

Evaluation of the Success Rate of Dental Implants in Oral Cavity Cancers: A Systematic Review and Meta-analysis

Evaluación de la tasa de éxito de los implantes dentales en los cánceres de cavidad oral: una revisión sistemática y un metanálisis

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Abstract

Objectives: There are many challenges and discussions about how and when Dental Implants and the survival rate of the implant are also very important. Therefore, the present study aimed to evaluate and determine the survival rate of implants in patients with Oral Cavity Cancers who received radiotherapy versus those who did not.

Methods: In this systematic review and meta-analysis study, all English-language full-text articles were published in international databases that listed the words Dental Implants, Oral Cavity Cancers in PubMed, Scopus, Science Direct databases, and Embase were reviewed between January 2012 and May 2022. Data analysis was performed using STATA.V16 software.

Results: The implant survival rate was 87.45% for non-irradiated jaws. The odds ratio for the survival rate of dental implants between irradiated and non-irradiated groups was 1.64 (OR, 1.64 95% CI 1.14, 2.15; p<0.01).

Conclusions: The present meta-analysis showed that in patients with Oral Cavity Cancers who were irradiated, the implant survival rate was 81.35%. In patients who were not irradiated, the survival rate of implants was high; it should be noted that this difference is not very significant

Key words: Dental Implants, Meta-Analysis, Survival Rate.

Resumen

Objetivos: Hay muchos desafíos y discusiones sobre cómo y cuándo los implantes dentales y la tasa de supervivencia del implante también son muy importantes. Por lo tanto, el presente estudio tuvo como objetivo evaluar y determinar la tasa de supervivencia de los implantes en pacientes con cáncer de cavidad oral que recibieron radioterapia versus aquellos que no la recibieron.

Métodos: En esta revisión sistemática y estudio de metanálisis, todos los artículos de texto completo en inglés se publicaron en bases de datos internacionales que enumeraban las palabras Implantes dentales, Cánceres de cavidad oral en PubMed, Scopus, bases de datos Science Direct y Embase se revisaron entre enero 2012 y mayo de 2022. El análisis de datos se realizó mediante el software STATA.V16.

Resultados: La tasa de supervivencia de los implantes fue del 87,45 % para los maxilares no irradiados. La razón de probabilidad para la tasa de supervivencia de los implantes dentales entre los grupos irradiados y no irradiados fue de 1,64 (OR, 1,64, IC del 95 %: 1,14; 2,15; p<0,01).

Conclusión: El presente metanálisis mostró que en pacientes con cáncer de cavidad oral que fueron irradiados, la tasa de supervivencia del implante fue del 81,35 %. En pacientes que no fueron irradiados, la tasa de supervivencia de los implantes fue alta; cabe señalar que esta diferencia no es muy significativa.

Palabras clave: Implantes Dentales, Metanálisis, Tasa de Supervivencia.

Introduction

According to reports, oral cavity cancers are one of the most common cancers caused by tobacco products; this type of cancer is prevalent in the Indian subcontinent. Surgery is used after the radiation therapy to treat this cancer, which can be done with or without chemotherapy^{1,2}. Free fibular transplantation or reconstruction methods are usually used for segmental resection of the mandible. Transplants are performed after radiotherapy and after surgery³. It should be noted that the treatment methods for this type of cancer are very challenging, and patient safety is the most important goal of treatment; Secondly, dental rehabilitation is important⁴. This rehabilitation in patients improves chewing function and speaking and is also aesthetically important⁵. Osseointegrated implants are a rehabilitation method that is a gold standard^{6,7}. Evidence suggests that about 85% of patients with this cancer receive radiotherapy after surgery^{8,9}. Radiotherapy, in turn, reduces vascularization and impedes bone resorption and the ability to regenerate tissues¹⁰. After radiation, the effects on bone can be vascular, cellular, and metabolic. After radiation therapy, hyperemia is generally reported in the tissues, followed by vascular shrinkage, which leads to osteoradionecrosis of the bone^{11,12}. There are many challenges and discussions about how and when dental implants, and the survival rate of the implant is also very important. Therefore, the present study aimed to evaluate and determine the survival rate of implants in patients with Oral Cavity Cancers who received radiotherapy versus those who did not.

Methods

The present study was a systematic review and meta-analysis. The PRISMA guide¹³ was used for this study conducted in 2022. Searches in PubMed, Scopus, Science Direct databases, and Embase were conducted to identify related articles until May 2022. A review of more recent studies can provide stronger evidence^[14], so the articles were reviewed over the last ten years in the present study.

The search terms ("Dental Health Services"[Mesh] OR "Dental Implant-Abutment Design"[Mesh] AND "Prostheses and Implants"[Mesh] OR ("Dental Implants"[Mesh] OR "Dental Implants, Single-Tooth"[Mesh])) OR ("Dental Implants/adverse effects"[Mesh] OR "Dental Implants/classification"[Mesh] OR "Dental Implants/statistics and numerical data"[Mesh])) AND ("Electromagnetic Radiation"[Mesh] OR "Radiation"[Mesh])) AND "Neoplasms"[Mesh] OR "Mouth Neoplasms"[Mesh] AND ("Survival"[Mesh] OR "Mortality"[Mesh] OR "Survival Analysis"[Mesh] OR "Survival Rate"[Mesh])were used, which were adjusted based on the mesh term. All articles were reviewed, and the extracted data were categorized.

Inclusion and exclusion criteria

Inclusion criteria

Randomized control studies, retrospective, and prospective studies.
Oral cavity cancer patients
Reported survival of implants in studies
Only studies published in English

Exclusion criteria

Letter studies to the editor, review, laboratory, and in-vitro studies.

Studies without full text. **Table I** is based on the answer to the PICO strategy.

Table I: PICO strategy.

PICO strategy	Description
P	Population: Oral cavity cancer patients with implant treatment
I	Intervention: Radiation
C	Comparison: Irradiated vs. non-irradiated
O	Outcome: The survival rate

Data collection and data analysis

The "data extraction form" designed by the researchers based on the research purpose was used to review the articles. The form included sections such as author name, year of publication, type of study, number of patients, age, and number of implants.

The Newcastle-Ottawa Scale (NOS)⁸ was used to determine the quality of cohort and case-control studies. With 9 items, this measure comprises three dimensions (selection, cohort comparability, and outcome). Any studies with NOS scores of 1-3, 4-6, or 7-9 were classified as low, medium, or high quality, respectively, in the analysis.

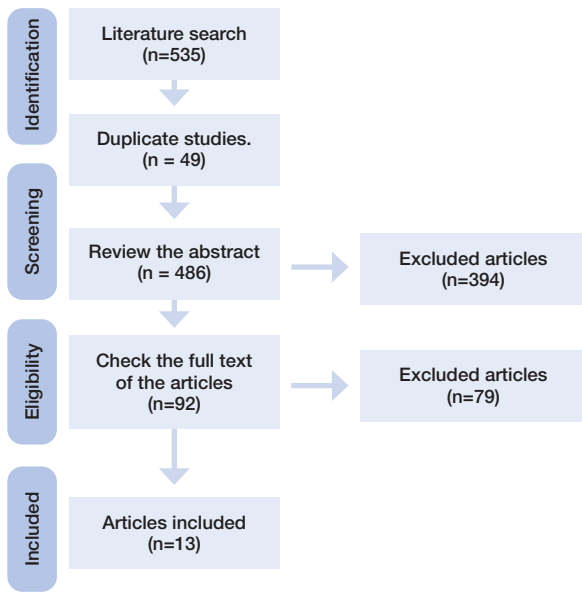
The STATA. V16 software was used to analyze data. I^2 index test was used to evaluate the level of heterogeneity ($I^2 < 50\%$ = low levels, $50 < I^2 < 75\%$ = moderate and $I^2 > 75\%$ = high levels). 95% confidence interval on the Odds ratio and effect size were done with the fixed-effect model and Mantel-Haenszel or in-variance method.

Results

The initial search result was 1535 articles, of which 821 were deleted due to lack of inclusion criteria; of the articles, 49 were deleted due to reprints in other journals and duplication. Of the remaining 665 articles, after deleting articles in accordance with the exclusion criteria (573 articles), the full text of 92 articles that met the inclusion criteria was prepared and reviewed, and 48 studies were inconsistent with the purpose of the present study, 31 studies presented incomplete data and were of very low quality and were excluded. Finally, 13 articles were included in the study. The flowchart of

the review and entry stages of the papers is shown in **Figure 1**.

Figure 1: PRISMA flowcharts.



Characteristics

Eleven studies and two studies that met the inclusion criteria for the present study were retrospective and prospective studies, respectively. The number of male and female participants was 473 and 253, respectively; the total was 726, and the number of implants was 2730. (Table II).

Bias assessment

According to the NOS tool, seven studies had a moderate risk of bias, whereas six studies had a low risk of bias. (Table III).

Survival rate

According to the findings of studies in patients with Oral Cavity Cancers, the implant survival rate was 81.35% for irradiated jaws and 87.45% for non-irradiated jaws. (Figure 2).

The odds ratio for the survival rate of dental implants between two groups was 1.79 (OR, 1.79 95% CI 1.36, 2.23; p<0.01) among nine studies with moderate heterogeneity I²=62.89%; P=0.01); there was a

Table II: Summary of patients' demographic data from selected studies.

Study. Years	Study design	Number of Patients		Number of Implants	Mean of Age (Years)
		Male	Female		
Sandoval et al., 2020 ¹⁵	Retrospective study	15	5	29	62.5
Menapace et al., 2018 ¹⁶	Retrospective study	6	7	121	62.4
Pellagrino et al., 2018 ¹⁷	Retrospective study	15	6	108	50
Woods et al., 2017 ¹⁸	Retrospective study	28	24	156	43.6
Kobayashi et al., 2016 ¹⁹	Retrospective study	27	14	134	61.3
Chang et al., 2016 ²⁰	Retrospective study	166	80	1132	60
Jackson et al., 2016 ²¹	Retrospective study	31	15	15	58.1
Pompa et al., 2015 ²²	Retrospective study	12	22	144	51
Dholam et al., 2013 ²³	Retrospective study	18	12	85	46
Mancha et al., 2012 ²⁴	Retrospective study	38	12	335	55.2
Sammartino et al., 2011 ³⁵	Retrospective study	51	26	172	55
Katsoulis et al., 2011 ³⁶	Retrospective study	31	15	104	57
Korfage et al., 2010 ³⁷	Retrospective study	35	15	195	61

Table III: Bias assessment (NOS tool).

Number of Studies	Selection (5 scores)				Comparability (2 scores)	Outcome (2 scores)		Total Score
	Representative sample	Sample size	Non-respondents	Ascertainment of the exposure		Based on design and analysis	Assessment of outcome	
Sandoval et al., 2020 ¹⁵	*	*	*	*	*	*	*	7
Menapace et al., 2018 ¹⁶	*	*	*	-	*	*	*	6
Pellagrino et al., 2018 ¹⁷	*	*	*	-	*	-	*	5
Woods et al., 2017 ¹⁸	*	*	*	**	**	*	*	7
Kobayashi et al., 2016 ¹⁹	*	*	*	-	*	-	*	5
Chang et al., 2016 ²⁰	*	*	*	*	*	*	*	7
Jackson et al., 2016 ²¹	*	*	*	*	**	*	*	8
Pompa et al., 2015 ²²	*	*	*	*	*	*	*	7
Dholam et al., 2013 ²³	*	*	*	*	**	*	*	8
Mancha et al., 2012 ²⁴	*	*	*	-	*	*	*	6
Sammartino et al., 2011 ³⁵	*	*	*	-	*	-	*	5
Katsoulis et al., 2011 ³⁶	*	*	*	-	*	-	*	5
Korfage et al., 2010 ³⁷	*	*	*	-	*	*	*	6

*=1 score, **=2 score, -= 0 score.

statistically significant difference between irradiated and non-irradiated groups ($p < 0.01$). **Figure 3** showed heterogeneity with binary data, and **Figure 4** showed graphical diagnostics of the small-study effect.

Figure 2: The Forest plot showed the survival rate of dental implants.

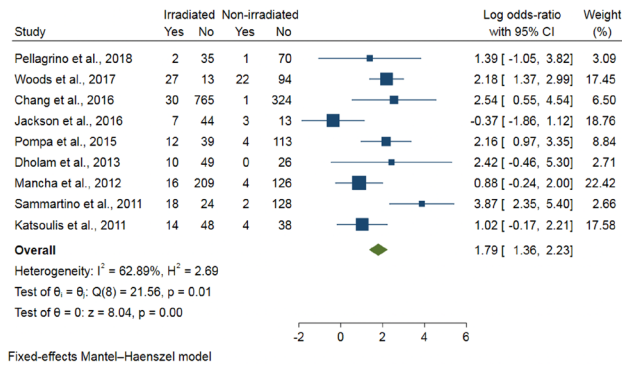


Figure 3: L'Abbe plot to check for heterogeneity with binary data.

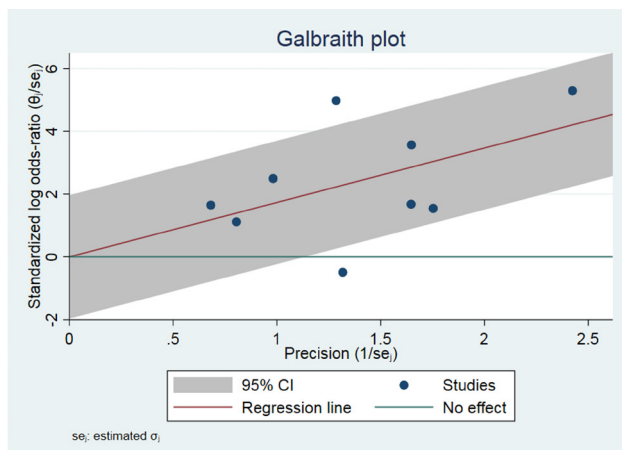
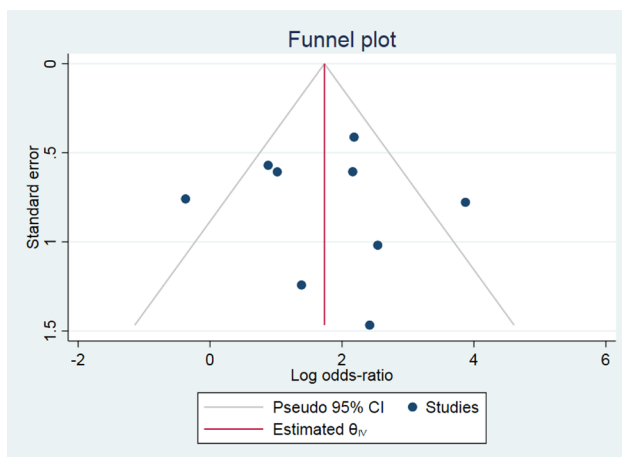


Figure 4: Funnel plot for graphical diagnostics of small-study effect.



Discussion

After surgical treatment and radiation therapy for patients with Oral Cavity Cancers, rehabilitation with dental implants has received much attention²⁵. A study showed that dental rehabilitation with implants increases patients' quality of life undergoing radiotherapy²⁶. According to the meta-analysis results, the failure rate of implants in irradiated people is about 15%. Based on the findings of the present meta-analysis, the survival rate of implants in irradiated patients and the control group was 81.35% and 87.45%, respectively²⁷; these findings are consistent. Based on the present study's findings, a significant difference was observed between the survival rates in the two groups, although this difference is not very significant. Since the present study used articles from the last ten years and considered the quality of the studies to be high, moderate downward heterogeneity was also observed. The present study results could provide good evidence for implant rehabilitation in patients with Oral Cavity Cancers. RCT studies have shown that the survival rate of implants in patients who were not irradiated was much higher than in the irradiated group; However, the existing RCT studies did not meet the inclusion criteria of the present study. They were not included in the study, but their findings were in line with the present results²⁸⁻³⁰. Some RCT studies also reported the same survival rates in both groups; these findings are inconsistent with the present study^{17,31}. One of the challenges in dental implants' survival is investigating the effect of radiation dose on the jawbone, which has not been investigated in the present study.

Further studies are needed in this field. According to a study with 50 Gray radiation, the failure rate of implants increases³². On the other hand, implant placement location may also affect the success and failure of implants. Evidence has shown no significant difference in the placement of implants in the upper and lower jaws. Some studies have shown that implant survival is higher in the mandible due to bone density and anatomy. Primary and secondary stability are two important points that increase the survival of implants. In irradiated patients, secondary stability is impaired, and survival is reduced because the arteries are affected³³. Also, the distance between the definitive treatment of oral cancer and the installation of dental implants may contribute to the success or failure of osteointegration. Improving the quality of life of cancer patients is very important, and rehabilitation of implants can help speech, eating, and facial beauty³⁴. The present study had limitations, the RCT study was not consistent with the purpose of the present study, and all selected studies were retrospective; On the other hand, the sample size of the studies was not high, and the follow-up period was not reported. Selected studies did not provide accurate information about the type of radiation therapy, which can be considered a confounding factor, and the severity of the disease; the studies that have

examined and compared the maxilla and mandible over the last ten years have been just one¹⁹.

Conclusion

The present meta-analysis showed that in patients with Oral Cavity Cancers who were irradiated, the implant survival rate was 81.35%. There was a significant difference between the two groups regarding survival rate. In patients who were not irradiated, the survival rate of

implants was high; it should be noted that this difference is not very significant. According to the findings of the study, the survival of implants in the mandible was higher.

Conflict of Interest

The authors declared that there is no conflict of interest.

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