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Two-Year Follow-Up Case Series of Periimplant Health and Periimplant Bone Stability After Immediate Implant Placement of a Newly Developed Bone Level Implant System -A First Report

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Abstract

Introduction: Immediate placement of implants in extraction sites has been proven to be a reliable alternative to delayed implant placement. The present case series describes, for the first time, the two-year follow-up results of a newly developed implant design with an immediate placement procedure.

Materials and Methods: In a patient collective of 21 patients, 50 dental implants were immediately placed and investigated clinically and radiologically over an observation period of two years. Peri-implant health was investigated by measuring the buccal width and thickness of the keratinized peri-implant gingiva, probing depth and presence of bleeding on probing (BOP). Marginal bone loss was determined by standard radiographics andthe Pink Esthetic Score was evaluated to determine the aesthetic results.

Results: Two years after placement, none of the implants failed or presented peri-implantitis. All of the implants presented a sufficient amount keratinized soft tissue, low rates of probing depth (mean 2.25 mm) and presence of BOP (34 %). The peri-implant bone level was stable, with a mean bone loss after two years of 0.83 mm.

Conclusion: The observed bone level implant system with a rough surface and a conical implant-abutment connection has been shown to maintain peri-implant hard- and soft tissue health in immediately placed implants over a mean observation period of two years.

Keywords: *Immediate implant placement; Bone level implant; Marginal bone loss; Pink Esthetic Score*

Introduction

Dental implants have become a reliable and predictable treatment modality in dentistry to replace missing teeth and retain dentures in case of edentulism. Thereby the oral health, form, function, mastication, articulation and esthetics of the stomatognathic system can be restored with multiyear success rates of more than 90% for implants placed in fully edentulous [1,2] or partially edentulous patients [3-6]. Variations in implant success have been determined dependent upon surgical technique, loading protocol, implant localization and bone quality, as, for example, lower success rates have been reported for maxillary implants than for mandibular implants [7,8].

In the past few decades, research on dental implants has led to a broad modification of the surgical and prosthetic protocols. The initially described protocol of submerged healing with complete mucosal coverage during the osseointegration phase allows the isolation of dental implants from the oral cavity, avoids trauma and infection and establishes favorable conditions for an uneventful initial healing [9]. Beside submerged healing, further surgical and prosthetic protocols, such as transgingival healing, immediate implant placement and immediate loading of dental implants, have proven to enable long-term stable clinical and aesthetical results [10-14]. The ultimate aim of implant placement, especially but not only, in cases of tooth loss in the aesthetic zone is the preservation of hard and soft tissue after tooth

loss to restore function and aesthetics. Different techniques have been reported for preserving the alveolar ridge morphology [15,16], such as guided bone regeneration [17], Socket preservation [18-20], immediate implant placement [21-24] and different combinations of the above mentioned options [15,25].

Especially in the esthetic zone, the maintenance of hard and soft tissue is of striking importance to achieve highly aesthetic results. The extraction of the front tooth typically results in the loss of hard and soft tissue volume, especially in the fragile buccal bone. To compensate for these changes, which might compromise the esthetic results of prosthetic rehabilitation, immediate implant placement in combination with minimally invasive extraction techniques that cause minimal trauma to the remnant tissues have been established in the past few years [26].

Beside anatomical considerations, such as the bone and soft tissue amount and quality, an implant system fulfilling specific technical and constructional demands is required for long-term implant success [27].The integration of material, physical, chemical, mechanical, biologic, and technical factors provides the osseointegration of dental implants and therefore long-lasting anchorage in the peri-implant bone [27]. Currently, numerous implant systems, varying in a range of sizes, shapes, coatings, and prosthetic components, are available [28].

For the surface of dental implants there is a clear consensus regarding the superiority of roughened/micro-textured surfaces compared to machined surfaces to maximize the implant surface area contact with peri-implant bone. *In vivo* and clinical studies have proven that there is a significantly higher bone apposition and integration in implants with micro-textured surfaces [29]. Beside surface modification, other possibilities to increase the implant surface include the thread design, length and diameter of the implants. Further, the implant design should incorporate features that best transform tensile and shear forces during mastication and minimize undesirable force components [30].

A further essential factor for the long-term stability of peri-implant bone tissue and an aesthetically and functionally sufficient dental implant is the stability of the implant-abutment connection, as it prevents, on the one hand, implant fractures and screw loosening and, on the other hand, keeps the peri-implant bone level stable [31-33]. A space or micro-gap between the implant and abutment is due to the two-peace design unavoidable; however, a smaller micro-gap could be detected in a platform-switching and Morse-tapered conical connection design, which transfers the micro-gap facing the implant axis and reduces micro-movement. Thus, the pumping of sulcus fluid and, consequently, crestal bone loss can be reduced, even when the implant is inserted below the alveolar crest (subcrestally)[34,35].

The aim of the present case series was to describe the clinical and radiological results of a new implant system with a grit-blasted and acid-etched surface topography and a Morse locking conical implant-abutment connection. Implants were inserted in fresh, intact extraction sockets of non-salvageable teeth in the upper and lower jaw and were followed up clinically and radiologically after a mean loading time of 2 years. Special focus was set on maintenance of peri-implant health and stability of peri-implant bone level.

Materials and Methods

Case series/patient population

The present case series reports clinical and radiological results from 50 dental implants (C-Tech Implants Esthetic Line, C-Tech Implants, Bologna, Italy) that were placed immediately after the extraction of non-salvageable teeth in 21 patients (11 women, 10 men) in the HL Dentclinic in Baden Baden, Germany. Patients presented prior to implant placement with teeth that were not worth preserving in the mandible and maxilla. Implants were placed immediately after tooth extraction in case of an intact alveolar socket in the upper (31 implants) and lower (19 implants) jaw. A total of 10 implants, all of which were inserted in the upper molar region, were loaded immediately, while 40 implants were restored after a mean Osseointegration period of six months after the implants were placed. In total, 44 implants were restored with fixed, and 6 implants with removable prosthetics. After a mean loading period of two years, the placed implants were examined regarding implant survival, implant success and marginal bone loss. In some of the participating patients, further implants were placed delayed after tooth loss, and these implants were, therefore, not included in the present follow-up investigation.

C-Tech Implant system

In the present case series, dental implants of the Esthetic Line (EL, C-Tech Implants, Bologna, Italy) were placed. The implant system combines several design features that have proven to guarantee long-term stability, peri-implant health and favorable handling. The Bone Level Implants allow equi- or subcrestal setting and prevent exposure of the implant through bone resorption. They are therefore ideal for the esthetic zone. Implants are manufactured with three different threading profiles, adapted to different bone structures along the depth of the implant, and guarantee high grades of primary stability. Further, they have a beveled shoulder, which facilitates bone growth above the shoulder and a grit-blasted and acid-etched surface topography. Regarding the implant abutment connection, the implant provides a Morse locking conical connection with platform switching and an indexing hex. Therefore, peri-implant bone loss is prevented and the biological width can be preserved.

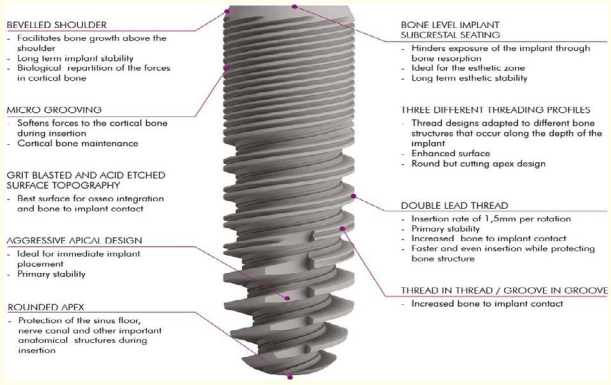

Figure 1: *Construction C-Tech EL Implants (Image provided by the manufacturer).*

Surgical procedure

Immediate implant placement was considered in case of teeth not worth preserving that were free of acute infections, with stable extraction sockets and sufficient bone quality and quantity to achieve a sufficient rate of primary stability. In all patients, implant placement and previous tooth extraction was performed under local anesthesia. After tooth extraction, a minimal-invasive mucoperiosteal flap without releasing incisions was mobilized for a better overview of the extraction site. Thereby, particular attention was paid to the buccal bone. In the upper incisor region, the implant position was set slightly palatinally in relation to the extracted teeth. Subsequently, implant bed preparation was performed according to the surgical protocol of the C-Tech dental implant system. The number, localization, length and diameter of the implants were planned by clinical patient investigation, analysis of jaw models and two- or three-dimensional radiographics (Dental volume tomography or panoramic radiographics). Implants were placed subcrestally with an insertion torque of at least 25 Ncm. A sealing screw was incorporated, and wound margins were adapted with absorbable tension-free single sutures.

In the case of delayed loading, implants were uncovered after a mean healing period of six months (4-7 months). In total, 44 implants were restored, with fixed and 6 with removable dentures. Medication after implant placement consisted of a Chlorhexidine 0.2% mouth rinse and 400 mg of Ibuprofen. In case of more than 2 implants or in combination with further augmentation procedures, additional antibiotics (Augmentin) were prescribed for 5 days.

Clinical follow- up investigation

Two years after implant insertion, a clinical and radiological follow up investigation was conducted at the HL Dentclinic Baden, Germany, according to previously published methods [36,37].

Patient	Gender (m/f)	Age (years)	Implant-lokalisation (Regio)	Implant-diameter (mm)	Implant-length (mm)	Loading protocol	Prosthetic rehabilitation
1	f	51	14	3,5	13	d.l.	f.p.
			11	3,5	13	d.l.	f.p.
			21	4,3	11	d.l.	f.p.
			24	3,5	13	d.l.	f.p.
			31	3	11	d.l.	r.p.
			41	3	11	d.l.	r.p.
2	m	74	21	3	11	d.l.	f.p.
			23	4,3	13	d.l.	f.p.
3	m	51	16	3,5	13	d.l.	f.p.
			24	3,5	13	d.l.	f.p.
4	f	54	25	3,5	13	d.l.	f.p.
5	m	69	14	3,5	11	d.l.	f.p.
			15	4,3	13	d.l.	f.p.
6	m	59	12	4,3	13	d.l.	f.p.
7	f	62	46	4,3	11	d.l.	f.p.
8	m	58	46	4,3	11	d.l.	f.p.
			26	4,3	11	d.l.	f.p.
9	f	65	12	3,5	13	d.l.	f.p.
10	f	66	15	3,5	11	i.l.	f.p.
			14	3,5	13	i.l.	f.p.
			13	3,5	13	i.l.	f.p.
			23	3,5	13	i.l.	f.p.
			24	3,5	13	i.l.	f.p.
			25	3,5	11	i.l.	f.p.
11	m	69	42	3,5	13	d.l.	f.p.
12	m	51	34	3,5	11	d.l.	f.p.
			46	4,3	11	d.l.	f.p.
13	f	64	15	3,5	13	d.l.	f.p.
14	f	71	44	3,5	11	d.l.	f.p.
15	f	69	36	3,5	11	d.l.	f.p.
16	m	54	22	3,5	13	d.l.	f.p.
			37	4,3	9	d.l.	f.p.
			47	4,3	11	d.l.	f.p.
17	f	47	13	3,5	11	d.l.	f.p.
			15	3,5	11	d.l.	f.p.
18	f	69	41	3	11	d.l.	f.p.
19	f	58	17	3,5	11	d.l.	f.p.
			21	3,5	13	i.l.	f.p.
			22	3,5	13	i.l.	f.p.
			23	3,5	13	i.l.	f.p.
			24	3,5	11	i.l.	f.p.

20	m	56	17	4,3	11	d.l.	f.p.
			27	3,5	11	d.l.	f.p.
			37	4,3	11	d.l.	f.p.
			46	3,5	11	d.l.	f.p.
			47	3,5	11	d.l.	f.p.
21	m	64	41	3,5	13	d.l.	r.p.
			43	3,5	13	d.l.	r.p.
			31	3,5	13	d.l.	r.p.
			33	3,5	13	d.l.	r.p.
Total:21	11*f; 10*m	Mean: 61	total:50; 31*u.j, 19*l.j.	4*3mm, 34*3,5mm, 12*4,3mm	1*9mm, 25*11mm, 24*13mm	10*i.l., 40*d.l.	44*f.p., 6*r.p

Table 1: *Participating patients and the number and site of the inserted implants.*

f: female; m: male; d.l.: delayed loading; i.l.: immediate loading; f.p.: fixed prosthetics; r.p.: removable prosthetics; u.j.: upper jaw; l.j.: lower jaw

The following parameters were investigated: implant survival, i.e. implants being in situ, width and thickness of peri-implant keratinized gingiva (in mm); pink esthetic score (PES); probing depth (in mm); bleeding on probing (BOP); peri-implant bone loss (in mm); and presence of peri-implant osteolysis. Probing depth was measured with a blunt periodontal probe at six sites (mesio-buccal, buccal, distal-buccal, mesio-oral, oral, disto-oral). The width and thickness of keratinized peri-implants soft tissue was measured with a pointed calibrated probe at standardized measuring points around the implant.

For the PES assessment, frontal photographs of implants restored with fixed prosthetics (44 implants) were taken, including the opposite/neighboring teeth for comparison. The photographs were composed into a presentation in random order. Three independent, experienced blinded investigators familiar with the PES scoring method reviewed all of the images on the same portable computer. The score was computed by adding the point score (from 0='very bad' to 2='excellent') for the seven items (mesial papilla, distal papilla, soft-tissue level, soft-tissue contour, alveolar process deficiency, soft-tissue color and texture) for a maximum score of 14. Further, peri-implant bone loss was investigated by digitally recorded panoramic radiographics taken routinely after implant insertion and upon reexamination. Bone loss was estimated with radiological software appropriate for the X-ray system.

With these examinations, the ability of the inserted implant system to maintain implant stability, peri-implant health and peri-implant bone was determined after a mean loading time of two years.

Investigation parameters:

- Implant being in situ
- Width and thickness of peri-implant keratinized gingiva
- Pink esthetic score (PES)
- Probing depth
- Bleeding on probing (BOP)
- Peri-implant bone loss
- Presence of peri-implant osteolysis

Results

Clinical Results

Altogether, 50 implants were placed after the extraction of non-salvageable teeth: 31 implants were placed in the upper jaw and 19 implants in the lower jaw. The implant diameter varied between 3 mm (4 implants), 3.5 mm (34 implants) and 4.3 mm (12 implants). The implant length varied between 9 mm (1 implant), 11 mm (25 implants) and 13 mm (24 implants). A total of 10 implants, all in the upper jaw, were restored and loaded immediately, and 40 implants were delay loaded after a mean healing period of 6 months (4-7 months). Prosthetic restoration consisted of fixed prosthetics (44 implants) and removable prosthetics (r.p.) (6 implants) (see Table 2).

During the two-year follow up investigation, all of the placed implants were in situ and suitable for prosthetic rehabilitation, which corresponded to an overall survival rate of 100%. It must be mentioned that in none of the implants prosthetic complications, such as screw fracture, abutment fracture or loss of retention were present during the two-year window.

Analysis of the width and thickness of the peri-implant keratinized gingiva was conducted to determine a potential correlation between keratinized peri-implant gingiva, a potential inflammatory response and peri-implant bone loss and peri-implant osteolysis. Around all of the implants, a band of keratinized gingiva of at least 1-mm width and thickness could be measured. The mean width of the peri-implant keratinized gingiva was 2.04 mm (upper jaw: 2.19 mm; lower jaw: 1.79 mm), and the mean thickness of peri-implant keratinized gingiva was 1.66 mm (upper jaw: 1.77; lower jaw: 1.47). No significant correlation between the width and thickness of the peri-implant gingiva and probing depth, BOP and marginal bone loss could be detected.

Patient	Implantlo-kali-sation (Regio)	Implant-loss (+/-)	buccal width of keratinized peri-implant gingiva (mm)	buccal thickness of keratinized peri-implant gingiva (mm)	Pink Esthetic Score (PES)	Probing depth (mm) at six sites (mb, b, db, mo, o, do)	Bleeding on Probing (BOP) (+/-)	Peri-implant bone loss (mm) mesial and distal	Presence of peri-implant osteolysis (+/-)
1	14	-	2	3	11	4,3,2,3,3,3	+	0.7; 0.5	-
	11	-	3	2	12	3,3,2,2,2,3	-	0.5; 0.9	-
	21	-	3	2	12	3,3,2,2,2,3	-	0.6; 0.8	-
	24	-	2	3	10	2,2,3,3,3,2	-	0.8; 0.9	-
	31	-	2	1	r.p.	2,2,1,1,1,2	-	1.1; 0.7	-
	41	-	2	1	r.p.	2,2,1,1,1,2	-	0.4; 0.6	-
2	21	-	2	2	12	4,2,3,2,2,3	+	1.1; 0.6	-
	23	-	3	3	11	3,2,3,3,3,2	-	0.5; 0.7	-
3	16	-	1	1	9	3,1,3,3,1,3	-	0.7; 0.6	-
	24	-	2	1	11	2,1,2,2,1,2	-	0.8; 0.5	-
4	25	-	2	1	11	3,1,2,2,1,2	-	0.7; 1.2	-
5	14	-	2	2	11	4,2,2,2,2,3	+	0.6; 0.8	-
	15	-	1	2	10	3,2,2,3,1,4	+	1.4; 0.7	-
6	12	-	3	2	12	4,2,3,2,2,3	+	1.1; 0.8	-
7	46	-	1	1	9	2,1,3,2,1,3	-	0.8; 0.7	-
8	46	-	2	2	10	4,2,3,2,2,3	-	0.6; 0.6	-
	26	-	3	2	11	3,3,2,2,2,3	-	0.8; 1.0	-
9	12	-	2	1	12	3,1,2,3,1,3	+	1.2; 1.4	-
10	15	-	2	1	11	3,1,2,3,1,4	+	0.8; 0.6	-
	14	-	2	1	12	3,2,1,1,2,2	-	1.2; 0.8	-
	13	-	3	2	12	3,3,2,2,3,2	-	1.4; 1.2	-

	23	-	3	2	12	3,3,2,2,2,3	-	1.1; 1.3	-
	24	-	2	2	12	2,1,2,1,1,2	-	0.6; 0.8	-
	25	-	1	1	11	3,2,2,3,1,2	-	0.5; 0.5	-
11	42	-	2	1	10	3,1,3,4,1,3	+	1.2; 0.9	-
12	34	-	2	2	11	2,2,3,2,1,3	-	1.2; 0.9	-
	46	-	1	1	10	3,2,2,2,1,3	-	0.8; 0.5	-
13	15	-	2	2	11	3,2,2,2,1,3	-	0; 0.4	-
14	44	-	1	2	13	4,2,1,2,2,3	+	0.4; 0.8	-
15	35	-	2	1	11	3,1,2,1,1,3	-	1.2; 0.6	-
16	22	-	2	2	13	2,2,3,2,1,3	+	1.4; 1.2	-
	37	-	1	2	11	2,1,2,2,2,1	-	0; 0.5	-
	47	-	1	3	12	2,1,3,3,2,2	-	0.7; 0.9	-
17	13	-	3	2	11	4,2,3,2,2,3	+	1.0; 1.2	-
	15	-	2	2	11	2,1,2,3,2,2	-	0.8; 0.6	-
18	41	-	3	2	10	4,2,3,2,2,3	+	0; 0.4	-
19	17	-	1	2	9	3,2,3,2,2,3	-	0.8; 1.4	-
	21	-	2	2	10	2,1,3,2,2,2	-	1.2; 0.7	-
	22	-	2	2	11	2,1,3,4,2,2	+	0.6; 0.6	-
	23	-	3	2	11	3,3,2,2,2,3	+	0.4; 0	-
	24	-	2	1	11	2,1,2,3,1,2	-	0.6; 0.9	-
20	17	-	2	1	10	4,1,2,3,1,3	-	1.0; 1.2	-
	27	-	3	1	9	3,2,3,2,1,3	-	1.6; 1.4	-
	37	-	1	1	10	2,1,3,2,1,2	-	0.9; 1.3	-
	46	-	1	1	11	3,2,2,1,1,2	-	1.7; 1.5	-
	47	-	1	1	10	4,2,2,3,3,3	+	1.2; 0.9	-
21	41	-	3	1	r.p.	3,1,2,1,1,3	-	0.6; 0	-
	43	-	2	2	r.p.	3,2,2,4,2,2	+	0.8; 1.3	-
	31	-	3	1	r.p.	3,2,2,3,1,3	-	1.3; 1.0	-
	33	-	3	2	r.p.	3,1,3,2,2,3	+	0.8; 0.6	-
Total:21	Total:50; 31*u.j; 19*l.j.	Total: 0	Mean total: 2.04mm; Mean u.j.: 2.19mm; Mean l.j.: 1.79mm	Mean total: 1.66mm; Mean u.j.: 1.77mm; Mean l.j.: 1.47mm	Mean total: 10.91; Mean u.j.: 11.03; Mean l.j.: 10.62	Mean total: 2.25mm; Mean u.j.: 2.31mm; Mean l.j.: 2.14mm	Mean total: 34.0%; Mean u.j.: 35.5%; Mean l.j.: 31.6%	Mean total: 0.83mm; Mean u.j.: 0.85mm; Mean l.j.: 0.8mm	0

Table 2: *Results from the clinical and radiological two-year follow-up investigation.*

mb: mesio-buccal; b: Buccal; db: disto-buccal; mo: mesio-oral; o: oral; do: disto-oral; +: present; -: absent; f.p.: fixed prosthetics; r.p.: removable prosthetics; u.j.: upper jaw; l.j.: lower jaw

The probing depths and BOP were assessed with a blunt periodontal probe to describe the condition of the peri-implant soft tissue and to determine potential inflammation. The mean probing depth, measured at six sites per implant, was 2.25 mm. BOP was present on

17 of the 50 implants (corresponding 34.0 %). A distinct correlation between accumulation of plaque and increased probing depth could be observed, as most implants with BOP presented probing depths of at least 3 mm.

The aesthetic appearance of the immediate placed implants was evaluated by the PES. The measured items were mesial papilla, distal papilla, soft-tissue level, soft-tissue contour, alveolar process deficiency, soft tissue color and texture, with a point score of 0 to 2 (from 0='very bad' to 2='excellent'). The mean evaluated PES achieved for the immediate placed was 10.91 (ranging from 9 to 13; upper jaw: 11.03; lower jaw: 10.62), from a maximum point score of 14.

Radiological Results

Radiological images (Yoshida, Japan), recorded after implant placement to control the implant position and for the regular follow-up investigation after two years of loading, were investigated to determine the peri-implant bone level and uncover potential peri-implant osteolysis. Analysis showed that in all 50 implants there was a stable peri-implant bone level reaching the implant shoulder. Further, no osseous peri-implant defect was obvious in the groups. The mean bone loss calculated digitally was 0.83 mm (upper jaw: 0.85 mm; lower jaw: 0.8 mm), ranging from 0 to 1.7 mm.

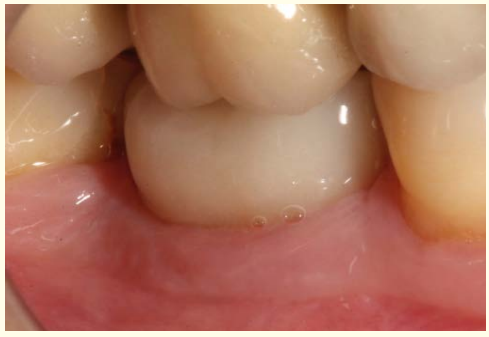

Figure 2: *Clinical image of patient 15 at the 2-year follow-up. Dental implant was inserted in regio 36 restored with fixed prosthetics.*

Discussion

The presented case series reports on a two-year follow-up investigation of a newly developed implant system placed immediately in fresh extraction sockets. Implants were analyzed regarding implant stability and peri-implant soft and hard tissue health by established methodology [36,37].

After a mean loading period of two years, all 50 inserted implants were in situ and useable for prosthetic rehabilitation. The peri-implant tissue presented, in all cases, a long-term stable healthy condition, without signs of acute infection or peri-implantitis.

Investigation of the probing depths and BOP around the implants was performed as a marker for peri-implant soft tissue health. The values for the probing depths (mean: 2.25 mm) and BOP (mean: 34%) were in accordance with the values found in the literature [38,39] When comparing the probing depths and BOP on dental implants and natural teeth, it always has to be mentioned that the anatomy and morphology of the peri-implant soft tissue structure is unlike that of natural teeth, as dental implants do not possess a compact barrier against the penetration properties of the oral cavity and they act more like a cuff-like barrier [40]. Further, the peri-implant soft tissue possesses a lower number of blood vessels [41,42] and cells, but a higher amount of collagen, which leads to a greater susceptibility to plaque-induced inflammation and bleeding [40,43]. Investigation of the mean peri-implant bone loss after two years of loading revealed 0.83 mm (upper jaw: 0.85 mm; lower jaw: 0.8 mm) after a mean period of loading of two years. The peri-implant bone around all 50 implants reached the implant shoulder and showed no signs of acute peri-implant osteolysis or peri-implantitis.

Immediate implant placement presents a reliable and promising technique to replace teeth not worth preserving and, at the same time, decreases the treatment time for patients and clinicians. By immediate implant placement, especially in the esthetic zone, the fragile

buccal bone, which is most important for an esthetically sufficient result, can be preserved. A further approach to achieve fast oral rehabilitation is the immediate loading of the placed implant, which requires a high primary stability of the placed implant. The prerequisites for both immediate placement and immediate loading of dental implants is an intact extraction site and an awareness of any acute inflammation within the same [26,44,45].

In the past, numerous studies have investigated the impact of immediate implant placement on implant failure, the occurrence of postoperative infection and the magnitude of marginal bone loss [13,46]. In a clinical study evaluating long-term bone stability up to 12 years by radiographic analysis, it was shown that 312 implants with an anodic oxidized surface presented a mean bone loss of 0.4 mm (± 0. 80 mm)[46]. In a systematic review, Chrcanovic., *et al*. analyzed whether immediate placement of dental implants increased the rate of implant failure, postoperative infection or marginal bone loss. This meta-analysis of a high number of reviewed publications (73) comparing implants in fresh extraction sockets to implants inserted in healed sites revealed no significant difference in failed implants (4.00% in fresh extraction sites, 3.09% in healed extraction sites), occurrence of postoperative infection or the magnitude of marginal bone loss[13].

The newly developed implant system used in the present case series is a bone level implant with a beveled shoulder, which allows for subcrestal insertion. Further, it has a thread design, varying in the crestal and apical portions of the implant, and it thus achieves a high rate of primary stability. The implant surface is grit-blasted and acid-etched, which, in combination with the thread design, achieves a large surface. The implant-abutment connection is a Morse locking conical connection with platform switching and an indexing hex, which aims to prevent peri-implant bone loss.

From the beginning of research in implant dentistry by Brånemark, it has become obvious that the most important factor for the longevity of dental implants is osseointegration. From previous research investigations it is known that primary stability in combination with a large surface are predictors for osseointegration [47]. The primary stability of the inserted implant within the implantation bed was found to be achieved by a progressive threat design and a combination of macro- and micro-groovings on the implant [48]. Further, modifications of the implant surface seemed to increase the rate of osteoblast accretion, which, in combination with primary stability, is the prerequisite for a sufficient and long-time stable osseointegration [49]. Especially in implants inserted immediately after tooth extraction, the achievement of a high rate of primary stability is of striking importance, as the extraction site determines the local bone amount and therefore the bone to implant contact [49]. A further important item in the construction of dental implants is the implant-abutment connection. Multiple in vitro and clinical investigations have shown that a conical connection in combination with internal platform switching reduces the micro-movement and thus bacterial contamination by pumping sulcus fluid, which results in marginal bone loss [34,35,50].

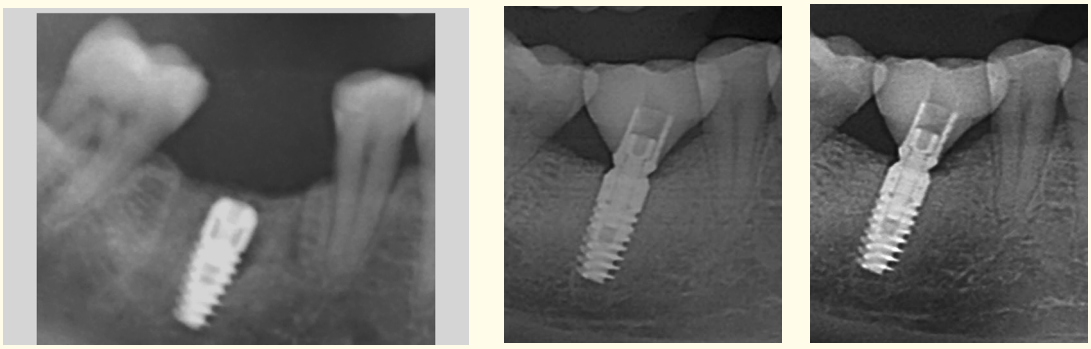

Figure 3: *Radiographic images of patient 15. (A) X-ray image of the implant placed immediately after extraction of tooth 36. (B) X-ray image of dental implant regio 36 one year after prosthetic rehabilitation. The bone level reaches the implant shoulder. (C) X-ray image of dental implant regio 36 at the 2-year follow up investigation. The peri-implant bone level is stable and no peri-implant osteolysis or bone resorption could be detected.*

With a combination of the aforementioned implant characteristics the investigated newly designed implant system seems to meet the requirements for a successful dental implant system. The results from the two-year follow-up investigation have demonstrated that immediate implant placement with the right implant system can, in certain cases, be a reliable and long-term stable approach to replace missing teeth and to restore articulation and mastication. In addition to all of the technical and surgical considerations, it has to be mentioned that, especially in immediate implant placement, a strict and cautious selection is necessary to achieve predictable outcomes.

Conclusions

The present retrospective analysis reports the results from a 2-year clinical and radiological follow-up investigation in 21 patients. A total of 50 implants of a newly developed implant system were placed immediately after extraction in the upper and lower jaw and were restored immediately or delayed. The focus in the follow-up investigation was on peri-implant hard and soft tissue health, by analyzing the buccal width and thickness of the keratinized peri-implant gingiva, probing depth, presence of bleeding on probing and marginal bone loss. Further, the aesthetic appearance of the implants and the implant-retained prosthetics were determined with the Pink Esthetic Score. All of the placed implants survived the two-year follow-up period without signs of peri-implantitis or acute peri-implant infections. All of the implants presented a sufficient amount of peri-implant keratinized soft tissue, low rates of probing depth (mean 2.25 mm), and presence of BOP (34%). The peri-implant bone level was stable, with a mean bone loss after two years of loading of 0.83 mm. Regarding the results from the two-year follow-up examination, it can be concluded that the investigated implant system affords a high rate of implant stability and adequate per-implant hard and soft tissue health. Immediate implant placement with a suitable implant system can, in certain cases, be a reliable, long-term stable and time- and cost-effective strategy to replace teeth not worth preserving.

Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the paper.

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