Immediate versus Conventional Loading of Post-Extraction Implants in the Edentulous Jaws

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ABSTRACT

Purpose: This retrospective study deals with the issue of how to realize the transition from a failing dentition to an implant-supported prosthesis. The main aim was to assess the reliability of immediate implant and immediate loading (IL) protocols in the edentulous jaws. A further aim was to investigate the role of patient-related, implant-related, and surgery-related secondary variables in the occurrence of implant failure.

Materials and Methods: Patients with at least a 4-year post-loading follow-up undergoing the transition from a failing dentition to an implant-supported prosthesis were retrospectively investigated. Primary variables of implant failure were immediate placement and IL. Secondary variables were categorized as demographic, anatomic, site, and prosthetically related. Cumulative survival rates (CSRs) were compared using the Kaplan-Meier survival estimate method. Predictors of failure were included in a multivariate Cox regression model to evaluate the simultaneous effects of multiple covariates and control for correlated observation. Crestal bone loss was also measured at the delayed and the immediately loaded implants.

Results: Five hundred nineteen implants rehabilitating 91 jaws in 80 patients were followed. The Kaplan-Meier survival estimate method showed that immediate implant and IL decreased the CSR significantly in the maxilla but not in the mandible. Some secondary variables were found to affect the CSR: maxillary location, age over 70 years, prostheses supported by only immediate implants or a majority of them, temporary cementation, implant diameter, and length. Crestal bone loss was not significantly related to the outcomes.

Conclusions: The present data may provide clinical recommendations to the practitioner treating the transitional patient. In the mandible, the use of immediate implants and IL does not increase the failure rate. In the maxilla however, combining immediate placement and IL may significantly increase the failure rate.

KEY WORDS: clinical study, delayed implant, immediate implant, immediate loading, post-extraction site, retrospective

INTRODUCTION

Since the introduction of the original Brånemark protocol for the rehabilitation of edentulous patients, a number of modifications of the clinical approach have been made over the years in order to address patient needs, improve clinical outcomes, apply implant treatment in different types of patients who could benefit from this type of rehabilitation, and reduce total treatment time. The last point in particular has represented a major breakthrough in implant dentistry. Several protocols have been proposed in order to decrease the time needed for delivering the prosthesis and allowing patients to restore their esthetic and functional needs.

The main approaches that have been adopted by clinicians are (1) early or immediate loading (IL)

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protocols; (2) the implant insertion right after tooth extraction, the so-called post-extraction implant placement protocols; and (3) a combination of IL and post-extraction implant placement protocols.[1–5]

Both of these approaches are currently documented, and the treatment success rates reported are often similar to those achieved by the standard protocol.[6–8] However, the achievement of high success rates is strictly dependent on a number of factors including rigid clinical protocols, a proper patient selection, and several other variables consisting of patient-, implant-, and surgery-dependent factors as well as clinician experience; the weight of these variables affecting the failure risk of the procedure is still undetermined.

Clinicians and patients need to know what the risks associated with any clinical procedure and modification of the standard protocol are, as well as being aware of factors that may affect the outcome. As treated subjects are not equally susceptible to biological or mechanical complications, it is important to identify the relevant risk factors for future pathological conditions, occurrence, or progression that may lead to treatment failure.[9] Risk assessment is an important step to validate any clinical procedure and requires specific studies with large sample sizes, supported by robust statistical analysis. Large retrospective studies or cross-sectional studies, if well performed and accompanied by proper statistical analysis, are good models for identifying risk indicators and determining their weight in association with the outcome of clinical procedure.[10,11] On the other hand, longitudinal studies may serve to confirm such indicators as correlated with a pathological condition and may allow their definition as established risk factors.[12]

Transition from a failing dentition to an implant-supported prosthesis can be handled in various ways. Patients can benefit from an expedite treatment through an IL protocol or a protracted delayed loading (DL) one. Currently, there is no standardized care for this type of patient, and data related to this situation are scarce.[1,3,4,12,13] The dental community needs reliable data to determine the appropriate ways to handle this patient category.

The creation of multifactorial risk assessment models, which include relevant risk factor analysis for future disease progression, was proposed in periodontology in order to identify the susceptibility of subjects for the recurrence of periodontitis.[14–18]

Similar approaches for implant dentistry are still scarce in spite of the worldwide diffusion of this discipline.[19–23] However, the introduction of novel protocols makes it mandatory to develop some tools that are able to provide an individualized total risk profile for the patient undergoing implant treatment.

The main aim of the present study was to assess retrospectively the weight of clinical protocol-related risk factors for future complication occurrence in patients undergoing IL and/or immediate implant placement (IIP) procedures.

A further objective of this paper was to investigate the role of other patient-related, implant-related, and surgery-related secondary variables in the occurrence of implant failure.

MATERIALS AND METHODS

Study Design and Sample

To address the specific aims of the present study, a retrospective cohort study design was used. The study received ethical approval by the Scientific Review Board of the Galeazzi Orthopaedic Institute. All patients were treated according to the principles of the Helsinki Declaration of 1975, as revised in 2000. Patients treated between April 2002 and November 2008 at the Dental Clinic of the IRCCS Galeazzi Orthopaedic Institute, University of Milan, were selected according the following inclusion/exclusion criteria. The patients were treated by three different surgeons and two prosthodontists who are working together as one team for more than 15 years utilizing a standardization in the surgical and prosthetic procedures.

Inclusion Criteria

Inclusion criteria were the following:

(1) patients had failing tooth-supported prostheses,
(2) they had to be able to tolerate conventional surgical and restorative procedures,
(3) no upper age limitation was set, providing that patients were in good health (ASA 1 according to the American Society of Anesthesiologists classification) or under controlled general diseases (ASA 2 following the same classification),
(4) an implant-supported prosthesis relying on at least four implants was indicated to rehabilitate the edentulous mandible or maxilla, respectively,

(5) according to the chosen protocol (IL or DL) and the patient individual needs, implants were placed in the fresh extraction sockets (IIP) and in healed sites (delayed implant placement [DIP]) if available.
(6) smoking was tolerated and patients were categorized into three groups: no smokers, smokers of ≤10 cigarettes/day, and smokers >10 cigarettes/day.

Exclusion Criteria

Exclusion criteria were:

(1) active infection or inflammation in the area intended for implant placement,
(2) uncontrolled systemic diseases,
(3) treatment with therapeutic radiation to the head within the past 12 months.

Surgical and Prosthetic Protocol

Patients received a prophylactic antibiotic (amoxicillin 2 g 1 hour before surgery and 1 g twice a day for 5 days postoperatively; patients allergic to penicillin were given clarithromycin 500 mg, 1 hour prior to surgery) and anti-inflammatory therapy (ibuprofen 600 mg, 1 hour prior to surgery and twice a day for 3 days). Extraction of teeth was atraumatically performed and the sockets were carefully curetted. The IL and DL procedures have been previously described.[5,24,25] The choice of adopting the IL or DL protocol was made prior to the intervention on the basis of clinical and radiographic evaluation and according to patient's desire. However, IL was not applied if intraoperatively two or more implants did not achieve a tight primary stability (insertion torque more than 32 Ncm), which, was assessed by setting the surgical unit.[25]

For the IL group, after tooth extraction and implant placement, an impression was made and sent to the laboratory for prosthesis preparation within 48 hours. When implant number varied from 4 to 6, a hybrid prosthesis composed of a metallic bar and resin teeth was delivered.[5] When implant number was 7 or 8, an implant-supported bridge was provided.[5] Implants belonged to the 3i implant system (Biomet 3i, Garden Beach, FL, USA).

After 6 months of loading, the classical steps of impression and preparation of the definitive prosthesis were undertaken.

For the DL group, implants were left to heal in a one-stage way. After 2 to 6 months of healing and according to the patient schedule and demand, the classical steps for preparation of a definitive prosthesis were undertaken.

Follow-Up

Patients belonging to the IL group underwent a weekly check-up during the first month, then monthly between the second and sixth month. Thereafter, patients entered an implant supportive protocol with a 4-month recall program. Orthopantomograms and periapical radiographs were performed at implant insertion; periapical radiographs were taken after at the end of the final prosthetic phase (6 months after placement) and 12, 24, and 48 months of functional loading. In the delayed group, implants were radiographically evaluated at the following milestones: immediately after implant placement, at connection of the prosthesis (usually 6 months after placement), and after 12, 24, and 48 months of loading.

Survival Criteria

In the present study, survival criteria were adopted as the prostheses were not removed after 4 years. They were: (1) the implant was present in the patient's mouth; (2) no evidence of peri-implant radiolucency; (3) no recurrent or persistent peri-implant infection; (4) no complaint of pain; and (5) no complaint of neuropathies or paraesthesia.

Study Variables

Variables were classified as primary and secondary. The primary variables were: (1) loading protocol, that is, DL versus IL, (2) implant placement status, that is, IIP in a post-extraction site versus DIP in a healed site. Therefore, four study subgroups could be identified: IIP-IL, IIP-DL, DIP-IL, DIP-DL.

The secondary variables, considered independent covariates, were categorized as,

(1) demographic (age at surgery, gender, tobacco use, health status, that is, ASA 1 vs ASA 2),
(2) anatomic (jaw, i.e., mandible vs maxilla; location, i.e., anterior vs posterior),
(3) site related (prosthesis involving only post-extraction sites vs prosthesis involving mixed sites, post-extraction and healed ones; prosthesis involving a majority of post-extraction sites vs not involving a majority of post-extraction sites),

(4) local (bone quality, i.e., dense, normal, or soft bone; insertion torque, i.e., <32, 32–50, and >50 Ncm; reason for extraction, i.e., chronic periodontal disease [P], endo-periodontal disease [PE], or extended caries [C]),
(5) prosthesis related (retention mode of the temporary prosthesis, i.e., screw-retained vs cemented; number of implants per prosthesis, i.e., group A vs group B, where group A had ≥6 implants in the maxilla and ≥5 in the mandible and group B had <6 implants in the maxilla and <5 in the mandible).

Standardized radiographs were used to measure the crestal bone loss at the 4-year loading check-up compared with implant placement.

Peri-implant marginal bone change was evaluated utilizing a computerized measuring technique applied to intraoral periapical radiographs.[25] Radiographs were scanned to provide a digital format (Epson Expression 1680 Pro, Epson Italia, Cinisello Balsamo, Italy) at a resolution of 600 dpi. The evaluation of the marginal bone level around implants was carried out using image analysis software (UTHSCSA Image Tool version 3.00 for Windows, University of Texas Health Science Center, San Antonio, TX, USA). Each image was calibrated using the known distance between five consecutive threads along the major axis of the implant. The precision obtained by the measuring system is accurate to within 0.01 mm. To facilitate the measurements, the images could be slightly rotated by a software function, to fix the major axis in the vertical direction. In order to improve the visual contrast between the bone and implant, an image processing procedure (sharpening) could be performed when necessary. The vertical distance between the coronal margin of the implant collar (taken as the reference point) and the most coronal bone-to-implant contact was measured. At each implant, this distance was measured at both the mesial and distal sides. An increase of the vertical distance between the reference point and the most coronal bone-to-implant contact at a given site in consecutive radiographs was considered indicative of a peri-implant marginal bone resorption. Bone loss at each visit was calculated for each implant by determining the difference between follow-up and baseline values.

Statistical Analyses

Descriptive statistics were computed to provide a general description of the population and to identify any possible differences between distribution of covariates in the study groups. Kaplan-Meier survival estimate analysis over the first year was used to compare implant survival of the study groups. This constraint to the first year allowed meeting the assumption of linear hazard over time because implants undergoing a deviation from a standard protocol are expected to have a higher failure rate during the osseointegration period but not afterwards.[6]

Stratification according to the primary variables and sub-stratification according to their combination was also performed.

The non-parametric Mann-Whitney *U*-test was used to compare the crestal bone loss at IL and DL implants. Statistical significance was evaluated with $\alpha = 0.05$. The SPSS 18.0 statistical software (IBM, Chicago, IL, USA) was used.

To identify variables associated with implant failure, univariate Cox proportional hazards modeling was subsequently implemented. Predictors of failure with $p \leq .15$ were included in a multivariate Cox regression model to evaluate the simultaneous effects of multiple covariates and control for correlated observation. To investigate the clustering effect of implant failure, the multivariate model with a Robust standard error adjusted for clustering effect was used. All tests of significance were evaluated with $\alpha = 0.05$. Analyses were conducted using the SPSS 18.0 statistical software and the STATA 10 (StataCorp LP, College Station, TX, USA) for the Robust standard error adjusted for clustered effect.

RESULTS

Demographic Data

Descriptive statistics of the study population are summarized in Table 1. The study sample consisted of 519 implants; 91 jaws in 80 consecutive patients (42 females and 38 males) were rehabilitated. Mean age of patients was 60.2 ± 9.8 (39–86 years). Non-smoking patients were 54 (67.5%), 11 (13.7%) smoked fewer than 10 cigarettes/day, and 15 (18.8%) smoked >10 cigarettes/day. Patients were distributed into ASA 1 (normal healthy patients) and ASA 2 (patient with mild systemic disease); they were 66 (82.5%) and 14 (17.5%), respectively.

In the mandible, 269 implants supported 52 prostheses; 38 were IL prostheses, and 14 were placed after

TABLE 1 Study Population. Descriptive Data Comparing Delayed Loading (DL) and Immediate Loading (IL) Groups

	DL	IL	
	134 Imp/21 Pat/23 Jaws	385 Imp/59 Pat/68 Jaws	*p* Value
Demographic variables			
Age ($n = 80$)			
Mean age	58.2 ± 9.1	60.8 ± 10.0	.13
<50 years	4	10	.97
50–69 years	13	38	
≥70 years	4	11	
Sex ($n = 80$)			
Male	14	24	.04*
Female	7	35	
Health status ($n = 80$)			
ASA 1	16	50	.24
ASA 2	5	9	
Smokers ($n = 80$)			
Non-smokers	15	39	.65
Smokers	6	20	
Implants in smokers ($n = 519$)			
Non-smokers	94	257	.47
Smokers	40	128	
Anatomic variables			
Jaw (prostheses, $n = 91$)			
Maxilla	9	30	.68
Mandible	14	38	
Jaw (implants, $n = 519$)			
Maxilla	60	190	.36
Mandible	74	195	
Implant placement status ($n = 519$)			
Delayed implant (DIP)	36	108	.79
Immediate implant (IIP)	98	277	
Prosthetic variables			
Retention mode (prostheses, $n = 91$)			
Cemented	7	18	.71
Screw-retained	16	50	
Retention mode (implants, $n = 519$)			
Cemented	43	72	.20
Screw-retained	91	205	
Implants per prosthesis ($n = 91$)			
Mandible			
<5 imp	2	12	.21
≥5 imp	12	26	
Maxilla			
<6 imp	0	4	.50
≥6 imp	3	26	
Prosthesis and implant status ($n = 91$)			
IIP only	8	20	.63
DIP only	0	0	
Mixed, IIP, and DIP	15	48	
Prosthesis and implant status distribution ($n = 91$)			
Majority of IIP	20	54	.42
IIP not majority	3	14	

*Significant difference between subgroups.

TABLE 2A Characteristics of the Failed Implants

Patient	Sex	Mx/Md	IL/DL	No. of Imp Per Prosthesis	No. of IIP	No. of DIP	Total Failed Implants	IIP Failed Implants	DIP Failed Implants	Time of Failure (Months)	Reason for Implant Removal	Prosthesis Failure
CV	M	Md	DL	6	6	0	1	1	0	9.9	PI	No
SP	M	Md	DL	6	6	0	1	1	0	2.0	M	No
AC (1)	F	Md	DL	3	3	0	1	1	0	2.4	M	No
MM b	F	Mx	IL	8	6	2	6	4	2	1.6	M	Yes
GC	M	Mx	IL	8	8	0	4	4	0	10.9	PI	Yes
RMG	M	Mx	IL	8	6	2	3	3	0	7.1	M	No
DL	M	Mx	IL	6	6	0	3	3	0	3.2	M	Yes
AV-6	F	Md	IL	6	4	2	1	1	0	2.7	M	No
MRC (2)	F	Mx	IL	5	2	3	1	0	1	5.7	M	No
MoGi	M	Md	IL	6	6	0	1	1	0	5.9	M	No

IL, immediate loading; DL, delayed loading; IIP, immediate implant placement; DIP, delayed implant placement; PI, peri-implantitis; M, mobility.

implant healing. In the maxilla, 250 implants supported 39 prostheses; 30 were immediately loaded and 9 placed after healing. Immediate implants placed in fresh extraction sockets and delayed ones placed in healed sites were 375 and 144, respectively.

The DL and the IL groups under investigation showed no discrepancy on most variables except gender (Table 1); women contributed more to the IL group than to the DL. All implants were controlled at the 1-year loading check-up. At the 4-year milestone, 35 implants (6.7%) were failed ($n = 22$ from 10 patients) or lost to follow-up ($n = 13$ from 2 patients). During the first year, one patient (six implants) died, and in the second year one patient (seven implants) dropped out.

Implant and Patient Data

All implants failures occurred during the first year (Table 2A and B). On patient basis, 10 patients experienced implant failures, accounting for 12.5%. However, it should be pointed out the clustering effect of the failures: four subjects accounted for 16 out of the total 22 failed implants. These four subjects were treated in the maxilla with IL protocol. Temporization was not interrupted due to implant failure in 7 out 10 patients; disruption happened only when multiple implant failure occurred within the prosthesis. In the life table analysis shown in Table 2B, it could be noted that no late failures have occurred.

For the two primary variables (both loading and placement timing) the IL and IIP groups showed

TABLE 2B Life Table Analysis

Time (Years)	No. of Implants at the Beginning of Interval	Failed Implants	No. of Patients	Implants (Patients) Lost to Follow-Up	Interval Survival Rate (%)	Cumulative Survival Rate (%)
0–1	519	22	80	6 (1)	95.8	95.8
1–2	491	0	79	7 (1)	100.0	95.8
2–3	484	0	78	0	100.0	95.8
3–4	484	0	78	0	100.0	95.8
4–5	484	0	78	0	100.0	95.8
5–6	373	0	59	0	100.0	95.8
6–7	289	0	47	0	100.0	95.8
7–8	221	0	37	0	100.0	95.8
8–9	140	0	24	0	100.0	95.8
>9	58	0	13	0	100.0	95.8

TABLE 3A Kaplan-Meier Cumulative Survival Estimates at 1 Year for the Primary and Secondary Covariates: Primary and Secondary General Variables

Time, 12 m	% Survival (95% CI)		*p* Value
DIP versus IIP	97.9 (95.5, 100)	94.9 (92.7, 97.1)	.13
DL versus IL	97.8 (95.2, 100)	95.1 (92.9, 97.3)	.18
Jaw, maxilla versus mandible	93.2 (90.0, 96.4)	98.1 (96.5, 99.7)	.005*
Age, <70 versus ≥70 years	96.6 (94.8, 98.4)	91.5 (85.3, 97.7)	.04*
Gender, male versus female	94.9 (92.1, 97.7)	96.6 (94.4, 98.8)	.36
Health, ASA 1 versus ASA 2	96.3 (94.5, 98.1)	92.9 (87.3, 98.5)	.14
Smoking, non-smokers versus smokers	97.7 (93.7, 97.9)	95.8 (92.8, 98.8)	.95
No. implants/prosthesis, group A versus group B†	95.5 (93.5, 97.5)	97.2 (93.4, 100)	.51
Implants in prosthesis, immediate implant only versus mixed	92.4 (88.0, 96.8)	97.1 (95.3, 98.9)	.02*
Immediate implants in prosthesis, non-majority versus majority	99.1 (97.3, 100)	94.8 (92.6, 97.0)	.04*
Retention mode, screw versus cemented	97.8 (96.2, 99.4)	91.1 (86.5, 95.7)	.001*

*The CSRs of the compared groups were statistically different.
†Group A, ≥6 implants in Mx and ≥5 in Md; group B, <6 implants in Mx and <5 in Md.
IIP, immediate implant placement; DIP, delayed implant placement; IL, immediate loading; DL, delayed loading; CI, confidence interval.

higher failure rates than the DL and DIP, respectively (Table 3A); however, the differences in cumulative survival rate (CSR) were not statistically significant.

The secondary covariates gender, health status, smoking habit, number of implants per prosthesis, that is, group A versus B, implant design (Table 3A), region of implant placement, bone quality, and insertion torque did not significantly affect the CSRs (Table 3B). Some other secondary variables did affect the CSR in a statistically significant way (Table 3A and B); these were: patients over 70 years of age, implant location (implants placed in the maxilla had a higher failure rate than those placed in the mandible), prostheses supported by immediate implants only, prostheses supported by a majority of immediate implants, cementation versus screw retention, and reason for extraction.

Stratification of the primary variables showed the following statistically significant CSR differences (Table 4A and B). In the maxilla, (1) the CSR of IL implants was lower than in the mandible ($p = .001$); (2) the CSR of IL implants was lower than DL ones ($p = .003$); (3) the CSR of immediate implants placed in

TABLE 3B Kaplan-Meier Cumulative Survival Estimates at 1 Year for the Primary and Secondary Covariates: Local Site and Implant Variables

Time, 12 m	% Survival (95% CI)					*p* Value
Location, anterior versus posterior	96.3 (92.4, 98.0)	93.5 (90.2, 98.6)				.214
Bone quality, dense versus normal versus soft	100	94.3 (83.2, 98.5)	93.8 (89.9, 96.8)			.17
Insertion torque, <32 versus 32–50 versus >50 Ncm	92.0 (88.6, 100)	98.0 (93.1, 98.7)	90.9 (84.1, 96.9)			.745
Implant design, cylindrical versus tapered	96.6 (93.2, 100)	93.4 (90.2, 96.6)				.236
Diameter, 3.25 versus 3.75 versus 4.0 versus 5 mm	100	98.4 (94.9, 100)	96.5 (93.8, 98.6)	77.5 (66, 91.2)		.001*
Length, 8.5 versus 10 versus 11.5 versus 13 versus 15 mm	87.5 (64.1, 100)	90.9 (81, 99.4)	94.4 (83.5, 98.7)	92.8 (86.7,97.1)	100	.002*
Extraction reason, C versus P versus EP	100	95.9 (93.6, 98)	87.0 (70.1, 95.7)			.009*

*The cumulative survival rates of the compared groups were statistically different.
C, extended caries; P, periodontal disease; EP, endo-periodontal disease; CI, confidence interval.

TABLE 4 Stratified Cumulative Survival Rates

	Maxilla, % (*n*)	Mandible, % (*n*)	All, % (*n*)
(A) Stratification according to the primary variables			
IL	91.1 (190)	99.0 (195)	95.1 (385)
DL	100 (60)	95.9 (74)	97.8 (134)
IIP	91.8 (171)	97.5 (204)	94.9 (375)
DIP	96.2 (79)	100 (65)	97.9 (144)
All	93.2 (250)	98.1 (269)	95.8 (519)
(B) Sub-stratification according to the combination of the primary variables			
IIP-IL	89.4 (132)	98.6 (145)	94.2 (275)
IIP-DL	100 (39)	94.9 (59)	97.0 (98)
DIP-IL	94.8 (58)	100 (50)	97.3 (108)
DIP-DL	100 (21)	100 (15)	100 (39)
All	93.2 (250)	98.1 (269)	95.8 (519)

IIP, immediate implant placement; DIP, delayed implant placement; IL, immediate loading; DL, delayed loading.

fresh extraction sites was lower than in the mandible ($p = .005$); (4) IIP affected the CSR of IL implants more than in the mandible ($p = .001$); and (5) Immediate implants affected the CSR of IL implants more than DL ($p = .003$).

In the mandible as well, stratification showed that the two primary variables, IL and immediate implants, led to more failures; however, the differences in survival rate were not statistically significant (Table 4A and B). In the maxilla, however, implants undergoing both immediate placement and IL had a statistically significant lower CSR than other combinations ($p < .001$). Crestal bone loss at the IL and DL implants was 0.9 ± 0.4 mm and 0.8 ± 0.5 mm, respectively; the difference was not statistically significant.

In the present clinical study, the prostheses were not removed to evaluating the individual implants, thus the results should be regarded as implant survival rates and not success rates.

DISCUSSION

Treatment of the transitional patient requires deciding between going for an IL protocol and a lengthier DL one. Unfortunately, data that might help take a sound decision with this regard are scarce.[4,12,13] This study focused on the transitional patient with the aim of identifying variables that might affect the failure rate.

Before performing the statistical evaluation of the data, homogeneity of the DL and IL groups was tested for all covariates. Only gender distribution (Table 1) was not homogeneous; it was not considered a potential bias because it has not been identified as a predictor of implant failure.[2–11]

Even if in the present clinical study a 4-year data are reported, it should be pointed out that no late failures occurred. This confirms data from previous systematic reviews on IL implants that documents that implant failures mainly occur during the first year and are negligible thereafter.[6,26,27] The present data confirms that finding; it strengthened statistical approach of restricting the Kaplan–Meier analysis to the first year.

On patient basis, it was found a failure rate of 12.5%, however, it should be pointed out that four subjects treated in the maxilla with IL protocol experienced multiple failures and accounted for 73% of the total failures. Out of these four patients, three were heavy smokers of more than 20 cigarettes/day.

The highest CSR was obtained when implants were undergoing no deviation from the standard protocol. When exposed to a single deviation, the survival rates in the mandible and the maxilla did decrease but not significantly. This is in line with previously reported meta-analyses[4,6] or papers published afterwards[13]; but it is in contrast with other studies that found that immediate implants[28] or IL ones[2] were significant predictors of failure.

From a clinical point of view, the present data might suggest approaching the upper and lower jaw

of the transitional patient differently. The edentulous mandible might be treated with immediate implants immediately loaded without significantly increasing the failure rate. In the maxilla, however, if the patient and the practitioner want to avoid implant failure, it might be recommended to delay loading of the immediate implants. This would be in line with a previous 2-year study that suggested that immediately loaded immediate implants were more prone to fail in the maxilla than the mandible (91.4 vs 100%).[29]

In the maxilla, immediate placement and IL treatment should be proposed only if the patient is ready to cope with an increased risk of implant failure in order to avoid wearing a removable appliance during the healing period. Davarpanah and colleagues in 2007 reported that transitional patients may accept a failure rate as high as 10% on condition that temporization remains uninterrupted.[30] It is worth noting that temporization of 7 out the 10 prostheses that underwent failure were not discontinued. Disruption happened only to those that suffered multiple implant failure.

To minimize the risk of implant failure, practitioners applying IL protocols may intuitively seek to place more implants or to include healed sites on top of post-extraction ones. So far, the relevance of these strategies has not been specifically investigated in literature. The specific covariates considered in Table 4A might provide some information with this regard. Analysis of the CSRs revealed that increasing the number of implants supporting an IL prosthesis did not decrease the failure rate. On the other hand, the data might be backing the clinicians that are aiming to avoid only post-extraction sites and strive for at least the same number of healed sites.

On a more local basis, getting the best bone quality and highest insertion torque did not increase the CSR statistically. But it appeared that the reason for extraction should be carefully monitored because endo-periodontal disease led to more failures. When focusing on implant characteristics, implants <10 mm failed more than longer ones and large Ø 5 mm implants more than smaller diameters. However, the latter result should be cautiously considered because the large diameter implants were used only as rescue implants.

Cementation of IL prosthesis was linked with more implant failure; this is in contrast with other studies that documented similar outcomes for screw-retained and cemented prostheses.[9,12,31] This discrepancy might be explained by the use of temporary cement; it is more prone to wash out and less reliable in terms of stability. To avoid this drawback, IL screw-retained temporary prostheses rather than temporary cemented ones were implemented.

In conclusion, in the mandible, the use of post-extraction implants and IL does not increase the failure rate. However, in the maxilla immediate placement and IL may significantly increase the failure rate. Within the limitations of this clinical study, the present results might offer clinical recommendations to the practitioner. More studies focusing on the transitional patient are warranted to confirm the validity of the present findings.

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