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ALVEOLAR CREST BONE AND İTS COMPARİSON WİTH SİNGLE-TOOTH RECONSTRUCTİVE IMPLANTS

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ABSTRACT

Introduction Dental implants are the most interesting method of treatment which have triggered a great revolution in dental treatments. Implant-supported cantilever prosthesis is one of the considerable treatments. Previous studies have discussed the point that these prostheses are the focus of the pressure. However, some studies put emphasis on the clinical success of these prostheses.
Materials and methods In the present study, 52 samples were studied 26 of which had a treatment with implant-supported cantilever design and the other 26 had a treatment with single-tooth reconstructive implant design. Patients whose treatment was less than six months ago were eliminated from the study. The rate of alveolar crest bone loss around implant-supported cantilever prosthesis and ordinary implants were assessed by specialists in periodontal surgery using radiographs.
Findings There was no a significant relationship between variables such as presence or absence of cantilever, gender, age, bone type and length of implant and the variable rate of bone loss. However, there was a relationship between rate of bone loss and the time factor; in such a way that as more time passed, an increase was seen in the rate of bone loss. The rates of bone loss in Ivory and Ritter implantation systems were significantly higher than others.
Conclusion In case of observation of technical principles during the implantation surgery and prosthesis placement, using implant-supported cantilever prosthesis could be a verified method. Of course, it is essential to conduct more researches that focus on this issue.

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Introduction

Three decades ago, the dentistry community was dubious about using dental implants while treating edentulous patients. But nowadays, after a wide spectrum of scientific studies, dental implants have come to be known as an appropriate alternative for previous treatment methods. Undoubtedly, dental implant is the most interesting treatment method which has entered the dentistry field of study and have created a great revolution in dental treatments. In fact, nowadays implants have been introduced as the third dental course [1, 2].

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Of course, these treatments have their problems too and there are different issues that have to be considered in designing the treatment for patients. Some of these issues are the number of implants needed for reconstructing lost teeth, the proper spot for implant placement, the prosthesis design in terms of how the implants are connected to one another, adequate length and diameter of the implants, what materials the implants are made of and the type of occlusion. These issues have been the topic of researchers' discussion for some years now and there have been different, and sometimes opposing, views and opinions about them [1].

The average crestal bone loss around the implants that are under function, in the first year of placement, was about 2mm and the average bone loss in the next years was approximately 0.1mm for each year. After years of functioning, the total loss might be worrisome, because in order to prevent the prosthetic system from breaking, healthy and alive bones are needed. Two etiologic causes for crestal bone loss associated with implant treatments are tissues supporting implant and mechanical traumatic forces; because these two create too much tension which cannot be tolerated by the implant and bone set [2, 3].

Using cantilever in implant-supported prostheses can apply the force undesirably and lead to an aberrant focus of stress on the place of implantation which can damage the implants in the bones and their adjacent tissues. As a result, long-term prognosis of prosthetic reconstruction might become problematic [4, 5].

Various studies have shown that the rate of stress focus is higher in implant-supported cantilever than no cantilever implants. Moreover, it has been reported that this stress has mainly been focused on alveolar crest bone and the adjacency of the rate of distal implant which is connected to the cantilever prosthesis. Although another group of studies put emphasis on the scientific and clinical success of implant-supported prostheses and argued that there is no significant difference between the function of these prostheses and the prostheses lacking cantilever [6, 7].

By taking the aforementioned items into consideration, the present study aims to determine the rate of alveolar crest bone loss around implement-supported cantilever and to compare it to single-tooth reconstructive implants and to clarify new angles of how this treatment design affects implant-supported bone health; because the spots of implant fixture placement and its superstructure might not be in line with one another and a cantilever design might be used and improper forces are applied to implement-supported bone in most patients under implant treatment.

Research method

The present study is a case-control study. The research population has been comprised of patients visiting department of dentistry of Mashhad University with implant-supported cantilever treatment design and single-tooth reconstructive implant treatment design. 52 of these patients were selected as the research sample using the purposive and convenience sampling method. 26 of the 52 patients taking part in this research had implant-supported cantilever and the other 26 had single-tooth reconstructive implant treatment. In the present study, patients whose treatment was less than six months ago were eliminated from the study. In order to evaluate the role time plays in bone loss, the time factor was reviewed separately for each patient. The rate of alveolar crest bone loss around implant-supported cantilever and ordinary implants were assessed by specialists in periodontal surgery using radiographs. After calculating the rate of alveolar crest bone loss around implant-supported cantilever and ordinary implants, the obtained results were compared using proper statistical tests.

Findings

Out of the 52 samples, 26 were put in the control group and the other 26 were put in the case group. The following variables have been reviewed for the samples in the two groups: gender, time, bone type, implant system, length of implant, force of the opposite jaw and "bone loss".

According to the research findings, in the case group, the bone around the four implant was of the D1 bone type, the bone around seven implants was of the D2 bone type, the bone around eight implants was of the D3 bone type and the bone around the other seven implants was of the D4 bone type. Also in the control group, the bone around the four implant was of the D1 bone type, the bone around seven implants was of the D2 bone type, the bone around nine implants was of the D3 bone type and the bone around six implants was of the D4 bone type. The Chi-square test was used in order to review the homogeneity of the distribution of the bone type variable in the case and the control group. According to the results obtained from this test, there was no significant difference in the distribution of the bone type variable in the case and the control group (p-value=0.987). This result indicates that the control and the case group are similar when it comes to distribution of the bone type variable. To put it differently, bone type cannot have a destructive impact in either of the two groups. In addition, in the case group, the opposite jaw of four samples has been of type A, the opposite jaw of four samples has been of type C, the opposite jaw of seven samples has been of type D and the opposite jaw of eleven samples has been of type E. Also in the control group, the opposite jaw of five samples has been of type A, the opposite jaw of four samples has been of type C, the opposite jaw of six samples has been of type D and the opposite jaw of eleven samples has been of type E. The Chi-square test was used in order to review the homogeneity of the distribution of the opposite jaw variable in the case and the control group. According to the results obtained from this test, there was no significant difference in the distribution of the opposite jaw variable in the case and the control group (p-value=0.979). This result indicates that the control and the case group are similar when it comes to distribution of the opposite jaw variable. To put it differently, bone type cannot have a destructive impact in either of the two groups. In the case group, the implant system of thirteen samples was of the Dio type, the implant system of four samples was of the Dentis type, the implant system of four samples was of the IDI type, the implant system of two samples was of the Ritter type, the implant system of one sample was of the Biotech type and the implant system of two samples was

of the Astratech type. Also in the control group, the implant system of fifteen samples was of the Dio type, the implant system of five samples was of the Dentis type, the implant system of four samples was of the IDI type and the implant system of two samples was of the Ritter type. The Chi-square test was used in order to review the homogeneity of the distribution of the implant system variable in the case and the control group and due to the frequency of zero in some cells of the table, the Fisher test has been used instead of the Chi-square test since it is more accurate. According to the results obtained from these tests, there was no significant difference in the distribution of implant system variable in the case and the control group (p-value=0.786). This result indicates that the control and the case group are similar when it comes to distribution of the implant system variable. To put it differently, implant system cannot have a destructive impact in either of the two groups. The case group and the control group were compared to one another in terms of duration of time until occurrence using the nonparametric Mann-Whitney test. According to the results obtained from this study, there was no significant difference between the control and the case group in terms of duration of time until occurrence (time). In other words, there was no significant difference between the mean score of time in the case and the control group (p-value=0.479). The case group and the control group were compared to one another in terms of the length of implant variable using the nonparametric Mann-Whitney test. According to the results obtained from this study, there was no significant difference between the control and the case group in terms of the length of implant variable. In other words, there was no significant difference between the mean score of the length of implant variable in the case and the control group (p-value=0.113).

Before running any kind of analysis on the data, the hypothesis of normality of distribution of the research variables was reviewed using the Kolmogorov-Smirnov test. According to the results obtained from this test, none of the variables had normal distribution; therefore, nonparametric tests were used for all analyses.

In order to review the rate of bone loss in the control and the case group, the nonparametric Mann-Whitney test was used (P-value=0.660). According to the findings, there was no significant difference between the two groups in terms of bone loss. In order to compare loss of bone close to cantilever and loss of bone far from cantilever in the case group, the Wilcoxon test was used because the data were in pairs. According to the table below, the p-value was equal to 0.162 which means that there was no significant difference between loss of bone close to cantilever and loss of bone far from cantilever in the case group. Mean of loss of bone close to cantilever (1.233) was higher than mean of loss of bone far from cantilever (1.094) and mean of bone loss in the control group (0.966). However, this difference was not statistically significant (P-value=0.660 and P-value=0.162).

	Loss of bones close to cantilever and far from it
Z	-1.397
P-value	0.162

The Spearman correlation test was used in order to review the relationship between bone loss and ratio of actuator arm to the resistance arm in the case group and according to the p-value, there was no significant relationship between bone loss and ratio of actuator arm to the resistance arm.

			ratio of actuator arm to the resistance arm
Spearman	Bone loss	Correlation coefficient	0.327
		P-value	0.102
		Number	26

Moreover, there was no significant relationship between ratio of the actuator arm to the resistance arm and loss of bones close to the cantilever and far from it (P-value=0.200 and P-value=0.199).

			Ratio of the actuator arm to the resistance arm	**Loss of bone adjacent to the cantilever**	**Loss of bone far from the cantilever**
Spearman	Ratio of the actuator arm to the resistance arm	Correlation coefficient	1.000	.260	.260
		P-value	.	.199	.200
		Number	26	26	26

Further, the Spearman correlation test was used in order to review the relationship between bone loss and length of implant in the case group. According to the results, there was no significant relationship between bone loss and length of implant in the case group. (P-value=0.900).

			Bone loss
Spearman	Length of implant	Correlation coefficient	-0.26
		P-value	0.900
		Number	26

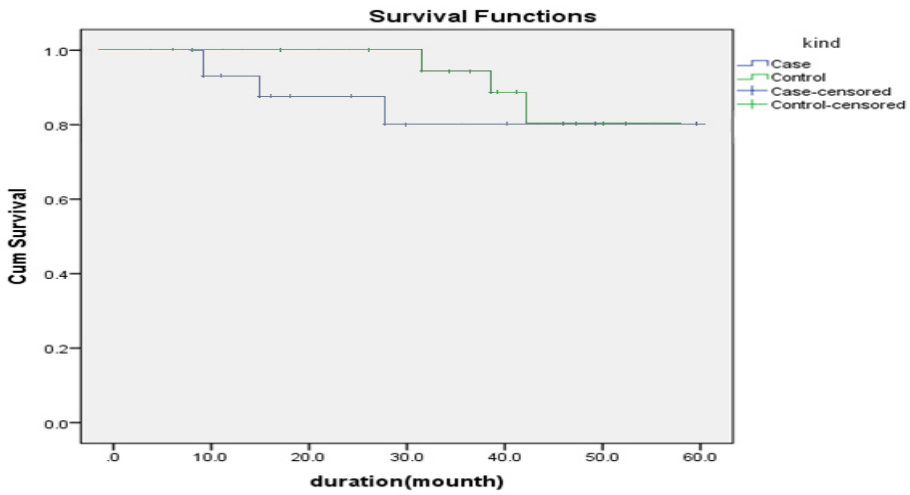
Mann-Whitney test was used in order to determine the rate of bone loss in mesial and distal groups for the cantilever area. There was no significant difference between the mean scores of the bone loss variable in the mesial and distal groups in the case group (P-value=0.033 which is less than 0.05). In other words, the rate of bone loss in the mesial location group was higher than that of the distal location group.

	Bone loss
Mann-Whitney U	41.500
Wilcoxon W	161.500
Z	-2.128
P-value	0.033
Exact Sig. [2*(1-tailed Sig.)]	0.032[b]

In order to compare time of survival in the control and the case group, the Cox model has been used. As it has been shown in the table, there was no significant difference between the case and the control group in terms of time of survival which means that it has been the same in the two groups. In order to draw the time of survival graph in the two groups, Kaplan-Meier graph was used as follows:

Variables in the Equation

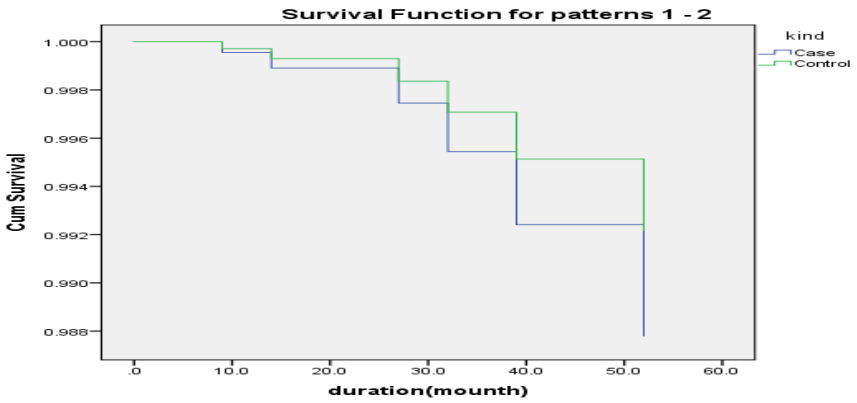
	B	SE	Wald	df	Sig.	Exp(B)
Group	-.240	.841	.081	1	.775	.787



Given that the lower rate of the graph is important in the survival analysis and shows the cumulative effect of survival, although we could not find a significant relationship, by comparing the lower rate of the graph in the case group with that in the control group, it can be concluded that the samples in the case group have reached a 2-milimeter bone loss sooner than the samples in the control group. Medium of the time of survival in the present study was calculated to be 42±3.194 which means that 50 percent of the sample have experienced a cumulative survival time of 42. After fitting the Cox regression model, no significant difference was seen between the control and the case group in terms of time of survival. However, as we can see in the data Kaplan-Meier graph, the lower rate of graph for the control group is higher than the case group which means that the time of survival in the control group is longer than that in the case group. The fact that there has been no significant difference, and because of low sample volume, thus, it is recommended to future researches to study a larger sample.

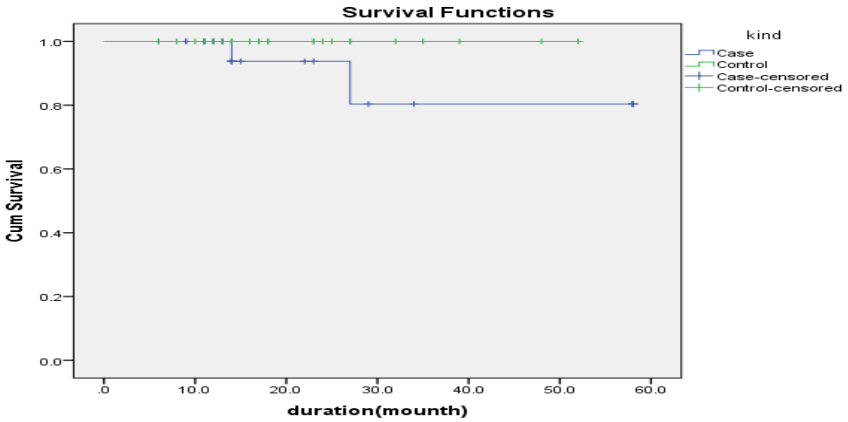
Given the bone type factor in the control and the case group cutoff=2, results of analyzing survival are as follows:

Iteration History					
	-2 Log Likelihood	Coefficient			
		Group	Bone type (1)	Bone type (2)	Bone type (3)
1	26.551	.563	.130	.908	2.262
2	25.729	.441	.105	2.271	3.270
3	25.478	.445	.106	3.258	4.316
4	25.390	.445	.106	4.270	5.327
5	25.358	.445	.106	5.275	6.332
6	25.346	.445	.106	6.276	7.333
7	25.342	.445	.106	7.277	8.334
8	25.340	.445	.106	8.277	9.334
9	25.339	.445	.106	9.277	10.334
10	25.339	.445	.106	10.277	11.334

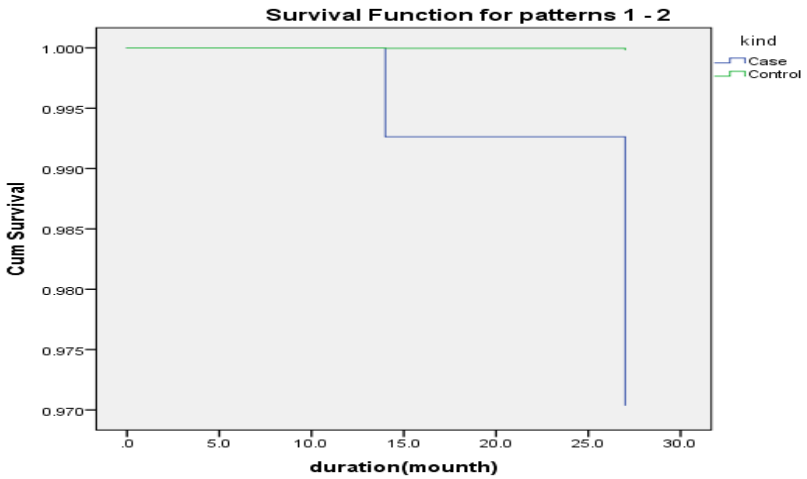


Cox regression model was used for comparing the time of survival in the case and the control group cutoff=3. As it can be seen in the following table, there was no significant difference between the times of survival in the two groups which means that the times of survival in the case and the control group have been statistically equal.

Variables in the Equation						
	B	SE	Wald	df	Sig.	Exp(B)
Group	4.273	5.813	.540	1	.462	71.707



Although we could not find a significant relationship, the lower rate of the graph in the case group has been lower than the lower rate of the graph in the control group. In the control group, none of the samples have been able to reach a 3-milimeter bone loss; however, in the case group, two samples have reached a 3-milimiter loss and more. Although no significant relationship was obtained according to the analyses, but the issue is worth of consideration. Given the bone type factor in the case and the control group, the results of analysis of survival can be seen in the following figure cutoff=3.



In order to review the relationship between the bone loss variable in 6 groups and the implant system variable, the nonparametric Kruskal-Wallis test was used. There was a significant difference between the mean scores of bone loss in the 6 groups. According to the obtained results, mean score of “bone loss” in the Ritter group and the Neo-Biotech group was significantly higher than that of the other groups. In order to review the relationship between “bone loss” and the force of the opposite jaw, the nonparametric Kruskal-Wallis test was used. The results showed that there was no significant difference between the mean scores of “bone loss” in different groups of the force of the opposite jaw variable.

Discussion and conclusion

The present study aims to review the rate of alveolar crest bone loss around implant-supported cantilever and to compare them with single-tooth reconstructive implants. The presumption about this research was that the rate of alveolar crest bone loss around implant-supported cantilever will be significantly higher than that of single-tooth reconstructive implants, because many of the previous studies have concluded that the osteoclasts are more active in the cantilever area and there is also more destruction in this area. One example of such studies is the research conducted by Barbier. Barbier et al. (1997) reviewed and compared the osteogenesis around implants. They came to the conclusion that the applies forces are associated with the length of the cantilever area. This research was done on the mandible bone of dogs and the results obtained from it indicated that the number of osteoclasts was higher near the cantilever area and there were more inflammatory lesions than fixed prostheses that are supported by implants from the two sides. Also, the cantilever prosthesis led to the increase of the density of trabecular bone and to the increase of thickness of the cortical layer adjacent to the alveolar ridge. It is essential to note that bone loss around the implant can have a considerable effect on the prognosis of this widely used treatment method [8]. Rangert B et al., in their research, discuss the point that the forces applied to the implant and its biomechanics can affect bone loss. They also expressed that presence of cantilever will apply more destructive forces to the bones and it will lead to bone loss. Nevertheless, the results obtained from our study differ from the existing research results and presumptions [4]. In our study, no significant relationship was found between the rate of bone loss in single-tooth implants and cantilever implants. Perhaps, it can be said that the main cause of this difference is the lack of sufficient studies in this field and the fact that previous studies have not reviewed all of the aspects and dimensions of this issue. Therefore, the fact that the results are quite different proves that more studies must be done on this subject. On the other hand, the results might suggest that if the therapists act professionally, observe the principles and are sufficiently skilled and knowledgeable, the rate of bone loss and survival will be close in the single-tooth and cantilever method; in such a way that there won’t be any significant relationship between the two. Among the existing studies, there are some that have come to the same results as ours. One instance of such research is that of Halg et al., which was conducted in 2008. They reviewed the rate of bone loss in dental prostheses with cantilever and no cantilever prostheses. They assessed a total of 54 patients which is almost as many as the sample of our research which is 52. However, in their research, the samples were under investigation for more than 5 years; while we studied our research sample for only 2 years. Therefore, their research was better than ours. Similar to us, they came to the conclusion that there was no significant relationship between bone loss and failure of implants. However, there were more technical complexities in cantilever prostheses than those with no cantilever and there were also some concerns about the rate of focus of stress on implant-supported cantilever than no cantilever implants and this stress has mainly been focused on alveolar bone crest and on the adjacency of the distal rate of implant which is connected to cantilever prosthesis [9].

Another issue in our study is that no significant relationship was found between the two groups in terms of survival. However, the lower rate of graph in the case group was lower than that in the control group which means that the samples in the case group have reached a 2-milimeter bone loss sooner than the samples in the control group. Perhaps, this is one of the only cases when the control group is better than the group with cantilever in our research. Of course, this issue is not worrisome like the results obtained from the study conducted by Halg and it cannot prove the superiority of the group with no cantilever.

Another study similar to ours was the research conducted by Wennstrom et al., in 2004. They reviewed and compared the rate of bone loss arounf implant in prostheses with or without cantilever. They investigated 50 patients 5 years after their implantation. Although they expressed concerns about the cantilever prostheses being damages in case an improper treatment was designed; but they were not able to prove that implant-supported prostheses with no cantilever were better than those with cantilever. These results comply with the results obtained from our study. This study also refers to the importance of skill and accuracy of the therapist in executing the cantilever treatments to a large extent and it can be said that designing a proper treatment and having the essential and sufficient skill can eliminate and resolve the existing concerns about cantilever treatments to a large extent [5]. The study conducted by Zurdo in 2009 aimed to present a systematic review of the life span and technical complexities of implement-supported cantilever prostheses. In the present study, the articles in MEDLINE up until 2008 were also reviewed. Ultimately, Zurdo et al., concluded that it is likely for small technical complexities to occur in implant-supported prostheses that use cantilever. However, there was no significant difference between bone loss around implants prostheses with cantilever and those with no cantilever. Nonetheless, they expressed that the existing information in this field are quite limited and the results must be judged cautiously. If we were to compare the results obtained from Zurdo's study with ours, we would see that they are similar when it comes to insignificance of the relationship between bone loss [6].

Studies that systematically review an issue can be useful and effective because their results are obtained from investigating many studies. Another study that systematically reviews implement-supported cantilever prostheses is the study conducted by Aglietta in 2009 which has reviewed the MEDLINE articles just like the study conducted by Zurdo. In Aglietta's research, studies that had evaluated implant-supported cantilever prostheses for a minimum of five years were reviewed. Aglietta concluded that there was no significant difference in the rate of failure and bone loss between prostheses with cantilever and those with no cantilever. They expressed that implant-supported cantilever prostheses treatment must be considered as a valid method. The results of this research comply with the results of ours to a very large extent and support the absence of a significant relationship between using cantilever prosthesis and bone loss. Perhaps it can be concluded that given the numerous concerns about destructive forces and the fact that these forces cause bone loss, researches that have practically studied patients suggest that the implant-supported cantilever treatment has been relatively successful. However, some researches express their concerns about technical complexities and put more emphasis on doing such studies, but they have not been able to prove that prostheses with no cantilever are significantly better than others [7].

The important point is that in most studies, the control group is the group in which prostheses are completely supported by the implant and there has been no explanation about whether these prostheses are single-unit and supported by an implant or are multi-units. However, in our study, we have clearly reviewed the single-tooth reconstructive implants which makes are comparison more accurate and more reliable. Although it seems that this issue has not changed the results that much. The other point is that in many studies, including the study conducted by Aglietta, in addition to osteogenesis and survival of implant, condition of prosthesis and success of prosthetic treatment have been evaluated which are issues that our study has not been able to cover [6, 7].

One of the most important studies that have a positive view of implant-supported cantilever prostheses is the study of Becker et al., in 2004. They expressed that the long-term outcomes of the implant-supported cantilever prostheses has not been completely specified yet and the weak results of dental-based cantilever prostheses shall not be assigned to these prostheses. In their study, they studied 60 implant-supported cantilever prosthesis for a long time (10 years) and concluded that none of these implants failed after these ten years and the results were quite successful. If we were to compare our study with Becker's, it can be said that Becker's study has been able to predict a longer period of time than ours and has been able to review the long-term future of these prostheses. However, our study is only able to review the short-term and average-term future. It is necessary to mention that Becker's study lacks a control group and has not presented generalizations, and therefore has some limitations when it comes to evaluating the success of prostheses. By reviewing Becker's study, it can be concluded that implants haven't failed yet after ten years and we cannot present an opinion about the rate of bone loss and thus, in terms of details, our study is the superior one [10].

Although the main purpose of our study was reviewing and comparing the rate of implant survival and bone loss in the control and the case group, but by accurately collecting information and recording demographic information, we have been able to answer the less important questions in this regard to some extent. The results indicated that the age, gender variables and many others that don't lead to significant changes in the results. However, according to the comparisons associated with various implant systems, it can be seen that the mean scores of bone loss in the ivory group and in the cmi group have been significantly higher than other groups. It is necessary to point out that in these calculations, there is not a large number of samples in each group; thus, one must be quite cautious when it comes to expressing their opinion about the results and the results must be considered as secondary ones that can pave the way for more research.

The results indicated that there has been no significant relationship between the rates of alveolar crest bone loss around the implant-supported cantilevers and single-tooth reconstructive implants. This complies with the results of many researches; although they are concerns about technical complexities about implant-supported cantilever prostheses and the need for more research in this field is felt. One of the limitations of this study is that the radiographic results were often evaluated two years after the surgery; thus, the study cannot provide an opinion about the long-term future of this treatment design. Further, due to

the retrospective structure of this study, there was the possibility that some information would be lost although it has been attempted to minimize this problem by accurately asking the patient about their information and specifications of treatment. According to the obtained results, it is recommended to future researchers to review the long-term presumption of implant-supported cantilever treatment plans by studying this topic for a longer time. Other criteria shall also be considered including level of satisfaction of patients. The patient must be asked about their pain, sadness as well as their masticatory force. By conducting prospective researches, the obtained results could be evaluated more accurately. Future studies can obtain a more inclusive view of implant-supported cantilever treatments by simultaneously reviewing prosthetic and periodontic results and they can assess the successfulness of this treatment.

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