

Retrospective monocentric study

One-year clinical experience with Progressive-Line implants

Implants are now firmly established in dentistry with high success rates. The trend in patient perception is shifting towards minimally invasive procedures, shorter healing times, simultaneous augmentation, immediate loading and immediate placement. The following study shows that the Progressive-Line implants investigated are well suited for shortened treatment protocols or minimally invasive treatment. This made it possible to implant simultaneously with all sinus floor augmentation procedures, even if the residual bone height was greatly reduced. With an average torque of above 30 Ncm, immediate restoration is possible in many cases with D3 and D4 bone or with reduced bone supply. The flexible drilling protocol also makes the implants suitable for D1 and D2 bone, making the system a clinically universal one.

Introduction

Dental implantology has made continuous progress over the last 20 years. Today, success rates of 95%–99% are standard thanks to advanced implant design and surgical techniques [1]. A comprehensive meta-analysis evaluating 23 publications covering a total of 7,711 implants found an average implant survival rate of 94.6% over 13.4 years [2]. Now that the high success rate has been accepted as given, emphasis has shifted to more efficient and faster, minimally invasive surgical techniques in addition to functionality and long-term stability.

Provided that the indications and limitations of such techniques are well understood, the success rates are just as high as with conventional techniques [3, 4]. Here a distinction is made between immediate, delayed, and late implant placement. This classification refers to the time of implant insertion. Immediate placement is defined as insertion of the implant immediately after extraction into the unhealed extraction socket. Delayed placement is defined as insertion of the implant 4 to 6 weeks after the extraction; the gingiva will have healed over the socket at that time, but bony regeneration will not yet be complete.

Three months after extraction, the healing processes in both soft tissue and bone will be completed, and implant insertion performed at that point is considered late placement.

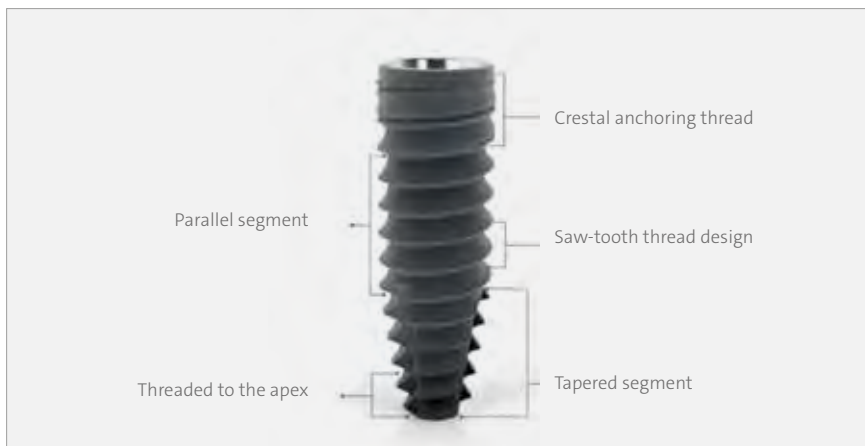
Another classification is that by loading protocol, where we must differentiate between immediate and delayed loading. Immediately loaded implants are loaded before complete osseointegration, which occurs on average 12 weeks after implant placement; usually the loading takes place immediately after implant placement. There are concepts with reduced occlusal forces (usually for single crowns) or full loading ab initio (usually designs with primary splinting involving fixed or removable multi-unit dental prostheses). Primary stability, i.e. the strength the implant derives solely from the anchoring of the implant thread within the bone, plays a determining role. The primary stability is usually measured by the insertion torque (in Ncm) or by resonance frequency analysis, RFA (in ISQ values). For immediate loading, ISQ values of > 65 and insertion torques of > 25 Ncm are recommended [5]. Immediate implant placement and immediate restoration are therefore two terms that must be fundamentally separated.

There are four different implantation protocols:

1. Immediate placement, immediate loading
2. Immediate placement, delayed loading (8–12 weeks after placement)
3. Late placement, immediate loading
4. Late placement, delayed loading (8–12 weeks after placement)

Unfortunately, the scientific literature often does not consider the different protocols separately, so that the study situation is very heterogeneous. In a retrospective analysis [3], found a two-year survival rate for immediately placed implants of 98.4%. A recent comprehensive meta-analysis included 69 studies of protocols 1 to 3 (see above) and demonstrated implant survival rates of 96%–100% [4]. Basically, and within their indication limits, the survival rates of the different implant placement protocols are very high and do not differ significantly.

Since the primary stability of an implant depends crucially on its surface design, implant systems are now available that have been specially developed for immediate implant placement and restoration. The Progressive-Line implant used in this study (Camlog, Wimsheim,



1 | Macrodesign of the camlog/conelog Progressive Line implant

Number of implants placed per patient	
n	%
1 implant	22 (30.6)
2 implants	29 (40.3)
3 implants	14 (19.4)
4 implants	3 (4.2)
6 implants	2 (2.8)
8 implants	1 (1.4)
12 implants	1 (1.4)

Table 1 | Number of implants placed per patient

0	13	25	9	10	4	4	3	1	4	5	12	7	27	16	0
18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
0	0	4	1	3	2	1	0	0	1	2	4	1	4	3	0

Table 2 | Implant position distribution

Germany) represents this new type of implant design. A combination of several properties optimizes the implant for immediate implant placement and restoration (Fig. 1).

The camlog Progressive-Line implant is a titanium implant with an SLA surface. The SLA coating extends to 0.4 mm below the polished implant neck, making it an RTT (rough-to-the-top) implant. The conelog implant has a conically shaped apical area. The crestal thread on the implant neck is intended to improve primary stability in cases with simultaneous implantation plus sinus lift and low residual bone height. The so-called saw-tooth thread is designed to increase primary stability in softer bone (classes

3 and 4 according to *Lekholm and Zarb*). The tapered implant apex with continuous thread to the end is designed to improve anchorage to the bottom of the alveolar socket in immediate implant placement. The manufacturer expects the parallel-walled central region of the implant to provide greater flexibility in vertical implant positioning and a linear increase in insertion torques.

Materials and methods

Between November 2018 and January 2020, a total of 72 patients were treated with 166 implants. Their mean age was 58.4 ± 13.9 years; the distribution per sex was balanced (male, 48%; female, 52%). Both smokers and non-smokers were in-

cluded in the study (12.5% : 87.5%). All implants were evaluated descriptively for bone quality, number, dimension, and position, augmentation (sinus lift, block augmentation), time of implant placement (immediate, delayed), and loading type of restoration, and implant survival rate.

A different number of implants was placed per patient (Table 1).

Of the implants, 140 were placed in the maxilla, primarily in the premolar and molar regions; 26 implants were placed in the mandible (Table 2).

All implants achieved primary stability. The average torque achieved was 31.6 ± 5.4 Ncm (15–40). To avoid possible complications due to excessive bone compression, the torque was reduced to 40 Ncm in cases with even higher insertion torques by alternating right-left rotations of the implant or by using the Dense Bone drill or taps (Table 3).

Seven implants were placed immediately after extraction and immediately restored, while the majority (159 implants) were placed in healed bone (late implant placement) and prosthetically restored only after an average healing time of 12 weeks. Among all implants, 66 were allowed to heal transgingivally and 100 implants by submerged healing.

		Frequency	Percent	Valid Percent
Valid	D1	3	1.8	1.8
	D2	46	27.7	28.0
	D3	70	42.2	42.7
	D4	45	27.1	27.4
	Total	164	98.8	100.0
Missing	System	2	1.2	
Total		166	100.0	

Table 3 | Bone density

The most frequently performed augmentation procedure was the internal sinus lift according to Summers. It was used with 125 implants. If the residual bone height was less than 5 mm, an external sinus lift was selected (Table 4). This was the case with 24 implants. In all cases, implantation was possible simultaneously with the external sinus lift; the lowest measured residual bone height was 2.4 mm. Even in this case, the inserted implant exhibited primary stability. Submerged healing was chosen for all 24 implants in this group, with site re-entry performed after an average of 12 weeks. A mixture of autologous bone and bovine bone replacement material was used as a graft. Autologous block augmentation was required for 35 implants. In the vast majority of cases ($n = 33$), implants were placed simultaneously; in 2 cases, a healing period of 3 months was prescribed for bone augmentation before implant placement.

After an average of 12 weeks, the implants were clinically and radiologically checked for osseointegration, and the submerged healed implants were exposed. The patients were then sent back to the referring dentists for restorative treatment. The vast majority of patients (92 %) received fixed crowns and bridges; 8 % of cases were fitted with removable restorations. At the end of the observation period, 103 implants had been restored; 63 implants had not yet been exposed or had not yet received a restoration.

Type of augmentation	n	%
Sinus, internal, single-stage	95	61.3
Sinus, external, single-stage	22	14.2
Block, single-stage	4	2.6
Sinus, external, single-stage; block, single-stage	2	1.3
Sinus, internal, single-stage; block, single-stage	27	17.4
Sinus, internal, single-stage; connective-tissue graft	3	1.9
Block, two-stage	2	1.3

Table 4 | Augmentation/Sinus floor elevation (sinus lift)

There was no case of implant loss during the study period; the implant survival rate was 100 %.

We have chosen a clinical case as an example:

The initial situation in the patient represented a critical case for the simultaneous sinus lift (Fig. 1). When preparing the sinus lift, special care was taken not to perforate the membrane. For this reason, the drillings were only widened in the crestal area, according to the drilling protocol (Fig. 2). A mixture of 70 percent autologous bone harvested from the maxillary tuberosity (Fig. 3) and drill chips, and 30 percent xenogenous bone grafting material was used to achieve the fastest and safest possible osseointegration. The cavity was initially loosely filled with the bone mixture (Fig. 4).

Since the implants must heal covered due to the extremely low bone height, they were closed with the screw (Fig. 5 to 7). The bone mixture was then placed compactly around the implants in the cavity (Fig. 8).

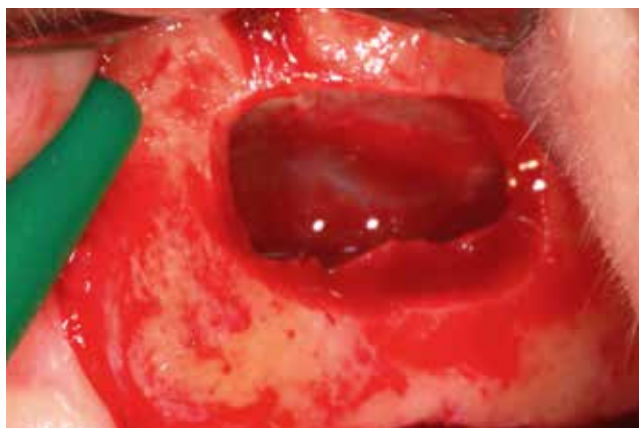
The bone graft which was stored in saline solution was placed over the vestibular window (Fig. 9). An x-ray image was made to check the augmentation with simultaneous implant placement (Fig. 10).

After taking the impression and fabricating the master models, abutment crowns were designed on titanium adhesive bases, fabricated from zirconium oxide in the CAD/CAM procedure and individually veneered (Fig. 11 to 16).

At the follow-up after 6 months the implant restoration was stable and in good hygienic condition. The gingival margin was not irritated (Fig. 17).



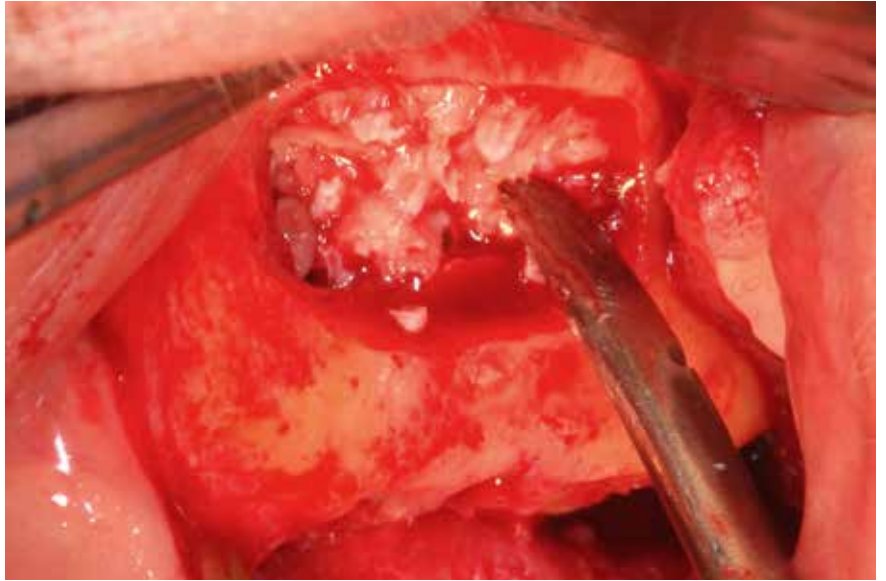
1 | Initial clinical situation



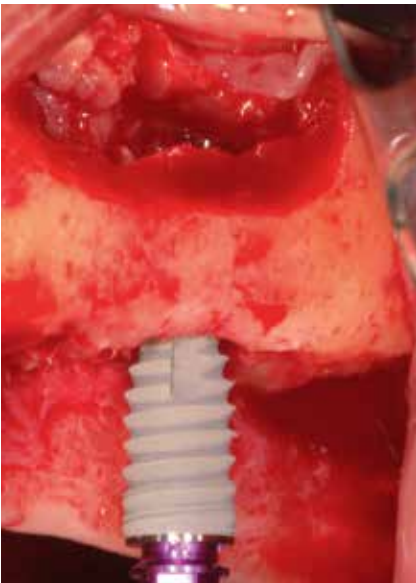
2 | Primed external sinus lift with view on the elevated Schneider's membrane.



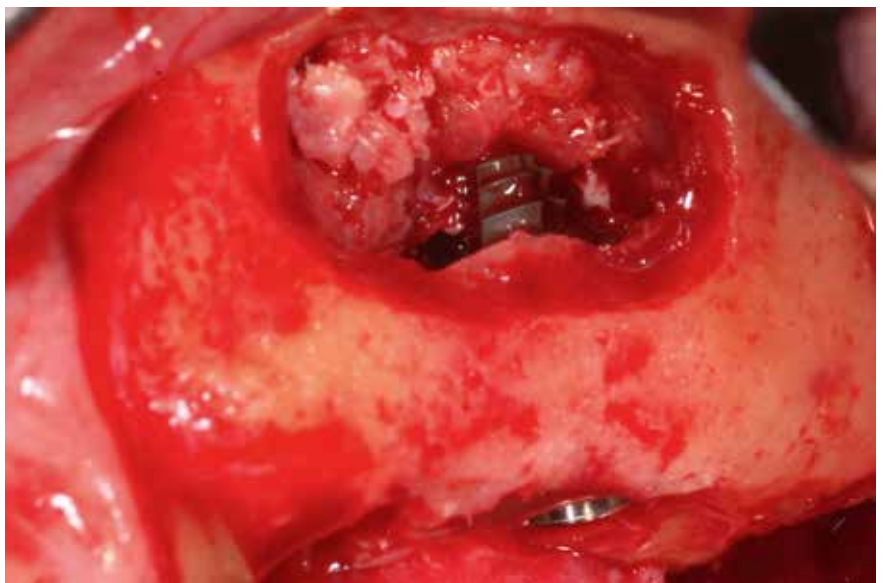
3 | Extraction of autologous bone chips



4 | Loose filling of the cavity with a mixture of autologous bone and bovine bone replacement material



5 | Implant insertion



6 | Distal implant in situ



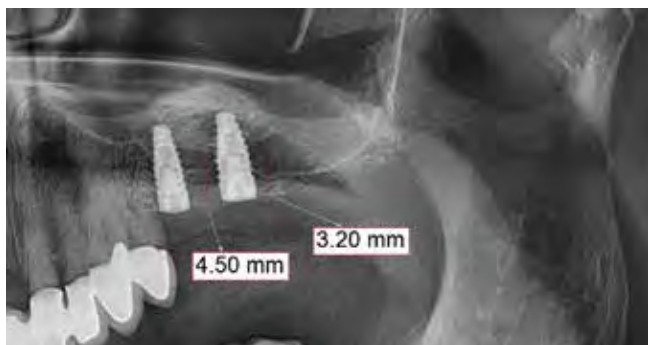
7 | Placed implants



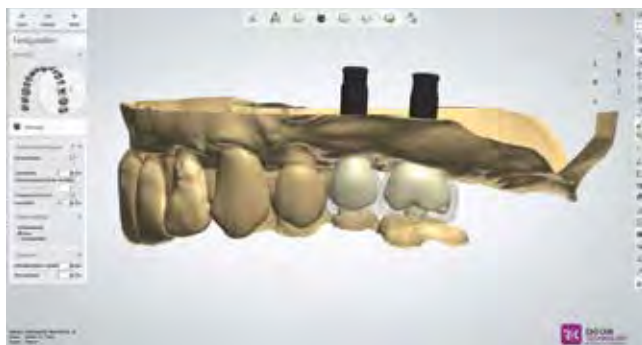
8 | Filling with autologous bone and bovine bone replacement material



9 | Replantation of the bone graft



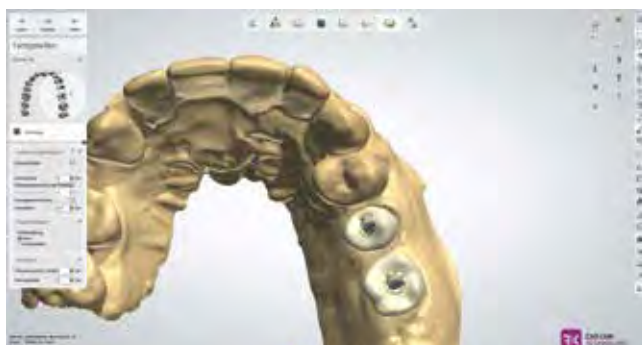
10 | Detail of the orthopantomogram immediately after surgery showing the residual bone height



11 | CAD/CAM construction as a hybrid abutment crown laterally



12 | CAD/CAM construction as a hybrid abutment crown frontally



13 | CAD/CAM construction as a hybrid abutment crown occlusal



14 | Adhesive abutments on the plaster model



15 | Finalization with molten mass



16 | Hybrid abutment crowns ready for insertion



17 | Crowns in place

A questionnaire was sent to both patients and referring dentists after the treatment was completed. The responses were tabulated anonymously.

Patients' questionnaire
(response rate: 55 of 72 questionnaires sent out were returned, 76.4%)

1. Where did you get information about implants/implant restorations before you went to the dentist or started therapy?

	Frequency	Valid %
From the internet	6	7.3
From friends/family	1	1.8
From the dentist	38	69.1
Got no information	3	5.5
Friends/family AND dentist	6	10.9
Internet AND dentist	2	3.6
Internet, friends/family, dentist	1	1.8
Total	55	100.0

2. Did you ask your treatment provider or family dentist for an immediate restoration (providing a dental prosthesis as soon as possible)?

	Frequency	Valid %	
Valid	Yes	19	35.2
	No	35	64.8
	Total	54	100.0

2.1 If yes, how did you feel about the treatment provider's/family dentist's attitude towards a quick restoration/treatment in as few sessions as possible?

	Frequency	Valid %	
Valid	Positive	18	62.1
	None discernible	8	27.6
	Negative	3	10.3
	Total	29	100.0

3. Were you proactively informed by your treatment provider/family dentist about the possibility of an immediate restoration before the treatment began?

	Frequency	Valid %	
Valid	Yes	24	46.2
	No	28	53.8
	Total	52	100.0

3.1 If yes, by whom?

	Frequency	Valid %	
Valid	Family dentist	18	72.0
	Treatment provider	7	28.0
	Total	25	100.0

3.2 Were the advantages and disadvantages explained to you?

	Frequency	Valid %	
Valid	Yes	24	85.7
	No	4	14.3
	Total	28	100.0

3.3 Were you given a cost comparison of the various restorative options?

	Frequency	Valid %	
Valid	Yes	16	57.1
	No	12	42.9
	Total	28	100.0

3.4 What was the primary reason an immediate restoration was agreed on?

	Frequency	Valid %	
Valid	Cost	1	7.7
	Dentist	3	23.1
	Aesthetics	5	38.5
	Treatment time AND aesthetics	1	7.7
	Necessity	1	7.7
	Costs, dentist, treatment time, aesthetics	1	7.7
	Dentist AND treatment time	1	7.7
	Total	13	100.0

3.5 What was the primary reason to reject immediate restoration?

		Frequency	Valid %
Valid	Dentist	1	10.0
	Treatment time	1	10.0
	Aesthetics	1	10.0
	Other	3	30.0
	Dentist AND aesthetics	2	20.0
	Fear of complications	1	10.0
	Not possible	1	10.0
	Total	10	100.0

4. Are you satisfied with the overall result of your implant restoration?

		Frequency	Valid %
Valid	Highly satisfied	38	73.1
	Satisfied	12	26.9
	Total	52	100.0

5. By hindsight, would you opt for the same treatment course again?

		Frequency	Valid %
Valid	Yes	48	90.6
	Uncertain	5	9.4
	Total	53	100.0

6. Was the result of the implant therapy worth the treatment cost?

		Frequency	Valid %
Valid	Yes	42	82.6
	Uncertain	9	17.4
	Total	51	100.0

7. How satisfied are you with the cooperation between your family dentist and the implanting dentist?

		Frequency	Valid %
Valid	Highly satisfied	40	76.9
	Satisfied	11	21.2
	Not satisfied at all	1	1.9
	Total	52	100.0

8. What was your main reason for choosing implant therapy?

		Frequency	Valid %
Valid	Recommendation by dentist	4	7.7
	Aesthetics	9	17.3
	Prosthetic reasons (fixed restoration, free palate, no bridge)	18	34.6
	Positive prior experience	7	13.5
	Other (necessity, durability, ...)	14	26.9
	Total	52	100.0

A1. In case of immediate restoration: would you consider a lengthier treatment course (late treatment with additional treatment appointments) if this were cheaper?

		Frequency	Valid %
Valid	No	18	66.7
	Yes, if at least 10% cheaper	4	14.8
	Yes, if at least 20% cheaper	5	18.5
	Total	27	100.0

B1. In case of late restoration: would you accept a higher risk of complications in the treatment for a faster treatment path (immediate restoration: fewer treatment appointments, aesthetic crown right from the start)?

		Frequency	Valid %
Valid	Yes	6	10.9
	No	49	89.1
	Total	55	100.0

B2. In the case of late restoration: would you accept a higher cost for an immediate treatment, i.e. a faster treatment course?

		Frequency	Valid %
Valid	Yes	11	20.8
	No	42	79.2
	Total	53	100.0

Referring dentists' questionnaire (response rate: n = 17, approx. 53%)

1. Where do you think your patients got their information about implants/implant restorations:
From the Internet?

		Frequency	Valid %
Valid	All	1	5.9
	More than half	9	52.9
	Few	3	17.6
	No data	4	23.5
	Total	17	100.0

From friends/family?

		Frequency	Valid %
Valid	All	3	17.6
	More than half	8	47.1
	Few	4	23.5
	No data	2	11.8
	Total	17	100.0

From the practice (waiting room, dental hygienist, dentist)?

		Frequency	Valid %
Valid	All	8	47.1
	More than half	7	41.2
	Few	1	5.9
	No data	1	5.9
	Total	17	100.0

Others?

		Frequency	Valid %
Valid	More than half	1	5.9
	No data	16	94.1
	Total	17	100.0

Got no information?

		Frequency	Valid %
Valid	Few	2	11.8
	No data	15	88.2
	Total	17	100.0

2. Is the healing time in oral implantology a reason for you to decide against implants?

		Frequency	Valid %
Valid	Yes	2	11.8
	No	15	88.2
	Total	17	100.0

3. Do your patients complain about problems with e.g. provisional restorations during the healing phase?

		Frequency	Valid %
Valid	Yes	13	76.5
	No	4	23.5
	Total	17	100.0

4. Type of problems (by category)

		Frequency	Valid %
Valid	Aversion to prostheses	1	10.0
	Fractures, retention	1	10.0
	Comfort	7	70.0
	Complete dentures	1	10.0
	Total	10	100.0

5. What is your assessment of the risk of complications for immediate restorations compared to late restorations?

		Frequency	Valid %
Valid	Identical risk	2	12.5
	Slightly elevated risk, 1%)	4	25.0
	Elevated risk, 60%	1	6.3
	Elevated risk, 20%	3	18.8
	Elevated risk, 50%	1	6.3
	Elevated risk, 30%	3	18.8
	Elevated risk, 10%	1	6.3
	Elevated risk, 40%	1	6.3
	Total	16	100.0

5. How many of your patients ask about immediate restorations?

		Frequency	Valid %
Valid	All of them	1	5.9
	Two-thirds of them	2	11.8
	One-third of them	1	5.9
	Hardly any of them	13	76.5
	Total	17	100.0

6. Did you proactively inform patients about the possibility of immediate restorations and alternatives?

		Frequency	Valid %
Valid	Yes	2	11.8
	No	15	88.2
	Total	17	100.0

7. Do your patients accept healing periods of several months, or do you have a feeling that patients may decide against implants because of the healing times?

		Frequency	Valid %
Valid	Healing times accepted by patients	10	58.8
	Healing times a reason to opt against implant treatment	5	29.4
	50/50: healing time, for/against implant treatment	2	11.8
	Total	17	100.0

Results

The implants were placed mainly in D3 and D4 bone (*Lekholm* and *Zarb* bone classes) (D3, 42.7%; D4, 27.4%). The number of implants inserted per patient varied (1–12 implants per patient), cases with one (30.6%) and two (40.3%) implants being the most frequent. The average insertion torque achieved was 31.6 ± 5.4 Ncm; all implants exhibited primary stability. Of the implants, 140 were placed in the maxilla and 26 in the mandible. Augmentation was performed in 93.4% of cases, most frequently an internal (61.3%) or external (14.2%) sinus lift, with simultaneous implant placement in all cases. Seven implants were immedi-

ately placed and also immediately loaded (immediate restoration with fixed dental prostheses). The majority of 159 implants were placed more than 3 months after extraction (late implant placement) and not restored prosthetically until after healing. A total of 66 implants healed transgingivally, while submerged healing was selected for 100 implants. 39.8% of implants healed transgingivally: for 60.2%, submerged healing was chosen. A combination of immediate implant placement and immediate loading was performed in 4.2% of cases. No complications were seen. The implant survival rate was 100%. The mean healing time until the final prosthetic restoration was 12 ± 6

8. Would the possibility of offering more immediate restorations in your practice be an important advertising tool or unique selling point?

		Frequency	Valid %
Valid	Yes	8	50.0
	No	7	43.8
	“Good question”	1	6.3
	Total	16	100.0

9. How satisfied are you with the cooperation as a referring dentist so far?

		Frequency	Valid %
Valid	Highly satisfied	14	82.4
	Satisfied	3	17.6
	Total	17	100.0

weeks. No complications occurred during the observation period of the study.

In addition to the implant evaluation, an anonymous questionnaire was submitted to both patients and referring dentists/prosthodontists. The evaluation of the patient questionnaire showed that 35.2% of patients had asked for an immediate loading or restoration of their own accord, while 46.2% were informed of the option by the treatment provider. Regardless of the chosen type of restoration, all patients were satisfied with their treatment outcomes (very satisfied, 73.1%; satisfied; 26.9%), and 90.6% would opt for the same treatment again. However, only few patients were prepared to ac-

cept higher costs or an elevated risk to enjoy a faster treatment course (higher costs, 33.3 %; elevated risk, 10.9 %).

Evaluation of the referrer questionnaire showed that healing time is a criterion that informs implant decisions for only 11.8 %. On the other hand, 76.5 % reported their patients had problems with their provisional restorations during the healing period (pressure sores, reduced comfort or aesthetics, restorative complications such as fractures, etc.). Of all dentists, 76.5 % said they were rarely or never approached by their patients about immediate restoration concepts; 29.4 % see healing periods of several months as a reason for patients to reject implant treatment; 87.5 % fear an increased risk of complications with immediate restorations. Around half of respondents believe that more immediate restorations in their practice could be an important advertising tool or unique selling point.

Discussion

Concepts for immediate implant placement or immediate loading have become increasingly salient in the perception of both patients and dentists. While initially, only the primary splinting of 4 interforaminal implants in the mandible for restoration with an overdenture prosthesis had been scientifically recognized, in 2002, the German Society of Implantology (DGI) published a statement by its president *Professor Friedrich W. Neukam* on immediate loading without limiting contraindications. Today it is scientifically well documented that within the indications and limits of these techniques, success rates are comparable to those of delayed loading or placement [3, 4].

There is consensus in the literature that ISQ values > 65 or an insertion torque of > 25 Ncm facilitate safe immediate loading, at least for designs with primarily splinting; for single teeth, the values should be higher [5]. Whether the highest possible insertion torque should be aimed for regardless of the circumstances has been controversial in the literature. The clinical study by [6] found no negative effects on implant survival or crestal bone loss within 3 years despite very high insertion torques of 76.1 ± 20.8 Ncm. By contrast, [11] demonstrated the exact op-

posite effect in their 3-year study: the patient population with insertion torques > 50 Ncm showed significantly greater bone loss and significantly reduced implant survival rates than the group with torques of < 50 Ncm (cumulative success rates: 91.3 % at > 50 Ncm versus 98.2 % at < 50 Ncm). On the other hand, a recent meta-analysis of the available literature suggests that insertion torques of > 50 Ncm do not have a negative impact on implant survival rates, but encourages further investigations [7]. However, it must always be remembered that very high torques also mean a risk of implant or abutment/screw fractures.

Internal and external sinus lifts have been scientifically documented for 30 years. Several literature meta-analyses have shown high survival rates for implants in combination with internal or external sinus lift procedures [8, 9]. Implant placement simultaneously with sinus lift procedures reduces patient morbidity as well as the number of surgical procedures and is therefore preferable. A prerequisite for this is the primary stability of the implants in the existing residual bone [10]. The present study shows that the crestal anchoring thread made it possible to place the implants investigated with primary stability in all cases, even in patients with very low residual bone heights of < 3 mm. Therefore, all patients in the study group could be implanted simultaneously with the sinus lift, regardless of whether an internal or external sinus lift was chosen. The implant survival rate was 100 % during the observation period.

The evaluation of the referring dentist and patient questionnaires showed that many patients are now aware of techniques for immediate restoration or immediate implant placement. Thus, 35.2 % of patients proactively requested immediate implantation or restoration. However, the majority of patients do not consider shortened healing times to be the determining factor for or against implant treatment. Irrespective of the selected implantation and restoration protocol, patient acceptance of the chosen method was very high (very satisfied, 73.1 %; satisfied; 26.9 %). Higher costs for immediate placement or restoration would be accepted by 20.8 % of patients;

only 10.9 % would be prepared to accept an elevated risk to this end.

In the perception of the referring dentists, there is still a clear level of distrust in immediate placement or restoration. Thus, 87.5 % of respondents fear an increased risk of complications compared to conventional late implantation/late restoration. This is not consistent with the scientific literature [3, 4]. Obviously, there is still a need for more information, information not available in postgraduate training and continuing education. Only 11.8 % of the referrers consider the duration of the healing time or the time until prosthetic restoration to be a factor against implants. However, problems with provisional restorations during the healing period are common (76.5 %). High-quality provisional restorations therefore seem to be more important than the duration of the healing period.

Conclusions

The thread design of the Progressive-Line implants used in this study makes them suitable for immediate implant placement and immediate loading techniques. Shorter healing times and less invasive surgical protocols with fewer procedures, e.g. simultaneous implantation with external sinus lifts, are possible without compromising implant survival rates. Immediate restoration concepts are playing an increasingly significant role in the patients' perception, but only few patients are prepared to accept higher costs or risks to this end. Regardless of the procedure chosen, patient acceptance of implant treatments is very high. The risks of immediate implant placement and immediate restoration are viewed much more critically by the majority of practitioners than the scientific literature justifies; there seems to be a need for more comprehensive information. ■

The references are available at www.teamwork-media.de/literatur

Contact address

Dr Jörg-Martin Ruppin
Dres. Ruppin & Kollegen
Bichler Straße 17
82377 Penzberg
Germany
dr.ruppin@implantzentrum-penzberg.de