



Surgical and Prosthetic Outcomes of 967 Implants Under Immediate or Delayed Loading in Full-Arch Rehabilitation: a Retrospective Study With up To 5 Years of Follow-Up

Resultados Cirúrgicos e Protéticos de 967 Implantes Submetidos à Carga Imediata ou Tardia Na Reabilitação de Arcos Completos: um Estudo Retrospectivo com Até 5 Anos de Acompanhamento

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ABSTRACT

Objective: The aim of this study was to evaluate implant and prosthesis survival rates in full-arch rehabilitation supported by implants with platform-switched Morse taper connection submitted to immediate or delayed loading, after up to 5 years of follow-up. **Material and Methods:** Data was retrospectively collected from clinical records of patients who were treated by means of implant-supported full-arch rehabilitation. Survival rates of implants and prostheses were evaluated according to immediate or delayed loading. **Results:** The sample comprised 967 implants. Of those, 627 were submitted to immediate loading (IL) while 340 to delayed loading (DL). After a follow-up period of up to 5 years, the implant survival rate for IL was of 99.7% (622/627 implants) and 97.2% (333/340 implants) for DL. The overall implant survival rate was 98.8% (955/967 implants). Prosthesis survival rate was 100% (N = 178) for both groups. Significantly more implants in the DL group presented bone loss ($p > 0.01$), either greater or lower than 2 mm, during the follow-up period. **Conclusion:** Within their limits, the present results suggest that full-arch rehabilitation with platform-switched Morse taper connection implants can lead to surgical and prosthetic predictable outcomes. Moreover, immediate loading protocol seems to be a good option for the

RESUMO

Objetivo: O objetivo deste estudo foi avaliar as taxas de sobrevivência de implantes e próteses em reabilitações de arco completo suportadas por implantes de conexão cone Morse e *platform switching* submetidos à carga imediata ou tardia, após até 5 anos de acompanhamento. **Material e Métodos:** Os dados foram coletados retrospectivamente em prontuários clínicos de pacientes que foram tratados por meio de reabilitação de arco completo suportada por implantes. As taxas de sobrevivência de implantes e próteses foram avaliadas de acordo com a carga imediata ou tardia. **Resultados:** A amostra foi composta por 967 implantes. Destes, 627 foram submetidos à carga imediata (IL) e 340 à carga tardia (DL). Após um período de acompanhamento de até 5 anos, a taxa de sobrevivência de implantes para IL foi de 99,7% (622/627 implantes) e de 97,2% (333/340 implantes) para DL. A taxa de sobrevivência geral dos implantes foi de 98,8% (955/967 implantes). Taxa de sobrevivência da prótese de 100% (N = 178) foi encontrada para ambos os grupos. Significativamente mais implantes no grupo DL apresentaram perda óssea ($p > 0,01$), seja maior ou menor que 2 mm, durante o período de acompanhamento. **Conclusão:** Os presentes resultados sugerem, dentro de seus limites, que a reabilitação de arco completo com implantes de conexão cone Morse e *platform switching* pode obter resultados cirúrgicos

rehabilitation of fully edentulous patients, as it involves a shorter treatment time, which may lead to greater patient satisfaction.

KEYWORDS

Dental implants; Rehabilitation; Survival rate; Retrospective study.

e protéticos previsíveis. Além disso, o protocolo de carga imediata parece ser uma boa opção para a reabilitação de pacientes totalmente edêntulos, pois envolve um menor tempo de tratamento, o que pode levar a uma maior satisfação do paciente.

PALAVRAS-CHAVE

Implantes dentários; Reabilitação; Taxa de sobrevivência; Estudo retrospectivo.

INTRODUCTION

The rehabilitation of completely edentulous patients with implant-supported prosthesis has developed and revolutionized dentistry over the years. Several authors have reported that this type of rehabilitation can remain successful for many years, although most studies focused only on edentulous mandibles[1-3].

Implant loading protocol is a key factor to consider in dental rehabilitation. Originally, long-term results included only procedures with a healing period of 3 to 6 months before loading, which clinicians believed to be essential for predictable outcomes regarding osseointegration[4].

Nevertheless, to minimize treatment time, a reduced healing period with an one-stage surgery has been proposed, whereby abutments and prostheses are inserted at the same procedure of implant placement and demonstrated good clinical outcomes [5,6]. Thereby, with faster functional and aesthetics reestablishment, authors have reported greater patient satisfaction [7].

Different studies have reported that there are no significant differences for prosthesis success, implant success or marginal bone loss when different implant loading protocols are applied [8-11]. However, few have evaluated only fixed full-arch rehabilitation and most of these present outcomes involving small samples and/or short follow-up periods [7,12,13].

Thereby, the aim of this study was to evaluate implant and prosthesis survival rates

in full-arch rehabilitation supported by implants with platform-switched Morse taper connection submitted to immediate or delayed loading, after up to 5 years of follow-up.

METHODS

Study Sample and Data Collection

The present retrospective study was approved by the Ethics Committee of the International University Center – UNINTER (CAAE 81117317.0.0000.5573) and was conducted according to the principles embodied in the Helsinki Declaration of 1975, as revised in 2000, for biomedical research involving human subjects. Data collection was designed to preserve patient confidentiality.

Were included in the study records of all fully edentulous patients, aged 18 years or older, who were treated by means of full-arch rehabilitation (maxilla and/or mandible) supported by implants with platform-switched Morse taper connection (CM, Neodent, Curitiba, PR, Brazil) at Ilapeo College (Curitiba, Brazil), between 2013 and 2014. Only implants with regular diameter (3.5-5mm) and length (8-16mm) were included in the study. Records of patients that presented uncontrolled systemic disorders, presenting lack of implant information and/or lack of radiographic follow-up were excluded from the data collection.

The full-arch rehabilitation of the selected patients were divided into two groups, according to implant loading protocol: Immediate Loading (IL) or Delayed loading (DL). According to the records, immediate loading was applied when

a minimal insertion torque of 32 N.cm was achieved, and acrylic fixed prostheses were installed within 48 hours after surgery. In cases of primary stability lower than 32 N.cm, cover screws or healing abutments (Neodent, Curitiba, Brazil) were inserted, and a minimum healing period of 3 months was awaited before implant loading (delayed loading). For final rehabilitation, acrylic or ceramic full-arch prostheses supported by a metal bar were inserted. After each procedure, patients received verbal and written oral hygiene instructions.

All surgical and prosthetic procedures were performed by trained surgeons. Subjects were followed periodically by means of clinical and radiographic exams.

Therefore, Cone Beam Computed Tomographies (CBCT), panoramic and periapical radiographies and photographs were retrieved from patients' files, as well as preoperative, intraoperative and post-operative details.

Clinical Outcomes Evaluated

For the implant survival analysis, an implant was considered as failure when records described implant mobility, fracture, and/or any infection dictating removal. Prosthesis survival was considered when clearly recorded as remaining in situ and in function.

Marginal bone loss was radiographically evaluated (periapical radiographies), using Sidexis software (Sirona Dental Systems, Bensheim, Germany), as the distance from the implant platform to the first crestal bone-to-implant contact and classified as greater or lower than 2 mm [14].

Additionally, data collected concerning patient's gender, age at implant placement, systemic conditions, bone grafting procedures, as well as implant length, diameter and insertion torque, were also analyzed.

Statistical Analysis

Descriptive analyses were performed for all variables. Implant and prosthesis survival rates were calculated by dividing the number of events, up to the last follow-up record available,

by the total number of implants/prostheses assessed.

Normal distribution was verified by Kolmogorov-Smirnov tests. The results were nonsignificant for all variables. Implant and prosthesis survival rates, as well as bone loss classification were compared between groups with Chi-square tests. Intergroup comparability regarding patients' ages and follow-up time was performed with *t* test.

All analyses were performed using Statistica Software (version 10, Statsoft, Tulsa, OK, USA). Results were regarded as significant for $p < 0.05$.

RESULTS

Records of 160 patients were included in the study and their main baseline characteristics are presented in Table I. The sample comprised 967 platform-switched Morse taper connection implants (CM; Alvim, Drive, Titamax Cortical and Titamax EX; Neodent, Curitiba, Brazil), inserted to support 178 full-arch prostheses (69 maxillary and 109 mandibular rehabilitation). Of those, 627 were submitted to immediate loading and 340 to delayed loading.

Six to ten implants were placed in the maxilla (mean 8.4 ± 1.4 in DL group and 8.1 ± 1.8 in DL group) and four to six implants for mandible rehabilitation (mean 4.5 ± 0.7 in DL group and 5.1 ± 0.5 in DL group). In some cases, bone augmentation was needed, and bovine or synthetic grafting material was used.

Groups were comparable regarding patient's sex, presence of parafunctional or smoking habits and presence of controlled systemic disorders (diabetes and/or hypertension). In comparison to the IL group, the DL group presented a higher number of implants with the following characteristics: hydrophilic surfaces (Acqua, Neodent, Curitiba, Brazil), placement in maxilla and need of bone augmentation. More implants in the IL group presented insertion torques ranging from 32 N.cm to 60 N.cm. All implants were loaded using straight or angled Mini Conical abutments (Neodent, Curitiba, Brazil), the majority in both groups were straight (Table I).

Table I - Patient and procedure characteristics at implant level

		Delayed Loading (N=340)		Immediate Loading (N=627)	
		N	%	N	%
Sex	Female	251	73.8%	434	69.2%
	Man	89	26.2%	193	30.8%
Controlled systemic disorders (diabetes and/or hypertension)	No	332	97.6%	618	98.6%
	Yes	8	2.4%	9	1.4%
Bruxism	Yes	6	1.8%	20	3.2%
	Not reported	334	98.2%	607	96.8%
Smoking	Less than 10 cigarettes/days	13	3.8%	41	6.5%
	More than 10 cigarettes/days	29	8.5%	59	9.4%
	No	298	87.6%	527	84.1%
Surface treatment	Hydrophilic	103	30.3%	47	7.5%
	Non-hydrophilic	237	69.7%	580	92.5%
Region	Maxilla	334	98.2%	96	15.3%
	Mandible	6	1.8%	531	84.7%
Bone graft	Yes	163	47.9%	0	0%
	No	177	52.1%	627	100%
Insertion Torque	> 32 N.cm	123	39.3%	17	3.7%
	32 – 60 N.cm	188	60.1%	400	86.8%
	>60N.cm	2	0.6%	44	9.5%
Abutment	Straight	320	94.1%	608	97.0%
	Angled – 17°	18	5.3%	17	2.7%
	Angled – 30°	2	0.6%	2	0.3%

In up to 5 years of follow up, seven out of 340 implants were lost in the DL group, resulting in a 97.9% (N = 333) implant survival rate, and five out of 627 implants were lost in the IL group, resulting in a 99.2% (N = 622) implant survival rate. No significant difference was observed between groups ($p = 0.165$; Table II). Of the lost implants in the DL group, 71.4% (N = 4) were lost during the first year after placement and, in the IL group, 60% (N = 3) were lost in the years thereafter.

The overall implant survival rate was 98.8% (955 of 967 implants). Prosthesis survival rate was 100% for both groups.

Significantly more implants in the DL group presented bone loss, either greater or lower than 2 mm, during the follow-up period ($p < 0.01$; Table II).

Patients were followed for up to 5 years (mean 3.3 ± 1.5 years). No significant differences were observed between groups with respect to patients' ages and follow-up time ($p = 0.467$; Table II).

Table II - Intergroup comparisons (Chi-square and *t* tests)

		Delayed Load (N=340)		Immediate Load (N=627)		Total N	P value
		N	%	%	N		
Implant survival		333	97.9%	622	99.2%	955	0.165
Prosthesis survival		340*	100%	627†	100%	967	-
	≤ 2 mm	25	7.4%	14	2.5%	39	
Bone loss	>2mm	21	6.2%	17	3.0%	38	<0.01*
	No	294	86.5%	537	94.5%	831	
Patients' age	Mean (S.D.)	51.43 (10.54) years		52.87 (11.63) years		-	0.057
Follow-up time	Mean (S.D.)	3.4 (1.2) years		3.2 (1.6) years		-	0.467

‡ Implants supporting 54 prostheses. † Implants supporting 124 prostheses.

*Statistically significant at the 0.05 level.

DISCUSSION

At the early years of development of osseointegrated implants, it was believed that only with the 2-stage surgery, in which surgical sites should be unaltered for 3 to 6 months, osseointegration was obtained. However, studies have already shown that it can also be achieved in immediately loaded implants [5,10,15].

The present study found no significant difference between the IL and DL groups regarding implant survival rate, with 99.2% and 97.9%, respectively. The results corroborate with the previously found by other authors but with smaller samples, with survival rates ranging from 93.9% to 100% for immediate loading and between 95.9% and 99% for delayed loading [7,16,17].

Whereas groups in the present study were comparable regarding gender, parafunctional and smoking habits, those were not confounding factors when comparing intergroup implant survival outcomes [18,19].

Regarding the lost implants, the majority in the DL group was lost during the first year after placement, while in the IL group, most were lost in the years thereafter. Most studies have reported that early failures are more frequent than late ones, that is, implants are lost before loading [18-21]. The causes and mechanisms for that are still unclear, but lack of osseointegration is considered to be the main reason, and significant related factors observed are health conditions, smoking, implant length and diameter, unfavorable bone quality and quantity, as well as maxillary implant location [19,22,23]. Thus, the greater prevalence of early failure among the lost implants in the DL group was expected. The causes of late failure are more controversial, periimplantitis and loading conditions have been reported as dominant factors [20,24].

The fact that more implants presenting hydrophilic surfaces (Acqua, Neodent, Curitiba, Brazil) were used in the DL group may be explained by the fact that delayed loading is usually applied to regions of low-density bone, like maxilla and areas that need bone augmentation [15,25]. It is known that hydrophilicity of implants correlates positively with stability and osseointegration by increasing bone-to-implant interface, leading to higher success survival rates [26,27]. Thus, that might have positively influenced the similar survival rates observed in the study groups.

In the descriptive analysis of the insertion torque, it was possible to notice that most implants in the IL group presented insertion torques ranging from 32 N.cm to 60 N.cm. This factor may also have favored the results obtained in the present study, since a minimum insertion torque of 32 N.cm has been reported to be a key factor for implant survival, especially in immediately loaded full-arches [28-30].

Our results showed 100% prosthesis survival rates in both groups, corroborating with

the previously found by most studies, which reported prosthesis survival ranging from 95% to 100%, with a follow-up period of up to 15 years [1,31]. However, few compared loading protocols.

In the present study, bone loss was significantly higher in DL protocol, as also reported by other authors [16,32]. However, the great majority of implants in both study groups showed no bone loss during the entire follow-up period. This may be explained by the fact that all study implants presented platform-switched morse taper connection, which are known to exhibit reduced bone remodeling when compared to standard implants restored with abutments of matching diameter [33].

Considering that no significant differences were found in implant and prosthesis survival rates between loading protocols, IL seems to be an effective alternative for full-arch rehabilitation, with predictable results in the long-term. This protocol involves a shorter treatment time, which is essential in achieving patient satisfaction [7]. Nevertheless, since retrospective studies may have some limitations that cannot be entirely overcome, such as limited and less accurate data, further prospective studies are needed to confirm the presented outcomes.

CONCLUSION

Within their limits, the present results suggest that full-arch rehabilitation with platform-switched Morse taper connection implants can lead to surgical and prosthetic predictable outcomes. Immediate loading protocol has presented to be a good option for the rehabilitation of fully edentulous patients, with significantly lower bone loss than delayed protocol. Moreover, it involves a shorter treatment time, which may lead to greater patient satisfaction.

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