri-implant bone changes around a novel triangular-neck bone-level implant in partially edentulous patients following final prosthetic placement. Secondary objectives included monitoring clinical indicators such as peri-implant probing depth (PPD) and bleeding on probing (BoP).

Materials and Methods

Patient selection

The present study was performed at the Department of Periodontics, School of Dentistry, Pontificia Universidad Católica Madre y Maestra (PUCMM), Santo Domingo campus, adhering to the ethical principles of the 1975 Helsinki Declaration, updated in 2000. The Faculty of Health Ethical Committee approved the protocol (COBE-FACS-M.EST-CSTA-002-2-2015-2016). All participants were fully informed about the study procedures and provided written consent before any clinical intervention.

A total of sixteen patients (12 females, 4 males) with a mean age of 45.82 ± 13.5 years, requiring one or more dental implants, were included between July 2016 and November 2019. Eligible participants were adults aged 18 years or older, with at least one missing tooth in the anterior or posterior maxilla or mandible, good oral hygiene (O'Leary plaque score ≤20%), and general health adequate to undergo implant surgery. Individuals were excluded if they presented untreated periodontal disease, oral pathology, total edentulism in both arches, required bone regenerative procedures, were pregnant or lactating, or smoked.

All subjects underwent comprehensive baseline assessments, including clinical examinations and CBCT imaging, to guide diagnosis and treatment planning. Once eligibility was confirmed, an experienced clinician (JC) performed all surgical procedures.

Surgical procedures

In this cohort, 25 V3 implants (MIS Implants Technologies Ltd., Bar-Lev Industrial Park, Israel) were placed in the maxilla and mandible. These implants featured a triangular neck design, with gap dimensions of 0.1 mm or 0.3 mm depending on the implant diameter, and incorporated a platform-switching design alongside a 12° conical connection **(Figure 1)**. The implant surface underwent sandblasting and acid etching, promoting osseoconductivity, particularly in regions of softer bone [32].

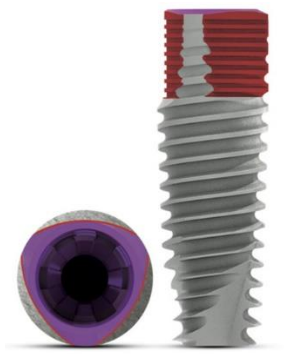


Figure 1. Conical connection platform and triangular geometry of the coronal third of the V3 implant.

Both narrow (3.3 mm) and standard (3.9 mm) diameter V3 implants, with lengths ranging from 8 to 13 mm, were utilized in this study. Patients received local anesthesia via 4 percent articaine with 1:100,000 epinephrine (DFL, Rio de Janeiro, RJ, Brazil). A full-thickness mucoperiosteal flap was elevated using a crestal incision to expose the alveolar ridge. Osteotomies were prepared according to the manufacturer's guidelines, and implants were seated in the healed ridge with the flat surface oriented toward the labial aspect, thereby distancing the fixture from the buccal crestal bone **(Figure 2)**. Insertion torque values were maintained at or above 30 Ncm, with sub-crestal positioning not exceeding 0.5 mm on the buccal side; no bone grafting or regenerative interventions were required. Flaps were closed using 5-0 monofilament nylon sutures (Ethicon, Johnson & Johnson, New Brunswick, NJ, USA), allowing for transgingival healing.

Post-surgery, patients were prescribed 25 mg dexketoprofen for two days and instructed to irrigate the surgical site three times daily with 0.12% chlorhexidine for one week. Follow-up visits occurred one week postoperatively for suture removal and clinical evaluation, which revealed minimal discomfort and swelling, with no infection or adverse events reported. In addition, patients were provided with detailed oral hygiene guidance, and professional cleaning—including supra- and subgingival debridement with both ultrasonic and manual instruments—was performed at one, four, and twelve weeks after surgery.

Figure 2. Occlusal perspective highlighting the flat portion of the triangular implant oriented toward the buccal ridge, showing the space between the implant surface and surrounding bone as well as the three points of contact responsible for primary stability.

Prosthetic procedures

Implants were uncovered between three and seven months post-placement using a slightly lingual crestal incision, aiming to maintain the maximum width of keratinized gingiva. After this healing period, temporary cylinders were attached to the implants, and provisional crowns were cemented with 3M Temporary Cement (Flemington, NJ, USA) for a duration of 3 weeks to gradually shape a customized emergence profile. Final impressions were obtained using impression copings to precisely capture implant positions. Implant analogs were then placed, and silicone material (Gingifast CAD, Zhermack, Badia Polesine, Italy) was applied around the analog to replicate the emergence profile.

Abutments were chosen based on individual case requirements, digitally scanned, and used to design crowns in a virtual model (Amman-Girrbach Ceramill Map 400, Koblach, Austria). All crowns were milled from conventional Zolid® zirconia (Amman-Girrbach, Koblach, Austria) using a five-axis Ceramill Motion 2 milling system with a vestibular cutback. Following milling, the restorations were laminated and sintered for seven hours (Ceramill Term 3, Amman-Girrbach / Nowak Dental Supplies, Carriere, MS, USA). The buccal surfaces were layered with vintage ZR dentin and enamel ceramics (Shofu Inc., Dental Asia-Pacific Pte. Ltd., Singapore) and fired at 900°C in a Porgramat 5000 oven (Ivoclar Vivadent, Amherst, NY, USA).

Of the 25 crowns, eighteen were screw-retained, with access holes sealed using Ketac Fil and flowable composite. The remaining seven crowns were cement-retained; their abutments were torqued to 30–35 Ncm, verified radiographically, and cemented with resin-reinforced glass ionomer cement (GC Fuji Plus, Tokyo, Japan) **(Figures 3a and 3b)**. Patients were provided with oral hygiene instructions and underwent professional full-mouth plaque removal at six, twelve, and eighteen months following final crown placement.

a)

b)

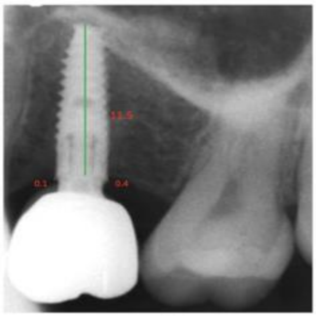
Figure 3. a) Immediate appearance of the implant following placement; b) clinical evaluation at a two-year follow-up.

Study endpoints

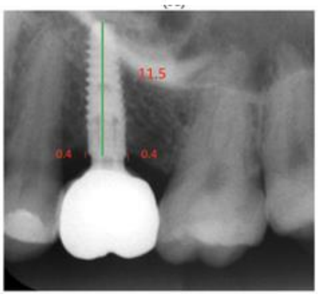
The principal focus of this study was the assessment of crestal bone changes around the implants, evaluated immediately after placement of the final prosthesis (baseline) and at the final follow-up using standardized periapical radiographs. Secondary outcomes included clinical parameters recorded on the mesial and distal surfaces of each implant, specifically peri-implant probing depth (PPD) and bleeding on probing (BoP), to monitor tissue health over time.

Radiographic analysis

Digital periapical radiographs were captured using a PSPiX® scanner (ACTEON® Group, Mérignac, France) on the day of definitive crown placement and at the last follow-up visit. Images were analyzed with Planmeca Romexis 5.0 software (Planmeca Oy, Helsinki, Finland) by a calibrated radiologist. To quantify peri-implant bone alterations, measurements were taken from the implant shoulder to the first bone-to-implant contact on both the mesial and distal aspects, using the full implant length as a reference **(Figures 4a and 4b)**.



a)



b)

Figure 4. a) Standardized long-cone radiographs showing implant length measurement (green vertical line). b) Distance from the implant neck to the first bone-implant contact (red vertical line).

Clinical assessments

All clinical recordings were performed by a single calibrated examiner using a periodontal probe (PCPUNC-12; Hu-Friedy, Chicago, IL, USA). Baseline assessments were conducted at the time of final prosthesis placement and included:

1. Peri-implant probing depth (PPD): Measured to the nearest 0.5 mm at both mesial and distal sites.
2. Bleeding on probing (BoP): Recorded as a binary outcome (0 = no bleeding, 1 = bleeding) at six sites per implant, covering mesial, mid, and distal points on both buccal and palatal aspects.

These parameters were re-evaluated for all participants at the final follow-up visit.

Statistical analysis

Paired t-tests were used to compare mean PPD values across mesial, mid, and distal sites on buccal and palatal surfaces (PPDMsB, PPDMB, PPDDB, PPDMsP, PPDMP, PPDDP) between baseline and follow-up. BoP data were converted into binary scores (0/1), averaged across six sites per implant, and analyzed using paired t-tests. Clinical attachment levels were also compared between baseline and follow-up using paired t-tests. Radiographic measurements were analyzed similarly, with paired t-tests applied to compare mesial and distal bone heights and evaluate potential differences between maxillary and mandibular implant sites.

Results and Discussion

Sixteen patients completed the study according to the outlined protocol. The cohort consisted of 4 men (25%) and 12 women (75%), with ages ranging from twenty eight to sixty five years. Of the 25 implants placed, 18 were standard-diameter platforms, and 7 were narrow platforms. Diameters of 3.9 mm were most commonly used, followed by 3.3 mm; implant lengths ranged from 8 to 13 mm, with a single narrow platform implant measuring 16 mm. Implants were distributed between the maxilla (11) and mandible (14). Restoration positions included 3 anterior, 15 premolars, and 8 molars. Eighteen restorations were screw-retained, while seven were cement-retained. Regarding patient treatment, 11 received single crowns, three received two crowns, one received three crowns, and one received five crowns. All implants achieved successful osseointegration, with no biological or prosthetic complications observed during either the healing or follow-up periods. The minimum follow-up after final restoration was 15.6 months, ranging from eight to twenty four months **(Table 1)**.

Table 1. Demographic data and dimensions of implants.

	N (%)
Female	12 (75)
Male	4 (25)

Patient number and number of implants	
Patient Number	**Number of Implants**
1	1
2	1
3	1
4	2
5	1
6	1
7	5
8	2
9	1
10	1
11	2
12	1
13	3
14	1
15	1
16	1
Age 45.82 (13.15) years	
Length and diameter	
Diameter	**N (%)**
3.3	7 (28)
3.9	18 (72)
Length	**N (%)**
8	4 (16)
10	8 (32)
11.5	6 (24)
13	6 (24)
16	1 (4)

Patient implant details

Patient Number	Age	Sex	Implant Tooth	Location	Diameter Length	Follow-Up Length (Mo.)
1	35	F	13	Maxilla	3.90 × 11.5	12
2	60	F	4	Maxilla	3.90 × 10	12
3	50	F	20	Mandible	3.90 × 11.5	8
4	57	F	3	Maxilla	3.30 × 10	12
4	57	F	4	Maxilla	3.90 × 8	12
5	38	F	19	Mandible	3.90 × 10	17
6	57	F	5	Maxilla	3.30 × 10	9
7	65	F	18	Mandible	3.90 × 8	24
7	65	F	17	Mandible	3.90 × 10	24
7	65	F	28	Mandible	3.90 × 11.5	13
7	65	F	29	Mandible	3.90 × 11.5	13
7	65	F	30	Mandible	3.90 × 10	13
8	65	F	27	Mandible	3.90 × 13	11
8	65	F	28	Mandible	3.90 × 13	11
9	33	M	29	Mandible	3.30 × 10	16
10	55	F	4	Maxilla	3.30 × 11.5	15
11	50	F	5	Maxilla	3.30 × 13	21
11	50	F	4	Maxilla	3.30 × 13	21
12	32	M	5	Maxilla	3.90 × 13	16

13	45	F	18	Mandible	3.90 × 8	24
13	45	F	19	Mandible	3.90 × 10	24
13	45	F	30	Mandible	3.90 × 8	24
14	35	F	28	Mandible	3.90 × 13	20
15	28	M	8	Maxilla	3.30 × 16	12
16	28	M	9	Maxilla	3.90 × 11.5	16
						Mean follow up 15.6 months

Radiographic comparisons between baseline and follow-up measurements are summarized in **Table 2**. At baseline, mean bone levels were 0.45 mm (±0.47) at the mesial sites and 0.57 mm (±0.69) at the distal sites. During follow-up, these values increased slightly to 0.59 mm (±0.42) mesially and 0.78 mm (±0.59) distally. These changes were not statistically significant for either the mesial (p = 0.30) or distal (p = 0.17) sites. However, a significant difference was observed for the mesial bone levels in the maxilla, which increased from 0.39 mm (±0.31) at baseline to 0.65 mm (±0.30) at follow-up (p = 0.046). No other comparisons between baseline and follow-up at mesial or distal sites reached statistical significance **(Table 3)**.

Table 2. Mean bone levels.

Bone Levels	Baseline Mean (SD)	Follow-Up Mean (SD)	p-Value
Mesial	0.45 (0.47)	0.59 (0.42)	0.30
Distal	0.57 (0.69)	0.78 (0.59)	0.17

Table 3. Bone levels according to site location.

		Baseline Mean (SD)	Follow-Up Mean (SD)	p-Value
Maxilla (N = 11)	Mesial	0.39 (0.31)	0.65 (0.30)	0.046
	Distal	0.44 (0.29)	0.78 (0.39)	0.09
Mandible (N = 14)	Mesial	0.5 (0.57)	0.54 (0.50)	0.87
	Distal	0.68 (0.88)	0.79 (0.73)	0.65

At follow-up, the average peri-implant probing depth for maxillary implants increased significantly compared to baseline (1.70 ± 0.7 mm vs. 2.20 ± 0.59 mm, p = 0.0016), whereas no significant change was detected for implants in the mandible (**Table 4**).

Table 4. Mean peri-implant pocket depth of maxilla and mandible sites at baseline and follow-up.

	Baseline		Follow-Up		
	N	Mean (SD)	N	Mean (SD)	p-Value
Maxilla PPD	11	1.70 (0.37)	11	2.20 (0.59)	0.006
Mandible PPD	14	1.46 (0.35)	14	1.57 (0.60)	0.60

Discussion

Several studies have highlighted the critical role of implant neck design in both primary and secondary stability, as well as in the early biological events that drive peri-implant tissue formation [33-35]. Implants with narrow or convergent necks tend to exert less stress on the crestal bone, whereas those with divergent necks may compress the alveolar crest more heavily, potentially leading to greater stress and subsequent loss of peri-implant tissues [36, 37]. In the current study, all implants were bone-level and achieved high insertion torque, with the flat portion of the neck oriented toward the buccal bone, thereby minimizing local compression and stress. Prior research has demonstrated that bone-level implants with a roughened coronal surface achieve superior bone-to-implant contact compared to implants with polished necks [38, 39]. Conversely, polished-neck implants are often recommended for patients with a history of periodontal disease or higher risk of peri-implantitis, including smokers, those with poor oral hygiene, or systemically compromised individuals [35, 37, 40].

In this investigation, clinical and radiographic outcomes were evaluated after an average follow-up of 15.6 months. No significant changes in radiographic bone levels were observed between baseline and follow-up, except for a modest increase at the mesial site in the maxilla (baseline: 0.39 ± 0.31 mm; follow-up: 0.65 ± 0.30 mm, p = 0.046). These findings are consistent with a recent randomized controlled trial by Li Manni *et al.* [28], which compared triangular and conventional circular neck implants. After one year of loading, interproximal bone loss averaged 0.22 ± 0.30 mm for triangular neck implants and 0.42 ± 0.67 mm for circular neck implants (p = 0.25). Similarly, they found no significant differences in clinical or radiographic outcomes in the posterior maxilla between the two designs.

No significant differences in clinical parameters were observed in the present study between baseline and follow-up. D'Avenia *et al*. [30] reported favorable esthetic, clinical, and radiographic outcomes for triangular-neck implants after one year of function. Likewise, Nevins *et al*. [31] conducted a human histological study in which four patients received full-mouth reconstructions including eight triangular-neck implants in healed maxillary or mandibular ridges. A 0.2 mm gap was deliberately maintained between the implant neck and the surrounding bone; after six months of submerged healing, the mean bone-to-implant contact (BIC) was 68.58 ± 3.76 percent, with no significant differences observed between µCT and histological measurements. To date, this remains the only human histological evidence for this implant design.

Implant macro-design encompasses thread geometry, body and neck shape, and micro-morphology produced by surface treatments, including roughness depth, width, and topography [41]. Degidi *et al*. [42], in a retrospective histological and histomorphometric study of ten parallel-walled, condensing-thread, self-tapping apex implants, reported high BIC percentages, indicating that both macro- and micro-design contribute to long-term implant success. Similarly, de Andrade *et al*. [43] evaluated the impact of collar and thread variations on stress and strain distribution in maxillary bone, demonstrating that collar design predominantly influences cortical bone stresses. Montemezzi *et al*. [44] compared rough wide-neck versus reduced-neck implants in 97 healthy, partially edentulous patients and observed comparable survival rates over two years (96.61 percent vs. 95.82 percent).

The V3 implants used in this study feature a sandblasted and acid-etched roughened surface with micro-morphology and micro-rings at the neck, which have been shown to enhance bone-to-implant contact and reduce marginal bone loss [29-31]. Furthermore, the flat surfaces of the triangular neck create small gaps with the cortical bone, which appear to accelerate bone formation compared to regions of complete cortical contact [45].

Several in vivo studies [26, 29] have investigated the triangular neck configuration of implants, reporting comparable levels of osseointegration and increased buccal peri-implant hard tissue thickness relative to conventional designs. Although traditional implant designs may demonstrate slightly greater crestal bone height than V3 implants, these differences were not statistically significant. A recent randomized, prospective longitudinal study also evaluated the secondary stability of V3 implants, finding similar outcomes to round-neck implants after six weeks of healing [27].

In this study, implants were placed in healed alveolar ridges of varying widths without requiring bone grafting procedures. It can be hypothesized that orienting the flat side of the triangular neck toward the buccal bone increases the distance from this critical area, potentially reducing bone loss caused by compression, stress, or remodeling, and enhancing the stability of both hard and soft peri-implant tissues. Therefore, this implant design may be particularly advantageous in narrow alveolar ridges or in cases with high esthetic demands.

The V3 implant incorporates a platform-switching concept with a 12° conical connection, which may promote peri-implant tissue preservation by increasing the horizontal thickness of the soft tissue, improving the seal at the implant-abutment interface, and minimizing micro-movements. Multiple studies on platform switching have shown that using a narrower abutment relative to the implant diameter generally helps preserve, maintain, or even enhance surrounding soft and hard tissues [13, 46-48].

Research on immediate implant placement suggests that positioning the implant slightly palatally can create a gap between the implant and the buccal bone, which may be filled by a blood clot or regenerative material, thereby supporting an improved emergence profile and long-term peri-implant tissue health. Although the present study focused on partially edentulous patients with healed ridges, the triangular design of the V3 implant is particularly useful in immediate placement scenarios, as its three flat surfaces provide primary mechanical stability while allowing spaces that facilitate clot stabilization and bone regeneration.

Some limitations of this study should be noted: the relatively small sample size, limited number of implants and patients, inclusion of both maxillary and mandibular sites, a mixture of cemented and screw-retained restorations, lack of a standardized periapical radiograph protocol, absence of a control group for comparison, and relatively short follow-up duration.

Conclusion

Within the constraints of this prospective clinical study, the findings indicate that the V3 triangular neck implant provides a predictable and reliable option for the rehabilitation of partially edentulous patients over a mean follow-up of 15.6 months. The design appears safe and effective in clinical practice. Further studies with larger cohorts, including partially and fully edentulous patients and using both immediate and delayed placement protocols, are needed to better understand the mechanical and biological behavior of peri-implant hard and soft tissues around this triangular implant design.

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Ethics Statement: None

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