Survival Rate of Sandblasted, Large Grit, Acid-Etched (SLA) versus Laser-Treated Implants in Completely Edentulous Patients Rehabilitated with Mandibular Implant-Retained Overdentures: A Split-Mouth Study

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A R T I C L E   I N F O.

Abstract

Objective: This study aimed to evaluate the survival rates of Sandblasted, Large grit, Acid-etched (SLA) and laser-treated implants supporting two implant-mandibular overdentures over a 12 months period.

Methods: Thirteen edentulous patients received two implants each in the intra-foraminal region of the mandible, with SLA in the left side of the midline, laser-treated implants in the right side and ball stud attachments for the overdenture. The overdentures were early loaded after 6 weeks. Implants survival rate was evaluated over a12 months follow up period using image analysis software (Digora Optime, Soredex). The statistical software SPSS (Statistical Package for the Social Science; 22.0, IBM Corp, Armonk, NY, USA) was utilized for data analysis. Implant survival rates were calculated using the Kaplan-Meier analysis.

Results: After 12 months follow up period, the implants survival rate was 92.3%. The overall mean survival times of the implants was 11.269 m. For the laser-treated implants and SLA the mean survival times were 11.308 and 11.231 months respectively. There was a non-statistically significant difference in the survival rate of implants in both groups with p value(P=0.97)

Conclusion: The use of SLA and laser-treated implants with stud attachments and an early loading protocol can provide a successful and reliable solution for edentulous patients.

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1.Introduction

The global increase in complete edentulism (CE) has led to various proposed treatment options to mitigate the associated speech, mastication, and appearance problems that can impact patient satisfaction and quality of life[1]. Among these options are conventional complete dentures and implant-supported prostheses, with the latter offering improved stability and retention in compromised arches. However, the financial considerations of patients and the challenges of selecting implants with the desired surface topography that aids in better osseointegration and increased bone-to-implant contact are important factors to consider[2].

To improve the osseointegration process, various modifications to the surface treatment of dental implants have been developed. Among these modifications, laser surface treatment has shown promise in improving the bone-to-implant contact and stability of the implant, leading to better marginal bone stability compared to other types of implant surface treatments. This improved osseointegration resulting from laser surface treatment can enhance the long-term survival rate, functional outcomes, and patient satisfaction of implant-supported prosthesis[3].

In light of these developments, this study aims to evaluate the impact of laser surface treatment versus sandblasting, large-grit, acid-etched (SLA) implants in improving the survival rate of dental implants in completely edentulous patients rehabilitated with two-implants retained mandibular overdenture. By examining the potential benefits of laser surface treatment, this study aims for contribution to the ongoing efforts to enhance the quality of life for completely edentulous patients.

1-1Null hypothesis:

Laser surface treatment compared to SLA of dental implants does not affect the survival rate of implants in completely edentulous patients rehabilitated with two-implants retained mandibular overdenture.

2-Material & Methods:

2.1. Patient selection:

Thirteen patients with complete edentulism were selected based on specific inclusion criteria, which included normal skeletal relationship, normal facial symmetry, last extracted canine not less than six months ago, sufficient intra-foraminal bone quality and quantity, minimal inter-arch space of 12mm, width of keratinized mucosa more than 6mm, and freedom from any temporomandibular disorders. Patients with general contraindications for surgical procedures, metabolic disorders affecting osseointegration, long-term immunosuppressive and corticosteroid drug therapy, bleeding disorders, flabby tissues or knife-edge mandibular residual ridge, neuromuscular disorders, or heavy smokers were excluded from the study.

2.2 Fabrication of complete dentures:

Complete dentures were fabricated for both groups to serve as temporization. The mandibular denture was also used as a radiographic stent to diagnose and evaluate bone dimensions in the canine regions. Additionally, it was used as a surgical stent to ensure accurate and prosthetically correct placement of the proposed implants (Figure.1).

(Figure 1) Radio-opaque marker on CBCT.

2.3. Preoperative instructions:

Two days prior to the surgery, the patients were instructed to antibiotic administration (Augmentin 1gm) two times daily for five days and to rinse their mouth with 0.12% chlorhexidine mouthwash three times a day.

2.4. Surgical procedure:

The canines were removed bilaterally from the stent, and the stent was then seated in the patient's mouth. A tissue punch was used to expose the bone, with a speed of 1100 rpm and 50 N/cm using a 1/20 contra angle. The initial osteotomy site preparation was made through the surgical stent using the pilot drill of both BIOMATE and IMPLURA implant systems, with copious external irrigation (Figure 2).

(Figure 2) Parallel osteotomy sites

2.5. Implant placement:

All patients received BIOMATE implant laser surface treatment on the right-side implants, with a size of 4.1 x 10mm, and IMPLURA implant SLA on the left-side implants, with a size of 4.2 x 10mm. The implants were manually inserted into the mandibular osteotomy sites, using a torque ratchet until the implant platform was level with the bone surface with torque of 35N.

Healing collars were screwed in place over both implants (Figure 3).

(Figure 3) Implants in canine region

2.6. Prosthesis placement:

The definitive complete dentures were early-loaded after 6 weeks of surgery. Healing abutments were removed and ball abutments of each implant type were torqued over the implants at 20 N. The denture was relieved adequately over the metal housing of the attachment until it was fully seated, guided by proper occlusion with the opposing arch. A small lingual hole was created in the relieved area to allow the escape of the acrylic resin used in the pick-up impression. A small piece of rubber dam was placed underneath the ball abutments to prevent the flow of the acrylic underneath the abutments (Figure 4,5).
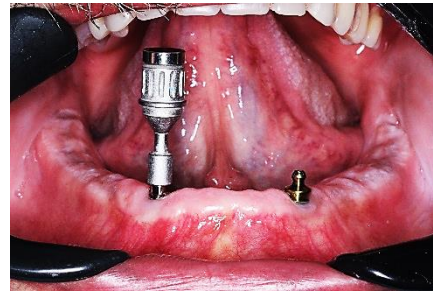
(Figure 4) Torqued ball abutments

(Figure 5) Preparation for pick-up procedures

Once the acrylic resin had set, the denture was removed from the patient's mouth for finishing and polishing.

2.7. Follow-up:

Follow-up evaluations were performed over a 12-month period, including clinical evaluation, Periotest test, implant stability quotient (ISQ) measurement, radiographic evaluation, and oral hygiene evaluation.

Radiographic evaluation using periapical radiographs to assess the bone-to-implant contact and marginal bone level changes around the implant was performed. The overdentures were evaluated for any occlusal discrepancies, attachment loosening, or fracture. Additionally, the patients were educated on proper oral hygiene techniques, and an oral hygiene evaluation was performed to check for any plaque accumulation or gingival inflammation.

Furthermore, the implant success criteria were evaluated according to the criteria established by the International Congress of Oral Implantologists (ICOI), which includes absence of persistent pain, no implant mobility, and no progressive bone loss.

These evaluations were performed regularly post-implant loading at 3,6,9 and 12 months, to ensure the long-term success and stability of the implants.

The outcome measure used was implant survival, which was defined as an implant that remained clinically stable and functional without any mobility. The implants were

considered to have failed if they had to be removed due to loss of integration, implant mobility (as verified by Periotest), symptoms such as pain, neuropathies, paraesthesia, or psychological reasons.

To determine the estimated failure rate, the number of implant failures was divided by the total amount of time the implants were in use. This total time includes the entire observation period, as well as the time until the failure of lost implants during the follow-up. This approach considers the whole follow-up period, from the initial placement of the implant to its removal or loss.

By using this outcome measure and calculating the failure rate, the survival rates of the implants can be determined. This information can be used to evaluate the effectiveness of the implant placement and to make informed decisions regarding future treatment options.

The research received ethical approval from the Faculty of Dentistry at Cairo University on February 18, 2020, with the approval number 20-2-34.

2.8 Sample size calculation

The sample size calculation for this study was conducted using a paired t-test to compare the implants survival rate between two interventions. The outcome of interest was the mean difference in survival rate, with a standard deviation of 0.41 for sandblasted implants. The minimum clinically important difference was set at 0.4 mm based on expert opinion. The significance level (α) was set at 0.05, and the desired power of the study was 0.8. Based on these parameters, the effect size was calculated using the values of 0.65 and 0.4. Using these inputs, the sample size was determined to be 10 cases. To account for anticipated missing data, an additional 20% was added, resulting in a total sample size of 13 cases.

2.9 Statistical Analysis:

The statistical software SPSS (Statistical Package for the Social Science; 22.0, IBM Corp, Armonk, NY, USA) was utilized for data analysis. Implant survival rates were calculated using the Kaplan-Meier analysis. For each group, the mean and median survival time were determined, along with their 95% confidence interval (CI). A p-value less than 0.05 was considered statistically significant, indicating a significant difference between the groups. This statistical analysis

can aid in determining the success and survival rates of the implants, thereby providing important insights for clinical decision-making.

3-Results

One implant failed in each group with an overall survival rate of 92.3%.

There was a non-statistically significant difference in the survival rate of implants in both groups with p value(P=0.97)

The survival rate of implants is shown in Kaplan- Meier graph (Figure 6) (Tables 1-4).
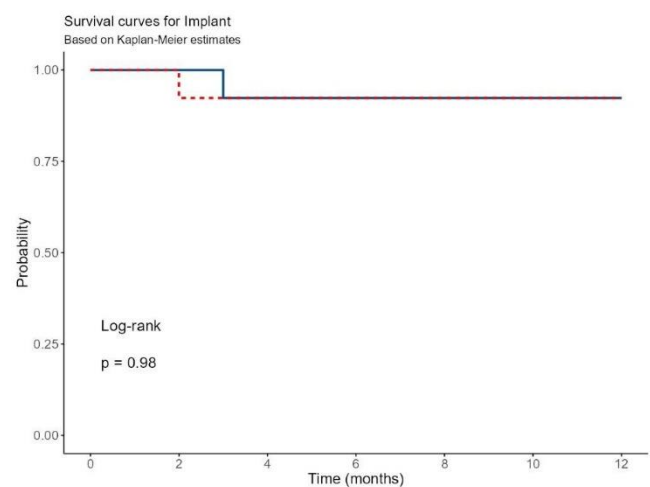
(Figure 6) Kaplan- Meier graph.

(Table 1) Kaplan- Meier analysis summary

Case Processing Summary			Censored	
Implant	Total N	N of Events	N	Percent
Laser surface treatment	13	1	12	92.3%
Sandblasted Acid-etched	13	1	12	92.3%
Overall	26	2	24	92.3%

(Table 2) Kaplan- Meier analysis for SLA and Laser treated implants

Means and Medians for Survival Time								
	Mean(a)		95% Confidence Interval		Median		95% Confidence Interval	
Implant	Estimate	Std. Error	Lower Bound	Upper Bound	Estimate	Std. Error	Lower Bound	Upper Bound
Laser surface treatment	11.308	0.665	10.004	12.611	.	.	.	.
Sandblasted Acid-etched	11.231	0.739	9.782	12.679	.	.	.	.
Overall	11.269	0.497	10.295	12.244	.	.	.	.

a. Estimation is limited to the largest survival time if it is censored.

(Table 3) Means and medians for survival time

Survival Table

Implant		Time	Status	Cumulative Proportion		N of Cumulative Events	N of Re
				Estimate	Std. Error		
Laser surface treatment	1	3.000	Yes	0.923	0.074		1
	2	12.000	No	.	.		1
	3	12.000	No	.	.		1
	4	12.000	No	.	.		1
	5	12.000	No	.	.		1
	6	12.000	No	.	.		1
	7	12.000	No	.	.		1
	8	12.000	No	.	.		1
	9	12.000	No	.	.		1
	10	12.000	No	.	.		1
	11	12.000	No	.	.		1
	12	12.000	No	.	.		1
	13	12.000	No	.	.		1
Sandblasted Acid-etched	1	2.000	Yes	0.923	0.074		1
	2	12.000	No	.	.		1
	3	12.000	No	.	.		1
	4	12.000	No	.	.		1
	5	12.000	No	.	.		1
	6	12.000	No	.	.		1
	7	12.000	No	.	.		1
	8	12.000	No	.	.		1
	9	12.000	No	.	.		1
	10	12.000	No	.	.		1
	11	12.000	No	.	.		1
	12	12.000	No	.	.		1
	13	12.000	No	.	.		1

(Table 4) Kaplan- Meier analysis p value

Overall Comparisons

	Chi-Square	df	p value
Log Rank (Mantel-Cox)	0.001	1	0.977

Test of equality of survival distributions for the different levels of Implant.

4-Discussion:

Two-implant supported mandibular overdentures have become a popular treatment option for edentulous patients because they offer better retention and stability than conventional dentures. They also help to prevent bone resorption in the mandible, which can lead to further complications[4].

The success of implant-supported mandibular overdentures depends on several factors, including implant surface treatment, implant placement location, surgical protocol, and overdenture retention mechanism. In this study, acid-etched sandblasted and laser-treated implants with stud attachments were used to optimize retention, stability, and success rates[5].

Acid-etched sandblasted implants are known for their increased surface area, which allows for better osseointegration[6].

Laser-treated implants, on the other hand, offer advanced, precise, and accurate surface modifications without altering the implant material's biomechanical properties. These surface treatments have been shown to enhance osseointegration and improve bone-implant contact, which can lead to better implant survival rates[7].

Stud attachments were used in this study due to their outstanding performance in mandibular overdenture retention and stability. They provide additional retention, which is extremely important for mandibular dentures, as well as improved support and easy maintenance[8].

The early loading protocol used in this study may have also contributed to the high success rate and marginal bone level maintenance. Early loading allows for stimuli at the bone-implant interface, leading to better differentiation of bone structure around the implant and higher marginal bone levels[9].

Implant survival rate is a clinical parameter used to measure the success of dental implants. It refers to the proportion of implants that remain stable and functional over a certain period of time. Typically, implant survival rate is reported as a percentage and is calculated by dividing the number of surviving implants by the total number of implants placed[10].

Implant survival rate is an important outcome measure because it reflects the physical presence of the implant in the patient's mouth. Factors that can lead to implant failure include implant fracture, infection, implant mobility, or peri-implant bone loss. A high implant survival rate indicates that the implant has remained stable and functional and has not needed to be removed as a result of complications[11].

The survival rate of dental implants can vary depending on various factors such as implant location, implant design, surgical technique, patient characteristics, and maintenance protocols. Generally, implant survival rates are higher in the anterior region of the jaw compared to the posterior region, as the bone in the anterior region has superior density and more resistant to resorption. Implant design features such as surface roughness, thread design, and implant diameter and length can also affect implant survival rates[12].

The present study evaluated the survival rates of Sandblasted, Large grit, Acid-etched (SLA) and laser-treated implants supporting two implant-mandibular overdentures over a 12 months period. The results showed a high implant survival rate of 92.3% for the entire sample, which is consistent with previous studies that reported high survival rates of implants retaining mandibular overdentures

There was no statistically significant difference in the survival rate of implants between the two types of surface treatments. Therefore, the null hypothesis, which stated that "laser surface treatment compared to SLA of dental implants does not affect the survival rate of implants in

completely edentulous patients rehabilitated with two-implants retained mandibular overdenture," is accepted.

After 12 months follow up period, the implants survival rate was 92.3%. The overall mean survival times of the implants was 11.269 m. For the laser-treated implants and SLA the mean survival times were 11.308 and 11.231 months respectively, which suggests that the surface treatment of implants provide long-term stability and function for patients.

While implant survival rate is an important measure of implant success, it should be noted that other outcome measures, such as prosthetic success and patient-reported outcomes, should also be considered when evaluating the success of dental implants. However, the results of this study suggest that two implant-supported mandibular overdentures using acid-etched sandblasted and laser-treated implants with stud attachments can provide high success rates and long-term stability and function for edentulous patients.

5-Summary and Conclusion:

In conclusion, acid-etched sandblasted and laser-treated implants with stud attachments in an early loading protocol for mandibular overdentures can provide high survival rates, and long-term stability and function for edentulous patients. These findings are consistent with previous research and support the use of these treatment modalities for implant-supported mandibular overdentures.

Recommendations:

Further studies can be conducted to evaluate the survival rate of laser and SLA surface treatments and their effects and marginal bone stability for longer period of times.

Authors' Contributions

Marwan Abdelsalam, principle investigator.
Amal Fathy Kaddah, and Dina Elawady managed manuscript writing and design.
Samer Mostafa Ali, managed concepts, design.
Doaa Alkady, managed definition of intellectual content.
All authors have read and approved the manuscript.

Informed consent

Patients accepted and signed a written informed consent to this treatment protocol.

Conflict of interest

The authors declare that they hold no competing interests.

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