A Multicenter Report on 1,022 Consecutively Placed ITI Implants: A 7-Year Longitudinal Study

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The aim of this multicenter study was to evaluate cumulative success and survival rates of ITI implants after 7 years. A complete medical report was obtained for all 440 patients enrolled in this investigation, which involved 10 different private practices. The 1,022 consecutively placed implants were distributed between completely edentulous, partially edentulous, and single-tooth replacement cases. During the annual follow-up visit, each implant was examined both clinically and radiographically using predefined success criteria. The cumulative survival and success rates were calculated for all implants. Implant subgroups were defined according to the medical history of the patients or pooled according to various indications, locations, implant designs, or implant lengths. In each subgroup, the related cumulative success rate was statistically compared to the global cumulative success rate. Fifteen implants (1.4%) were regarded as early failures, and at the end of the follow-up, the global failure rate reached 6.6%; 30 implants (3%) were lost to follow-up. At 5 years, the cumulative survival rate was 95.4%; this declined to 92.2% at 7 years. The weakest success rates were observed for implants placed in older patients, periodontally treated patients, and completely edentulous arches. Conversely, cumulative success rates that were significantly above average were observed for patients between 40 and 60 years old without pathology, implants placed after bone regeneration, solid-screw implants, implants placed in edentulous spaces, and implants placed as single-tooth replacements. This investigation has demonstrated that in these 10 private practice settings, the success rate for ITI implants remained high for up to 5 years and declined slightly between 5 and 7 years. It should be noted that in later year intervals, a relatively small number of implants remained for the analysis of cumulative success rates. (Int J Oral Maxillofac Implants 2000;15:691–700)

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A number of studies published in the last decade have permitted better appreciation of the long-term outcome of various oral implant systems[1–4] in partially edentulous[5–7] as well as completely edentulous patients.[8–10] In some studies, different implant systems were compared among each other[11–13] and in various locations.[14,15] Others have addressed submerged versus nonsubmerged implant placement.[16,17] However, because of the wide variety of protocols, comparison of these studies is difficult. In particular, the notions of survival and success have often been used in a confusing manner, although precise definitions are available.[18–20] It is generally accepted that evaluation of an implant system should be multicenter, with a minimum number of centers and patients as well as follow-up of longer than 5 years.[21]

The simplified technique of 1-stage nonsubmerged implant placement has largely contributed to the success of the ITI implant system (Institut Straumann AG, Waldenburg, Switzerland), to the extent that other implant systems are now incorporating the same procedure.[22,23] Among longitudinal follow-up studies of ITI implants, some involve 1 to

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3 years of observation,[4,24–26] medium-term studies observe implants for up to 5 years,[27] and very few studies have followed up implants for a longer term.[9] The only valid prospective, multicenter, long-term study has been published by Buser et al.[28] Multicenter studies are frequently conducted in hospitals by university-affiliated staff, under conditions and with results somewhat different from those encountered in an average private practice.

The aim of the present study was to evaluate, over a 7-year period and using precise predefined criteria, the fate of nonsubmerged, consecutively placed ITI implants in 10 private practices, analyzing factors that might have influenced the results.

MATERIALS AND METHODS

Patients

Four hundred forty patients, 184 males and 256 females 16 to 90 years of age (mean age 53 years), participated in this multicenter study. The patients were treated by 10 periodontists working in 10 different private practices. Prior to the beginning of the study, these periodontists were trained in the ITI Dental Implant System and belonged to the Groupe de Recherche et Etude en Parodontologie (REP group) in Toulouse, France.

A complete medical report permitted the disqualification of subjects with an untreated systemic disease. However, patients with a systemic disease (n = 98) such as diabetes or hypertension were not excluded, as long as these pathologies were treated and stabilized within normal biologic parameters. Smokers (n = 132) and patients with clenching or bruxing habits who exhibited signs of enamel and/or dentin wear (n = 66) were not excluded from the study. Prior to implant placement, some patients (n = 147) were treated for periodontal disease. This involved a hygienic phase consisting of scaling, root planing, and oral hygiene instructions, followed in some cases by periodontal surgery. All patients were enrolled in a periodontal maintenance program with regular professional plaque control. The patient population included 76 completely edentulous arches, 158 distal extension base situations, 150 extended edentulous spaces, and 101 single-tooth replacements.

Implants

A total of 1,022 ITI implants was consecutively placed between April 1991 and April 1999; 415 were placed in the maxilla and 607 in the mandible, with 346 in the anterior zone (zone 1) and 676 in the posterior zone (zone 2). In patients with insufficient bone volume (177 sites), a guided bone regeneration (GBR) procedure was performed either prior to or during implant placement using bioabsorbable collagen membranes (Paroguide, Pierre Rolland, Mérignac, France) with or without hydroxyapatite spacer (Biostite, Pierre Rolland, Mérignac, France). The 3 implant designs used were hollow screws (n = 464), solid screws (n = 251), and hollow cylinders (n = 307), with standard diameters and various lengths of less than 8 mm (n = 16), 8 mm (n = 232), 10 mm (n = 480), 12 mm (n = 276), and greater than 12 mm (n = 18).

Postsurgical Follow-up and Data Collection

After 6 months of healing, clinical and radiographic examinations were conducted before prosthetic rehabilitation to assess the success criteria previously defined by Albrektsson and colleagues[18] and adapted by Buser and coworkers.[28]

- Absence of functional signs of pain or discomfort
- Absence of inflammation or infection during the clinical examination
- Absence of mobility
- Absence of radiolucency or radiographically detectable bone loss

These examinations were repeated after each year of follow-up.

The results were established from life tables proposed by Cutler and Ederer,[29] which allowed the calculation of survival and success rates. Only implants fulfilling the previously defined criteria were included for the evaluation of success rates; the remaining implants were considered as failures or lost to follow-up. The cumulative success rate was calculated for each implant subgroup, so as to compare these rates with the global average using the reduced deviation test ($\varepsilon \leq 1.96$, $P \leq .05$). Thus, the influence of different parameters involving patients, indications, or implants could be assessed.

RESULTS

After 6 months of healing and before prosthetic rehabilitation, 13 implants were not osseointegrated and therefore were not loaded. After the first year, 15 implants had been lost, corresponding to an early failure rate of 1.4%.

Survival data for 1,022 implants over 7 years are presented in Table 1a. Implants with signs of periimplant infection and maintained by adapted antimicrobial treatment[30] were not considered failures. However, in Table 1b, where success rates are presented, implants not strictly fulfilling the predefined success criteria were considered as failures. Thirty

Table 1a Life Table Analysis and 7-Year Survival Data for 1,022 Implants

Interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Survival rate during interval (%)	Cumulative survival rate (%)
0 to 1	1022	2	1021	14	1.3	98.7	98.7
1 to 2	913	4	911	6	0.6	99.4	98.1
2 to 3	739	4	737	8	1.0	99.0	97.1
3 to 4	570	7	566.5	9	1.5	98.5	95.6
4 to 5	371	9	366.5	1	0.2	99.8	95.4
5 to 6	208	4	206	4	1.9	98.1	93.6
6 to 7	132	0	132	2	1.5	98.5	92.2

Table 1b Life Table Analysis and 7-Year Success Data for 1,022 Implants

Interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
0 to 1	1022	2	1021	15	1.4	98.6	98.6
1 to 2	913	4	911	12	1.3	98.7	97.3
2 to 3	739	4	737	8	1.0	99.0	96.3
3 to 4	570	7	566.5	13	2.2	97.8	94.2
4 to 5	371	9	366.5	2	0.5	99.5	93.7
5 to 6	208	4	206	8	3.8	96.2	90.2
6 to 7	132	0	132	10	7.5	92.5	83.4

implants (3%) were lost to follow-up following the death or moving away of some patients during the 7 years of observation. Sixty-eight other implants did not fulfill the success criteria, leading to a global failure rate of 6.6%.

Analysis with Respect to Patients

Because of the diversity of the patients treated, success rates were calculated according to age (under 40 years, 40 to 60 years, and over 60 years), medical health status, existence of a risk factor, and surgical corrections of the implantation sites (Tables 2 and 3).

For younger patients (< 40 years), the cumulative implant success rate (82.5%) was not different from the global success rate (83.4%). For patients aged between 40 and 60 years, the rate was significantly higher than the global mean (88.6%, $P < .01$, Table 2). In contrast, the implant success rate of older patients (> 60 years) was statistically lower (78.1%, $P < .02$, Table 2). While the cumulative implant success rate of healthy patients was significantly higher (88.8%, $P < .01$, Table 3) than the global success rate (83.4%), this rate was significantly lower for periodontally maintained patients (74.7%, $P < .001$, Table 3). The implant success rates of patients treated for systemic pathology and those presenting a risk factor (smoking or bruxism) were not significantly different from the global mean, in contrast to the higher success rate of patients treated by GBR (91.3%, $P < .01$, Table 3).

Analysis with Respect to Implant Location

Success rates were calculated according to the site of placement (maxilla or mandible and anterior or posterior) (Tables 4 and 5). Compared to the global mean, these success rates were not significantly different.

Analysis of Implant Types or Designs

Results relating to implant type/design are presented in Table 6. While the cumulative success rates for hollow-screw implants (82.3%) and hollow-cylinder implants (84.4%) were close to the global success rate, the same rate for solid-screw implants (94.7%) was higher than the global rate; this difference was statistically significant ($P < .00001$; Table 6).

The implants were divided into 3 groups according to their length (≤ 8 mm, 10 mm, and ≥ 12 mm), with success rates for each group being comparable to the global success rate (Table 7). Because of their small numbers, implants shorter than 8 mm (n = 16) and longer than 12 mm (n = 18) were regrouped in their respective classes of ≤ 8 mm or ≥ 12 mm.

Table 2 Life Table Analysis and 7-Year Success Data for Implants According to Patient Age

Patient age/ interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
Under 40 years							
0 to 1	116	1	115.5	1	0.8	99.2	99.2
1 to 2	107	0	107	0	0.0	100.0	99.2
2 to 3	89	0	89	0	0.0	100.0	99.2
3 to 4	76	1	75.5	0	0.0	100.0	99.2
4 to 5	49	1	48.5	0	0.0	100.0	99.2
5 to 6	25	1	24.5	1	4.0	96.0	95.2
6 to 7	15	0	15	2	13.3	86.7	82.5
40 to 60 years							
0 to 1	445	0	445	8	1.7	98.3	98.3
1 to 2	384	2	383	8	2.0	98.0	96.3
2 to 3	319	4	317	4	1.2	98.8	95.1
3 to 4	263	6	260	5	1.9	98.1	93.3
4 to 5	164	8	160	1	0.6	99.4	92.8
5 to 6	89	3	87.5	1	1.1	98.9	91.7
6 to 7	58	0	58	2	3.4	96.6	88.6*
Over 60 years							
0 to 1	461	1	460.5	6	1.3	98.7	98.7
1 to 2	422	2	421	4	0.9	99.1	97.8
2 to 3	331	0	331	4	1.2	98.8	96.6
3 to 4	231	0	231	8	3.4	96.6	93.3
4 to 5	158	0	158	1	0.6	99.4	92.7
5 to 6	94	0	94	6	6.3	93.7	86.9
6 to 7	59	0	59	6	10.1	89.9	78.1†

*Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 2.6$, $P < .01$).
†Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 2.4$, $P < .02$).

Analysis by Type of Edentulism

Implants placed in completely edentulous arches (Table 8) demonstrated a cumulative success rate that was significantly lower (76.5%, $P < .02$) than the global success rate, inversely to implants placed in edentulous spaces with more than a single missing tooth (89%, $P < .03$, Table 8). In distal-extension situations, implants had a success rate close to the global cumulative success rate (79.5%, Table 8). There were no failures in the single-tooth replacement group (Table 8), with, obviously, a maximum success rate (100%, $P < .00001$, Table 8).

DISCUSSION

To conduct this clinical investigation, all criteria required for prospective studies were respected.[21] Gathering data from 10 different private practices warrants a good reproducibility of results. Success criteria were strictly defined, including radiographic analysis. However, measurement of crestal bone changes was not done so as to avoid important variabilities between the 10 practices. A life table analysis according to Cutler and Ederer[29] was used for results analysis. A recent and similar study[28] demonstrated the advantages of this type of life table analysis: the survival and success rates were calculated, taking into account the implants lost to follow-up.

The 68 observed implant failures correspond to a global failure rate of 6.6%; 13 implants were lost in the first 6 months, for an 1.2% early failure, compared to the 0.55% failure rate reported by Buser and colleagues.[28] This difference could be explained by the more or less restricted selection of patients. Among 8 fractured implants (0.8%), most failures occurred between 2 and 4 years and involved only hollow implants. Other failures were either the result of peri-implant infection (n = 49, or 4.8%) or occlusal overload (n = 11, or 1%) (but without precise differentiation between these 2 etiologies). The rather high percentage of peri-implant infection could be related to the relatively significant proportion of periodontally maintained patients (33.4%). Indeed, there is a potential risk for peri-implant contamination from the periodontal pathogenic flora.[31] Among implants with peri-implant infection, 13 developed rather late (between the last 2 examinations).

Table 3 Life Table Analysis and 7-Year Success Data for Implants According to Patient Health Status, Risk Factors, and Surgical Status

Status/ interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
Healthy							
0 to 1	647	1	646.5	11	1.7	98.3	98.3
1 to 2	568	0	568	4	0.7	99.3	97.6
2 to 3	477	4	475	3	0.6	99.4	97.0
3 to 4	363	1	362.5	3	0.8	99.2	96.2
4 to 5	243	1	242.5	0	0.0	100.0	96.2
5 to 6	126	4	124	5	4.0	96.0	92.4
6 to 7	77	0	77	3	3.8	96.2	88.8*
Treated systemic disease							
0 to 1	235	0	235	4	1.7	98.3	98.3
1 to 2	226	2	225	5	2.2	97.8	96.1
2 to 3	193	4	191	3	1.5	98.5	94.7
3 to 4	151	0	151	3	1.9	98.1	92.9
4 to 5	112	0	112	0	0.0	100.0	92.9
5 to 6	63	0	63	2	3.1	96.9	90.0
6 to 7	37	0	37	5	13.0	87.0	78.3
Periodontally maintained							
0 to 1	375	1	374.5	4	1.0	99.0	99.0
1 to 2	345	4	343	8	2.3	97.7	96.7
2 to 3	262	0	262	5	1.9	98.1	94.8
3 to 4	207	6	204	10	4.9	95.1	90.2
4 to 5	128	8	124	2	1.6	98.4	88.7
5 to 6	82	0	82	3	3.6	96.4	85.6
6 to 7	55	0	55	7	12.7	87.3	74.7†
Risk factor							
0 to 1	386	1	385.5	9	2.3	97.7	97.7
1 to 2	359	2	358	4	1.1	98.9	96.6
2 to 3	294	2	293	4	1.3	98.7	95.3
3 to 4	227	0	227	4	1.7	98.3	93.7
4 to 5	158	3	156.5	0	0.0	100.0	93.7
5 to 6	78	4	76	1	1.3	98.7	92.5
6 to 7	44	0	44	6	13.0	87.0	80.5
GBR surgery							
0 to 1	177	0	177	2	1.1	98.9	98.9
1 to 2	157	0	157	2	1.2	98.8	97.7
2 to 3	137	0	137	0	0.0	100.0	97.7
3 to 4	113	2	112	0	0.0	100.0	97.7
4 to 5	76	1	75.5	0	0.0	100.0	97.7
5 to 6	38	0	38	1	2.6	97.4	95.1
6 to 7	25	0	25	1	4.0	96.0	91.3‡

*Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 3$, $P < .01$).
†Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 3.8$, $P < .001$).
‡Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 2.6$, $P < .01$).

The cumulative survival rate (92.2%) observed in this study is similar to those published by others for different implant systems. After 6 years, the cumulative success rate (90.2%) is above the generally admitted cumulative rate[21]; however, an important decrease in this rate (83.4%) occurred between 6 and 7 years, in contrast to the 93.3% reported by Buser and coworkers.[28] Comparison with other trials is irrelevant because of the large variation in studies.

Few studies have analyzed the influence of parameters such as age or past medical history of patients on implant success. The observed differences between various age groups are probably a consequence of anatomic and histologic variations in implantation sites, in addition to the temporal modification of bone remodeling. Also, older patients are more often completely edentulous, and for complete edentulism, the observed success rate was one of the lowest in the investigation.

Table 4 Life Table Analysis and 7-Year Success Data According to Implant Location (Maxilla or Mandible)

Location/ interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
Maxilla							
0 to 1	415	0	415	3	0.7	99.3	99.3
1 to 2	371	0	371	10	2.6	97.4	96.7
2 to 3	293	0	293	6	2.0	98.0	94.7
3 to 4	221	1	220.5	6	2.7	97.3	92.2
4 to 5	146	0	146	0	0.0	100.0	92.2
5 to 6	89	1	88.5	1	1.1	98.9	91.2
6 to 7	63	0	63	4	6.3	93.7	85.4
Mandible							
0 to 1	607	2	606	12	1.9	98.1	98.1
1 to 2	542	4	540	2	0.3	99.7	97.8
2 to 3	446	4	444	2	0.4	99.6	97.4
3 to 4	349	6	346	7	2.0	98.0	95.4
4 to 5	225	9	220.5	2	0.9	99.1	94.6
5 to 6	119	3	117.5	7	5.9	94.1	89.0
6 to 7	69	0	69	6	8.6	91.4	81.3

Table 5 Life Table Analysis and 7-Year Success Data According to Implant Location (Anterior or Posterior)

Location/ Interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
Anterior							
0 to 1	346	0	346	6	1.7	98.3	98.3
1 to 2	316	0	316	6	1.8	98.2	96.5
2 to 3	269	2	268	6	2.2	97.8	94.4
3 to 4	209	1	208.5	6	2.8	97.2	91.7
4 to 5	140	1	139.5	1	0.7	99.3	91.1
5 to 6	93	0	93	4	4.3	95.7	87.2
6 to 7	67	0	67	3	4.4	95.6	83.3
Posterior							
0 to 1	676	2	675	9	1.3	98.7	98.7
1 to 2	597	4	595	6	1.0	99.0	97.7
2 to 3	470	2	469	2	0.4	99.6	97.3
3 to 4	361	6	358	7	1.9	98.1	95.4
4 to 5	231	8	227	1	0.4	99.6	95.1
5 to 6	115	4	113	4	3.5	96.5	91.7
6 to 7	65	0	65	7	10.0	90.0	82.5

Patient selection was not too restricted, with a number of implants being placed in patients with treated systemic diseases. In these situations, the observed implant success rate demonstrated that treated systemic diseases are not absolute contraindications for implant placement. However, the success rate for healthy patients was higher than the overall success rate. The lowest success rate was observed in periodontally maintained patients, with a success rate below the minimum 5-year required rate. This observation is not surprising if one assumes that periodontal disease not only decreases available bone volume, but also affects the capacity of osseous tissue to remodel.[32] Indeed, diminished bone volume in this patient population led to the application of guided bone regeneration procedures at 177 sites. The practitioners involved in this study were all periodontists, with a high proportion of periodontally treated patients (33.5%), which in turn resulted in a reduced overall success rate. In contrast to what

Table 6 LifeTable Analysis and 7-Year Success Data with Respect to Implant Type

Implant type/ Interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
Hollow screw							
0 to 1	464	2	463	10	2.1	97.9	97.9
1 to 2	453	4	451	2	0.4	99.6	97.5
2 to 3	422	2	421	5	1.1	98.9	96.4
3 to 4	358	6	355	7	1.9	98.1	94.6
4 to 5	234	9	229.5	1	0.4	99.6	94.2
5 to 6	136	3	134.5	6	4.4	95.6	90.0
6 to 7	92	0	92	8	8.6	91.4	82.3
Solid screw							
0 to 1	251	0	251	1	0.3	99.7	99.7
1 to 2	169	0	169	4	2.3	97.7	97.4
2 to 3	71	1	70.5	0	0.0	100.0	97.4
3 to 4	37	0	37	1	2.7	97.3	94.7
4 to 5	17	0	17	0	0.0	100.0	94.7
5 to 6	6	1	5.5	0	0.0	100.0	94.7
6 to 7	4	0	4	0	0.0	100.0	94.7*
Hollow cylinder							
0 to 1	307	0	307	4	1.3	98.7	98.7
1 to 2	291	0	291	6	2.0	98.0	96.7
2 to 3	246	1	245.5	3	1.2	98.8	95.5
3 to 4	175	1	174.5	5	2.8	97.2	92.8
4 to 5	120	0	120	1	0.8	99.2	92.1
5 to 6	66	0	66	2	3.0	97.0	89.3
6 to 7	36	0	36	2	5.5	94.5	84.4

*Statistically signficant difference when compared to the cumulative success rate for 1,022 implants ($\epsilon = 4.5$, $P < .00001$).

Table 7 Life Table Analysis and 7-Year Success Data with Respect to Implant Length

Length/ Interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
8 mm or less							
0 to 1	248	0	248	4	1.6	98.4	98.4
1 to 2	224	1	223.5	3	1.3	98.7	97.1
2 to 3	182	2	181	2	1.1	98.9	96.0
3 to 4	143	0	143	4	2.7	97.3	93.4
4 to 5	87	2	86	1	1.1	98.9	92.4
5 to 6	43	1	42.5	1	2.3	97.7	90.3
6 to 7	27	0	27	3	11.1	89.0	80.3
10 mm							
0 to 1	480	1	479.5	8	1.6	98.4	98.4
1 to 2	440	3	438.5	6	1.3	98.7	97.1
2 to 3	374	2	373	5	1.3	98.7	95.8
3 to 4	289	7	285.5	4	1.4	98.6	94.5
4 to 5	180	5	177.5	0	0.0	100.0	94.5
5 to 6	94	3	92.5	4	4.3	95.7	90.4
6 to 7	55	0	55	4	7.2	92.8	83.9
12 mm or more							
0 to 1	294	1	293.5	3	1.0	99.0	99.0
1 to 2	249	0	249	3	1.2	98.8	97.8
2 to 3	183	0	183	1	0.5	99.5	97.3
3 to 4	138	0	138	5	3.6	96.4	93.8
4 to 5	104	2	103	1	0.9	99.1	92.9
5 to 6	71	0	71	3	4.2	95.8	89.0
6 to 7	50	0	50	3	6.0	94.0	83.7

Table 8 Life Table Analysis and 7-Year Success Data with Respect to Indication

Indication/ Interval (y)	No. of implants	Lost to follow-up	Under risk during interval	Failures during interval	Failure rate during interval (%)	Success rate during interval (%)	Cumulative success rate (%)
Completely edentulous							
0 to 1	208	0	208	4	1.9	98.1	98.1
1 to 2	198	0	198	8	4.0	96.0	94.1
2 to 3	175	2	174	4	2.2	97.8	92.1
3 to 4	128	0	128	4	3.1	96.9	89.2
4 to 5	84	0	84	1	1.1	98.9	88.2
5 to 6	61	0	61	3	4.9	95.1	84.0
6 to 7	45	0	45	4	8.8	91.2	76.5*
Distal extension							
0 to 1	447	2	446	9	2.0	98.0	98.0
1 to 2	385	4	383	2	0.5	99.5	97.5
2 to 3	300	2	299	2	0.6	99.4	96.9
3 to 4	243	2	242	4	1.6	98.4	95.3
4 to 5	169	5	166.5	1	0.6	99.4	94.8
5 to 6	79	3	77.5	4	5.1	94.9	89.9
6 to 7	43	0	43	5	11.6	88.4	79.5
Edentulous space (> 1 tooth)							
0 to 1	255	0	255	2	0.7	99.3	99.3
1 to 2	228	0	228	2	0.8	99.2	98.5
2 to 3	183	0	183	2	1.0	99.0	97.5
3 to 4	138	4	136	5	3.6	96.4	94.0
4 to 5	76	4	74	0	0.0	100.0	94.0
5 to 6	46	0	46	1	2.1	97.9	92.0
6 to 7	30	0	30	1	3.3	96.7	89.0†
Single-tooth replacement							
0 to 1	112	0	112	0	0.0	100.0	100.0
1 to 2	102	0	102	0	0.0	100.0	100.0
2 to 3	81	0	81	0	0.0	100.0	100.0
3 to 4	61	1	60.5	0	0.0	100.0	100.0
4 to 5	42	0	42	0	0.0	100.0	100.0
5 to 6	22	1	21.5	0	0.0	100.0	100.0
6 to 7	14	0	14	0	0.0	100.0	100.0‡

*Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 2.3$, $P < .02$).
†Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 2.2$, $P < .03$).
‡Statistically significant difference when compared to the cumulative success rate for 1,022 implants ($\varepsilon = 4.7$, $P < .00001$).

has been published,[33] smoking did not seem to negatively influence the results, probably because no threshold had been placed for the number of cigarettes smoked per day and because many smokers were light smokers (no more than 5 cigarettes/day).

For many investigators,[8,10,28] implants placed in the mandible are less prone to failures, whereas in this study, the opposite was observed. To explain this apparent contradiction, the distribution of different implant subgroups should be compared between the mandible and the maxilla (Table 9). Indeed, implants in older patients, with a lower success rate, were more frequently located in the mandible (62.3% versus 37.7% in the maxilla); the data are similar for implants in periodontally maintained patients (58.2% versus 41.8% in the maxilla) or in completely edentulous arches (74% versus 26% in the maxilla). The opposite was observed for 40- to 60-year-old patients (39.6% success versus 60.4% in the maxilla), after GBR (33.4% versus 66.6% in the maxilla), and for single-tooth replacements (31% versus 69% in the maxilla), all of which showed a higher success rate than the global success. Therefore, it seems that the random distribution of implants was not favorable for implants placed in the mandible.

In a recent 6-year prospective study of implants placed in the posterior regions,[34] success rates of 82.9% in the maxilla and 91.5% in the mandible were reported. These results are similar to those observed by Buser and colleagues[28] for the same observation period (86.7% and 95.4%) and are comparable to those observed in the present study 6 years after placement of posterior implants (91.7%). For anterior implants, the present results are less favorable and should be compared to implants placed in completely edentulous patients, particularly in the mandible.

Table 9 Maxillary and Mandibular Distribution of Implant Subgroups

	Patient age		Periodontally maintained	Guided bone regeneration	Completely edentulous	Single-tooth implants
	40 to 60 y	> 60 y				
Maxilla (n)	269	174	157	118	54	77
Maxilla (%)	60.4	37.7	41.8	66.6	26.0	69.0
Mandible (n)	176	287	218	59	154	35
Mandible (%)	39.6	62.3	58.2	33.4	74.0	31.0

In this study, the success rate of implants placed in completely edentulous arches diminished appreciably between 5 and 7 years. It has been mentioned[35] that a significant correlation exists between failures and the presence of removable dentures. This type of rehabilitation requires precise and frequent prosthetic adjustments/revisions because of osseous and/or mucosal changes over time. In general, it is noteworthy that in later year intervals, a relatively small number of implants remained for the analysis of cumulative success rates.

Regarding implant design, the best results were those involving solid-screw implants, confirming previous observations[28] and justifying the recent evolution of the ITI implant system. Another important observation in this study was the fact that implant length did not significantly influence the results, especially for 8- to 12-mm implants, confirming previously reported results.[28]

SUMMARY

This multicenter study performed in 10 regular private practice settings demonstrated good results after 6 years for 1,022 implants placed in 440 patients. However, the cumulative success rates declined slightly between 6 and 7 years. This decrease involved more particularly implants placed in older or periodontally maintained patients, as well as implants located in completely edentulous arches. This prospective follow-up study is ongoing and results of a 10-year observation period would be published in the future.

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