Immediate Placement of Dental Implants after Extractions and Immediate Loading of Complete Restorations of the Maxilla, Mandible and Full-Mouth: A Retrospective Consecutive Case Series on 121 Patients and 1042 Implants with up to 8 Year Follow Up Period

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Abstract

Purpose: The aim of this retrospective cases series was to present results of post extraction immediate implantation and immediate loading at maxilla, mandible and full-mouth with follow-up from 1 to 8 years and to report on survival rate and prosthetic success of a total of 1042 implants.

Material and Methods: This study included 121 patients requiring full-arch maxilla, mandible or full-mouth prosthetic rehabilitation between June 2006 and September 2012. After the extraction of hopeless teeth, each patient received in one unique surgical session 6 to 10 implants per arch, and immediate provisional screw-retained acrylic resin prosthesis. After 4 months at mandible and 6 months at maxilla (6 months for full-mouth), the provisional screw-retained prosthesis was removed, and all fixtures were checked for stability. Then all patients received their final screw-retained or cemented prosthesis (produced using CAD-CAM system) with 12 to 14 teeth (for one arch). There was 28% of screw-retained prosthesis and 72% of cemented prosthesis.

Results: The Cumulative Survival Rate (CSR) reached 98% at the maxilla, 100% at the mandible and 98% when the two arches had implants placed and restored in one unique session. Implant in non-distal positions had lower risk of failure than those in distal position (HR=0.35, 95% CI: 0.13-0.90).

The rate of prosthetic success remained high during the course of the follow up analysis: 100% at each end-point for the 3 options (maxilla, mandible, and full-mouth) under analysis.

Conclusion: Combining immediate placement of dental implants after extractions and immediate loading of complete restorations at the maxilla, the mandible or both is a reliable alternative to more conservative approaches.

Keywords: Dental implant; Edentulous mandible; Edentulous maxilla; Full arch prosthesis

Introduction

Conventional implant placement procedures achieve predictable and high success rates for an implant-supported single tooth [1-3]. During the last decade, the 5-year survival rate of implant-supported prostheses appeared to be significantly increased in more recent as compared to older studies (from 93.5% to 97.1%) [4]. In the case of implant-supported full-arch fixed dental hybrid prosthesis, results appear promising for up to a 10 year follow up period (87.89% to 100%), but more disappointing if a time period longer than 10 years is considered (78.3% to 98.9%) [5]. Consequently, clinicians recommend avoiding the use of this type of rehabilitation after strategic removal of all the remaining teeth [5].

However, implants placed in healed sites and remaining unloaded during osseo integration present some clinical drawbacks. During healing time and osseo integration, the patients have to wear a removable provisional full arch prosthesis known to be uncomfortable because of the pain caused on the extraction sockets during the healing process (due to pressure), the size of the prosthesis

and the lack of stability. This induces psychological problems by negatively affecting the quality of social, professional and personal life of these patients. Furthermore, before implant placement, during the post-extractional healing time a provisional removable prosthesis contributes to alveolar bone loss particularly with non-grafted extraction sockets. It is known that 50% of the initial alveolar bone volume can be lost during the first 12 months and that 65% of the bone loss occurs during the first 3 months after the extractions took place [6-9]. Moreover, this classical approach increases the number of surgical interventions and the total treatment time. A recent review of Papaspyridakos et al. [10] concluded that when selecting cases carefully and using dental implants with a rough surface, immediate loading with fixed prostheses in edentulous patients results in similar implant and prosthesis survival and failure rates as early and conventional loading. Therefore, immediately-loaded post-extraction implantation with a fixed provisional appears to be beneficial in case of full arch rehabilitation to shorten treatment duration, offer the best comfort to the patient, preserve alveolar bone volume after extraction and thus avoid invasive intervention and optimize aesthetic results. To the best of our knowledge, only a few international publications reporting from six months to five year follow up are suggesting that immediate loading of implants at the time of placement is not deleterious to the clinical outcome [11-14]. Furthermore, we know of no study that analyzes implant success rates for immediate placement/immediate loading in full-arch full-mouth restorations, especially in the long term. Therefore, we have identified a gap in clinical results related to immediate placement/immediate loading results on full arch restorations, particularly in: 1) mandible alone, 2) maxilla alone and 3) full-mouth. This retrospective study aims to help fill this gap by presenting independent results from these three aforementioned surgical site interventions. The authors developed procedures consisting in extraction of teeth immediately followed by implant placement and immediate loading with provisional screw-retained full arch bridges at the maxilla, mandible and at the both the upper and lower jaws simultaneously (full-mouth). The authors report on the survival rate and prosthetic success of an immediate implantation and immediate loading treatment protocol in follow up cases extending up to 8 years.

Materials and Methods

Patient selection

A consecutive retrospective case series analysis was conducted on 122 patients who were treated from June 2006 to September 2012 at the Afopi Campus dental clinic (Paris - Sarcelles Village, France). The selected patients consisted of 69 females and 53 males with an age range from 34 years to 79 years old. At their initial visit, all patients presented with a hopeless dentition at mandible or/and maxilla. The treatment consisted in extractions of the remaining teeth followed by immediate dental implants placement and immediate loading of a provisional full arch screw-retained acrylic resin restoration. All the procedures were conducted by one seasoned operator (Dr. Jean-Louis Zadikian) who placed a total of 1042 implants. All the relevant data were recorded after the patients gave their consent and the study was registered at the CNIL (Commission Nationale Informatique et Libertés, Paris, France) under the number 1790755V0 assuring the confidentially of the data compilation and analysis.

Inclusion criteria: The patients treated in this study were men and women over 18 years old, were partially edentulous and presented the need for extraction of all or remaining teeth. They had no contraindications to implantology. Within the frame of a conventional treatment, they were candidates for a post extraction removable complete prosthesis. Conventional implant treatment (with delayed implant placement and delayed restoration) and the alternative method were proposed to each patient. They all wished to benefit from the alternative treatment with post-extraction implant placement, immediate fixed full-arch provisional resin-acrylic prosthesis and final fixed full arch prosthesis.

Exclusion criteria: Patients fully edentulous wearing a full removable prosthesis were excluded from the study. Furthermore, these patients had sufficient bone volume to place at least 6 implants in the maxilla and 5 implants in the mandible or a bone volume allowing the stabilization and the creation of bone around the implants with help of a bone substitute and a GBR membrane (BioOss, Biogide, Geistlich, Switzerland). These patients presented no contraindication to implantology.

Pre-operative procedure

Clinical examinations and imaging: The examinations consisted of medical history recording and analysis; clinical intra-oral and extra-oral examination, panoramic radiographs and Cone beam Computed Tomography (CT) (Planmeca, Planmeca Oy, Helsinki, Finland and Vatech, Vatech Fance, Champs sur Marne, France) to perform the adequate surgical planning.

Planning and initial prosthetic initiation phase: A primary impression and a secondary impression with a custom impression tray were taken using alginate. Then a stone model was obtained and mounted in a dental articulator (FAG Industry et Dentaire – Quick Master B2). Teeth extraction was anticipated and simulated on the stone model. Then, a diagnostic wax-up was realized in centric relation and consequently provided a template for the future prosthetic restoration considering its volume, contour, occlusion and implants positioning. The following elements were prepared ahead of surgery:

- Multi-functional surgical guide (maxillary, mandibular)

- Provisional removal complete resin prosthesis

After assuring the good positioning of the existing removable prosthesis by visual inspection through a window prepared in the middle of the acrylic palate, a translucent acrylic resin duplicate was shaped as a multi-functional surgical guide.

Premedication: All the patients received the same premedication/medication prescription (Birodogyl 2,5 mUI spiramycin, 250 mg metronidazole 3 times per dayor Augmentin 3 times 1000 mg per day, 48 hr prior to the surgery, Célestène 6 mg – MSD FRANCE) the morning of the intervention, mouth rinse Listerine - long term use) and were operated under local anesthesia (4% articaine with 1:100.000 adrenalin, Zizine, Paris, France).

All surgeries were performed by a single experienced surgeon (Dr. Jean-Louis Zadikian).

Surgeries

Maxilla or mandible: The remaining teeth were extracted atraumatically in a special suite dedicated to surgery of septic tissues. In order to preserve the bone volume, the extractions were done atraumatically with conventional or with ultra-sonic (Piezzotome, Acteon-Satelec, Merignac, France) methods. The removable full arch prosthesis was placed to confirm occlusal relation and for

Table 1: Diameter of the implant by implantation areas.

Implants diameters	Maxillary Incisal & canine	Maxillary Pre-molar	Maxillary Molar	Mandibular Incisal & canine	Mandibular Pre-molar	Mandibular - Molar
3,5 mm	28%	7%	3%	28%	5%	0%
3,75 mm	4%	1%	1%	4%	0%	4%
4.1 mm	67%	88%	79%	68%	90%	86%
5.0 mm	1%	3%	13%	1%	5%	11%
6.0 mm	0%	1%	3%	0%	0%	0%

Table 2: Length of the implant by implantation areas.

Implants length	Maxillary Incisal & canine	Maxillary Pre-molar	Maxillary Molar	Mandibular Incisal & canine	Mandibular Pre-molar	Mandibular - Molar
7 mm	0%	0%	0%	0%	1%	0%
8.5 mm - 9 mm	0%	1%	3%	2%	4%	9%
10 mm	11%	20%	30%	16%	32%	47%
11 mm - 11.5 mm	26%	17%	23%	24%	25%	26%
13 mm	44%	39%	29%	45%	29%	18%
15 mm	17%	19%	14%	13%	8%	0%
18 mm	2%	3%	1%	1%	0%	0%

aesthetic validation purposes. The surgical multi-functional guide was inserted and occlusion verified. The implantation surgeries were always performed in an aseptic environment in a dedicated suite. With the aid of the surgical multifunctional guide, one incision was realized along the lingual limit corresponding to the lingual aspect the teeth. This incision allows for raising one single vestibular flap and maintaining the guide in its accurate position during the surgery helps to visualize the implant axis. The following implant systems were used: Speedy Groovy (Nobel Biocare AB, Göteborg Sweden) or Titamax Ex (Neodent, Curitiba, Brazil) with diameter and length matching the surgical planning (6 to 10 implant at the maxillary, 5 to 9 at the mandible).In molar area, when the height of bone was insufficient to place implant, implants were placed tilted. There were 905 Nobel Speedy Groovy implants placed (87%) and 137 Neodent Titamax implants placed (13%). The frequencies of diameter and length according to the position are detailed (Tables 1 and 2). At completion of the drilling sequencethe insertion torques were recorded directly from the digital screen of the surgical engine (W and H Implantology Motor, W and H, Bürmoos, Austria). Primary stability was then assessed based on these maximum insertion torques. Brånemark System® Mk III or Speedy Groovy (Nobel Biocare AB, Göteborg Sweden) implants were used with implants diameter and length-varying depending on location. All the implants were immediately loaded on the same day taking into account that they were all linked within the screw-retained provisional bridge. Implants with external connections were used and immediately after implant insertion, open-tray transfers were placed and fixed to the multifunctional surgical guide with Voco Structure resin (Voco, Cuxhaven, Germany) in order to register the implant positions. The gap between the buckle bone plate and the implant was systematically filled up with a bone substitute (Bio-Oss, Geistlich AG, Wolhusen, Switzerland). The flaps were temporary closed with absorbable sutures (Vicryl Plus, Ethicon, Cincinnati, OH, USA) without the use of healing abutments.

Prosthetic protocol: During the same day, after the surgical procedure, the complete removable prosthesis was transformed into a provisional screw-retained prosthesis. Then, the screw retained provisional prosthesis was placed, completing the rehabilitation of

Table 3: Number of implant by follow-up years.

Follow-up time	Number of implants
[1 - 2[years	31
[2 - 3[years	230
[3 - 4[years	191
[4 - 5[years	186
[5 - 6[years	137
[6 - 7[years	156
[7 - 8[years	104
> 8 years	7

the patients after about 6 hr (in average for one arch) and 8 hr (in average for two-arches) reaching already improved aesthetic results. In this retrospective case series, a total of 160 bridges on implants at maxilla or mandible (including full arch and full-mouth treatment) were immediately loaded. The patients were instructed on hygiene maintenance methods, and a soft diet was recommended up to 3 months after surgery. The absorb able sutures were placed. In case of full-mouth treatment patients benefited from a full rehabilitation of both maxilla and mandible at the same time.

Follow up

Patients were examined clinically after one week, two weeks. Radiographs and CT were taken at 3months for mandibular and six months for maxillary and full-mouth cases. *The patients were followed at 6 and 12 months and thereafter, yearly. The mean follow-up time was 4.1 years with a standard deviation of 1.8. The maximum follow-up was 8 years and the minimum 1 year.* The study covered 504 person-years. For every patient yearly follow-up visit, a clinical examination, a panoramic X-ray and a CBCT were performed. If a patient exhibited bleeding around an implant associated with an image showing a bone defect then the prosthesis was removed (whatever the type of prosthesis, screwed or cemented), and the implants were checked. Implant mobility was evaluated manually. During the study, 16 implants resulted in failure and were lost before the final prosthesis. During all the period following the placement of the final prosthesis, no loss of implant was observed. Table 3 detailed

Table 4: Number of implant supporting final prosthesis.

Number of implants supporting the rehabilitation	Mandibular		Maxillary	
	Numberof rehabilitations	Frequency	Number of rehabilitations	Frequency
5	12	20%	0	0%
6	23	38%	33	37%
7	18	30%	8	9%
8	5	8%	45	50%
9	3	5%	3	3%
10	0	0%	1	1%

Table 5: Risk of an implant failure in function of different risk factors.

Risk factor	Value	N implants	Implant failure			
			n (%)	Hazard Ratio*	95% CI	p-value
Arch type	Maxilla	441	9 (2.04)	1.1	0..36-3.31	0.863†
	Maxilla+Mandible	395	8 (2.03)			
	Mandible	206	0 (0.0)	-	-	-
Tooth Extraction	Healed	409	7 (1.71)	1.17	0.44-3.13	0.76
	Extracted	633	10 (1.58)			
Position	Not distal	740	8 (1.08)	0.35	0.13-0.90	0.03
	Distal	302	9 (2.98)			
Inclination (if distal)	Straight	171	5 (2.92)	0.96	0.26-3.58	0.952
	Inclined	131	4 (3.05)			

*Cox regression models were used to calculate the Hazard Ratios. The effect of patient was included as a random effect
†p-value for the hazard ratio between maxilla and maxilla+mandible

Table 6: Implant survival proportions by different risk factors.

Risk factor	Value	N implants	Implant failure	Cumulative proportion*	
			n (%)	Survival	Standard error
Arch type	Maxilla	441	9 (2.04)	0.98	0.02
	Maxilla+Mandible	395	8 (2.03)	0.98	0.02
	Mandible	206	0 (0.0)	1	0
Tooth Extraction	Healed	409	7 (1.71)	0.983	0.017
	Extracted	633	10 (1.58)	0.984	0.016
Position	Not distal	740	8 (1.08)	0.99	0.011
	Distal	302	9 (2.98)	0.97	0.03
Inclination (if distal)	Straight	171	5 (2.92)	0.971	0.029
	Inclined	131	4 (3.05)	0.97	0.031

*Given cumulative proportions are those at end of study and were estimated using the Kaplan-Meier survival method

the number of implants by follow-up time.

Final prosthesis

After 4 months at mandible and 6 months at maxilla (6 months for full-mouth), the provisional screw-retained prosthesis was removed, and all fixtures were checked for stability. Then all patients received their final screw-retained or cemented prosthesis (produced using CAD-CAM system) with 12 to 14 teeth (for one arch). There was 28% of screw-retained prosthesis and 72% of cemented prosthesis and the number of implant supporting each prosthesis was as detailed in (Table 4).

Data collection and statistical analysis

The data recording on the standardized case documentation form was electronically given by a skilled assistant. A double check for consistency was conducted by another individual. Data were retrospectively collected from the case documentation data bank. An implant was considered as a failure if it was removed because of mobility, loss of integration, on-going bone loss, infection, persistent pain or patient discomfort. A "successful prosthesis" is a prosthetic reconstruction that is stable and fulfills the patient expectation with respect to function and aesthetic. Descriptive statistical analysis depicted mean, standard deviation or frequency distribution depending on the nature of the parameters. Respectively, the Chi-squared test or the Kruskal-Wallis tests were used for the comparison of groups. Survival analyses were performed using the Kaplan-Meier method and the log rank test was used for the comparison between groups. Cox proportional hazard models were used to determine the association of implant failure and different risk factors. The effect of the factor patient was included in the models as a random effect. All performed tests were two-tailed and the considered alpha level was

Table 7: Risk of an implant failure in function of different risk factors stratified by arch type.

Arch type	Risk factor	Value	N implants	Implant failure			
				n (%)	Hazard Ratio*	95% CI	p-value
Maxilla	Tooth Extraction	Healed	175	4 (2.29)	1.25	0.32-4.81	0.747
(n=441)		Extracted	266	5 (1.88)			
	Position	Not distal	319	3 (0.94)	0.18	0.05-0.72	0.015
		Distal	122	6 (4.92)			
	Inclination (if distal)	Straight	63	3 (4.76)	0.93	0.19-4.62	0.932
		Inclined	59	3 (5.08)			
Maxilla+Mandible	Tooth Extraction	Healed	155	3 (1.94)	1.06	0.25-4.55	0.936
(n=395)		Extracted	240	5 (2.08)			
	Position	Not distal	279	5 (1.79)	0.68	0.16-2.84	0.595
		Distal	116	3 (2.59)			
	Inclination (if distal)	Straight	69	2 (2.90)	1.38	0.13-15.25	0.791
		Inclined	47	1 (2.13)			
Mandible	Tooth Extraction	Healed	76	0 (0.00)	-	-	-
(n=206)		Extracted	127	0 (0.00)			
	Position	Not distal	142	0 (0.00)	-	-	-
		Distal	64	0 (0.00)			
	Inclination (if distal)	Straight	39	0 (0.00)	-	-	-
		Inclined	25	0 (0.00)			

*Cox regression models were used to calculate the Hazard Ratios. The effect of patient was included as a random effect

0.05. SAS version 9 (SAS Institute Inc, Cary, NC, USA) was used for the statistical analysis.

Results

The probabilities of survival for all implants depend on several risk factors (arch type, extraction, position and inclination of an implant) are shown in (Table 5). Although the risks of implant type was higher for maxilla compared to full-mouth and of healed versus extraction, they were not statistically significant (Table 5). The risk of an implant failure in a non-distal position was statistically significant lower for implants in non-distal positions than those in a distal position (hazard ratio=0.35, 95% CI: 0.13-0.90, p=0.030). Implant failure was similar for straight/inclined implants in distal positions.

Maxillary

61 patients, 37 women and 24 men benefited from the surgical and prosthetic treatments. 430 teeth were extracted with an average of 7.0 per patient (ranging from 1 to 15). A total of 441 implants were placed in the maxilla, the survival rate at the end of the study reached 98% (Table 6). 266 implants were placed in extraction sockets and 175 in healed sites. The risk of implant failure was higher but non-statistically significant in extracted than in healed sockets (Table 7). Each patient received 6 to 10 implants per maxilla. Implants placed in the most distal position had a much lower risk of failure than those implanted in a distal position (HR=0.18; 95% CI:0.05-0.72; p=0.015). If only distal implants are considered, the failure risk of straight implants was a bit lower than those of tilted implants (Table 7).

Mandible

32 patients, 21 women and 11 men were treated. 233 teeth were extracted with an average of 7.3 per patient (ranging from 2 to 15). A total of 206 implants were inserted. 127 implants were inserted in extraction sockets and 79 in healed sites. The implant survival rate in the mandible was 100% (Table 6), therefore respective survival rates by all other implant characteristics was 100%. Each patient received 5 to 9 implants. Out of 64 implants in distal position, 39 straight and 25 angulated. Full mouth 29 patients, 11 women, and 18 men had in total 459 teeth extracted with an average of 15.8 per patient (ranging from 5 to 25). A total of 395 implants were placed, 240 in extraction sockets and 155 in healed sites. The overall implant survival rate was 98% (Table 6). The risk of implant failure for implants place in non-distal positions was lower, although not statistically significant, than those placed in a distal position (HR=0.68; 95% CI:0.16-2.84; p=0.595. If only distal implants are considered, straight implants showed higher implant failure than tilted implants (Table 7).

Prosthetic success

The prosthetic success was assessed in regard of the number of cases where we were not able to place a fixed provisional prosthesis of a fixed definitive prosthesis. If a patient received a removable prosthesis during the treatment it was counted as a prosthetic failure. The rate of prosthetic success remained high during the course of the follow up analysis: 100% at each end-point for the 3 options (maxilla, mandible, and full-mouth) under analysis. The level of patient satisfaction was very high and particularly related to avoiding the transition period with removable denture between surgery and final screw-retained restoration.

Discussion

The primary function of a dental implant is to support a prosthetic system (abutment and restoration), in a similar way as natural tooth root with a crown. Any success criteria, therefore, must consider the foremost support of a functional prosthesis. In addition, high patient satisfaction related to function and aesthetic appearance of the rehabilitation is required. In the present retrospective consecutive clinical report, the prosthetic success rate and the patient satisfaction

level were assessed at each end point. By reference to the combination of criteria proposed by Papaspyridakos et al. [15]. (Success at the prosthetic level during a five-year period) and patient satisfaction the results of the present study are very high after short and long periods of time. It must be taken into consideration that evaluations of aesthetic results refer mostly to implant rehabilitation in the maxillary anterior zone and that there are yet no universally accepted evaluation criteria of the aesthetic result [16]. Immediate functional loading is a new surgical-prosthetic technique that can be used extensively in implant placement. The improvement of clinical protocols, the attention to biological principles, modification in implant design and surfaces has resulted in increased utilization and predictability of this procedure [17]. However, there are a large number of parameters to be taken into account in the proposed "one-step" surgical procedure that could affect the clinical outcome: extraction socket *vs.* healed site implant placement, single teeth replacement *vs.* single jaw full arch replacement and/or bimaxillary full arch replacement, as well as the effect of immediate loading [12]. The overall implant survival rate after 6 months was 99.1%. Five lost implants were inserted in fresh extraction sockets (1.4%) and one in a healed site (0.3%). In our study the failure rate was 1.9% of implants lost when placed in fresh extraction sites *vs.* 2.3% when inserted in healed sites Similar to Gillot et al. [12]. The statistical analysis did not depict any significant differences between implant placed on healed site or in extraction socket. In our own case series, no differences were shown whether the implants were placed in an extraction socket or in a healed site whatever jaw was treated (maxilla alone, mandible alone, the both simultaneously) [18]. Conducted a systematic review of the literature and a meta-analysis of 10 controlled randomized trials on the annual failure rates and marginal bone-level changes of immediate compared to conventional loading of dental implants. They did not found any clinically relevant differences regarding annual failure rates or radiographic bone-level changes between conventionally and immediately loaded implants for up to 5 years of follow-up.

Maxillary full-arch treatment

While our study reports on implants placed on healed site and in extraction socket with immediate loading, the reached CSR (98%) is equivalent to those reported by Degidi et al. [19]. Who dealt only with fully edentulous patient. In addition, we show that there are no significant differences of CSR between implant placed on healed site or in extraction socket. We can draw the conclusion that immediate functional loading is a reliable surgical-prosthetic procedure in maxillae rehabilitation on fully edentulous patient. We confirm the study of Gillot et al. [12]. Where only short terms follow up is considered (inferior to 1 year). Immediate implant placement and loading resulted in high implant as well as high prosthetic survival rates (98% implant survival in the present study). With longer term observation periods the results become equivalent to those obtained by Balshi et al. [20,21]. Who reached a CSR of 96.3% (after 6 years). At the two observational periods and in the 3 above studies the prosthetic survival remained very close to 100% as in the present study. As shown in the above reported studies the full-arch maxillary implant insertions and immediately loaded provisional prostheses provides a lasting state of osseo integration as the foundation for long-term stability of fixed prostheses. By comparing immediate and conventional loading Peñarrocha-Oltra et al. [22] an implant success rates of 96.8% and 99.0% respectively after 12 months. The success rate of the immediately loaded prostheses was 100%. In the immediate loading group, the most common complications were screw loosening

and tooth fractures; in the control group, dentures caused discomfort and soft tissue irritation. We indicated this drawback in the present paper as common in daily practice. The above reported studies all concluded high success rates after implantation in the maxilla as confirmed by our study.

Mandibular full-arch treatment

In general rehabilitations in the mandible are less documented [21]. Reached a CSR of 97.8% (after 6 years), to be compared to the 100% obtained in our study. The prosthesis survival was in both studies close to 100%.

Studied 12 mandibles, 5 maxillary, including 3 bi-maxillary patients [11]. The results suggested that immediate loading of implants at the time of placement added a valuable predictability to the treatments for both mandibular and maxillary arches [23]. Published a systematic review referring to 46 prospective studies, with a mean follow-up time of 2.08 years. The annual failure rate of immediate implants was 0.82% translating into the 2-year survival rate of 98.4%. Lower failure rates were found in groups that were provided with a course of post-operative antibiotics. This information can potentially apply to the present study in which patients benefited from antibiotic treatment before and after the implantation surgery. The number of cases reported in the present study allow for a comparative statistical analysis between full-arch treatments at the mandible and maxilla. With respect to CSR a significant difference exists between mandible and maxilla. In single tooth restoration, it is well known that implant placement success rates are typically higher in the mandible than in the maxilla. Interestingly, this same trend appears valid for full-arch restorations, with a slightly higher failure rate noted in the maxilla (albeit not statistically different).

Full-mouth treatment

Conducted a survey on 659 immediate post-extraction implants obtained from a bibliographic review of 25 articles [24]. 322 patients have been treated with a total of 659 implants placed immediately following extraction. A total of 441 implants were inserted in the maxilla, 152 in the mandible and 64 were placed in an unspecified location. The survival rate ranged between 85% and 100%. Although these results are interesting the problem of implants contributing to full arch restoration was not addressed [11]. Is the only one reporting on full-mouth treatment on a limited number of 3 cases. During an 8 to 24-month follow-up period, the survival rate was 97.2%. This result is to be compared with the much longer follow up periods reported in our study the CSR appeared to be stabilized at 97.97% and for a much larger number of cases (29). Our consecutive observational study is the much larger conducted so far on maxillary, mandibular and bimaxillary reconstruction (121 patients, 1042 implants) over a long time period. The average follow up period of 5 years allows for drawing substantial surgical and clinical conclusions. The CSR is slightly less at the maxilla (97.7%) than at the mandible (100%) and full-mouth approach exhibited results of 97.97%. We observed a similar CSR for full-arch maxillary rehabilitation and full-mouth rehabilitation. The same absence of difference has been found between maxillary full-arch rehabilitation and full-mouth rehabilitation. It could be hypothesized that preserving both the bone structure and gingival architecture, as well as providing immediate functional loading is positive.

Single tooth *vs.* multiple teeth

We agree with Sanz-Sanchez et al. [25]. That single teeth implants show greater risk of failure, when compared to immediately load full

arch restorations. This study reinforces our choice to load the implants because the screw-retained prostheses maintain the implants together and increase their stability. It is assumed that the provisional screw-retained prosthesis maintains the implants together and secures the implants inserted with a low torque value (10-20 Ncm), even though the vast majority of the implants in this study had a higher insertion torque than 30 Ncm. If we consider only the implants that were inserted with a "low" insertion torque(less than 30 Ncm), the success rate results of these implants support the idea that the provisional screw-retained prosthesis indeed maintain some kind of increased stability over time.

Distal *vs.* non-distal implants

Shows that 97.81% of tilted implants and 98.11% of axial implants were osseo integrated [26]. (Meta-analysis on 11 articles with 1623 implants - 63 straight and 60 angulated). We report a slightly lower success rate for angled implants as compared to straight-placed implants but it has to be noticed that in the present study, angled implants were systematically placed in the distal position. While distally placed implants can also be straight, the success rate between distal and angled distal implants was found to be equivalent.

Conclusion

In the present observational study, the prosthetic success and patient satisfaction was very high. This is likely to be related to the initial clinical stand point of these patients whose dental health is very severely compromised. As they suffered during years of a very poor oral health they indubitably felt improvement. Combining immediate placement of dental implants after extractions and immediate loading of complete restorations at the maxilla, the mandible or both is a reliable alternative demonstrating a Cumulative Survival Rate (CSR) similar to that of more conventional techniques. The high Cumulative Survival Rates (CSRs) demonstrate that the above described treatments are a viable alternative for rehabilitating the edentulous maxilla or mandible or the both jaws at the same time.

Approval

Concerning the approval from an Institutional Review Board (IRB) or an Ethics Review Committee (ERC). This study is a retrospective study based on treatment performed on regular basis in his private practice and as we write it in the manuscript: "All the relevant data were recorded after the patients gave their consent and the study was registered at the CNIL (Commission Nationale Informatique et Libertés, Paris, France) under the number 1790755V0 assuring the confidentially of the data compilation and analysis."

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