Evaluation of Alveolar Crest Bone Resorption Around Contilever Based Implants and Its Comparison with Single Tooth Restorative Implants

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Abstract

A healthy and efficient dental system plays a decisive role in human life. In addition to the tremendous impact of teeth on the appearance of beauty, many basic and everyday things such as nutrition, speech, hygiene, general health and in general the quality of life will be disturbed in the absence of proper jaw and teeth function. Implant-based cantilever prostheses are one of the used treatment methods. Some previous research points to a greater concentration of pressure on the bone in these prostheses, although a group of studies emphasizes their clinical success. The purpose of this study is to conduct a scientific and research investigation on the analysis of alveolar crestal bone around cantilever base implants using scientific sources. In this research, 55 samples with cantilever base implant treatment plan were examined. Patients whose treatment was less than three months old were not included in the study. The amount of alveolar crestal bone resorption around cantilever base implants and conventional implants was evaluated in radiographic images by a periodontal surgeon. The statistical analysis of the data was performed using the Kolmogorov-Smirnov normality test and the non-parametric Menwitney, Wilcoxon, Spearman, Kaplan-Meier and Kruskal-Wallis tests. There was no significant relationship between the presence or absence of cantilever, gender, age, bone type and implant length with the amount of bone resorption.The amount of bone resorption was related to the time

factor and increased with its passage. If the technical principles of implant surgery and prosthesis placement are followed, the use of implant-based cantilever prosthesis is very realistic.
Key words: Cantilever Prostheses, Implant, Bone Resorption of the Alveolar Crest.

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Introduction

Dental implant is one of the best and most popular methods to replace a lost tooth. Dental implants are one of the methods of tooth restoration that is done to replace a fallen or decayed tooth. Implants are screw-shaped titanium roots that are implanted in the jawbone under the gums. This screw replaces the root of the tooth [1-3]. After the implant is in place, it provides a solid base for the crown, the main tooth, to sit on the implant. Implants are the most natural tooth restoration option and unlike artificial teeth, you do not need to remove them for cleaning. You can brush the dental implant like your natural teeth and chew food with it. This is why implants are the best option after natural teeth [4-6]. There are two types of Impellent now:

1- **Endosteal in bone:** Endosteal implant is the most common type of implant. This implant is available in different shapes such as screw, cylinder or blade, which is surgically placed in the jaw bone. Each implant has one or more artificial teeth. This type of implant is generally an alternative for patients who currently use a bridge or removable denture [7-9].

2- **Subperiosteal on the bone:** The subperiosteal implant with a metal frame is placed on top of the jaw. This framework protrudes from the gum and holds the implant in place. Subperiosteal implants are usually used for patients who are unable to use conventional dentures and do not have sufficient bone height to hold (Figure 1) an endosteal implant [10-12].

Figure 1. Alveolar Crestal Bone Around Cantilever Base Implants Using Scientific Sources

Search strategy and selection of articles

Search in Scopus, Google scholar, PubMed databases and by searching with keywords such as " Analysis of Alveolar Crestal Bone" and " Cantilever Base Implants Using Scientific Sources" and "Fracture Problems" and “Special Care Unit” to obtain articles related to the selected keywords [13]. Case report articles, editorials, and articles that were not published or only an introduction of them were available, as well as summaries of congresses and meetings that were in languages

other than English, were ignored. Only the original research articles that evaluated the effectiveness of different drugs in the treatment of COVID-19 using standard methods were studied (figure 2).

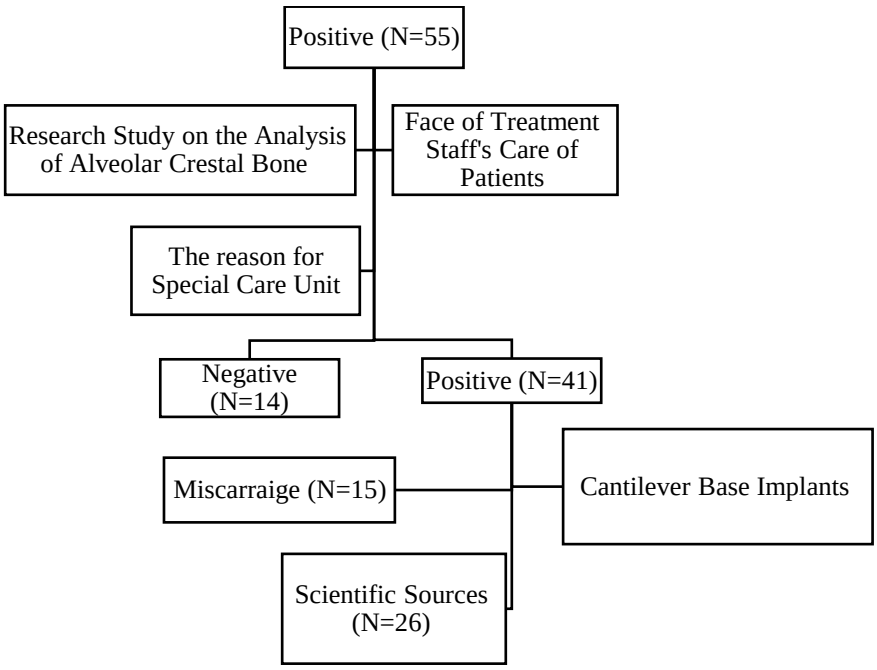


Figure 2. Flow chart of included subjects

Advantages of dental implants

Some of the advantages of dental implants include:

- ✓ It helps prevent the destruction or erosion of the jawbone that is associated with tooth loss.
- ✓ It is a great way to improve your smile and overall dental health.
- ✓ Dental implants are a more natural alternative to artificial teeth.
- ✓ It restores the ability to chew.
- ✓ It preserves the health of surrounding bones and gums.
- ✓ It helps to keep adjacent teeth stable.
- ✓ It improves the quality of a person's life [14].

Disadvantages of dental implants

The most common disadvantage of dental implants is that it is an expensive procedure and may not be covered by insurance. Other disadvantages of dental implants include:

- ✓ Pain, bleeding and tooth swelling after implant which is caused by surgery.
- ✓ Infection caused by bone fracture and loosening.
- ✓ Implant rejection by bone [15].

- ✓ The implant may wear out after some time or if oral hygiene is not followed. There is also a possibility of fracture of the implant crown.
- ✓ Damage to surrounding natural teeth during implant placement.
- ✓ Injury during surgery (for example, jaw bone fracture).
- ✓ Improper function (for example, the feeling that the teeth no longer meet normally).
- ✓ The feeling that the tooth is loose or rotating (Figure 3), caused by the loosening of the implant screw.
- ✓ Untreated periodontal disease [16].

Figure 3. Dental Implants

The difference between implant and dental composite

Composite dental veneers are a great way to improve the appearance of your smile and don't require much recovery time compared to other types of dental services [17-19]. The best thing about these veneers is that you can restore your teeth with the desired color, shape and form in no time. Composite results are immediate and you can see the final result immediately after doing it. Composite veneers are tooth-colored coverings that the dentist places on the teeth to improve the appearance of the teeth. These veneers are often placed on teeth to hide cracks, chips, cracks, stains, or discoloration [20-22]. Composite is an effective way to change the shape of your smile without extensive and invasive treatment. This process involves removing a small amount of tooth enamel and then placing a composite veneer on the tooth. Composite is generally done for partial restorations or for cosmetic purposes, but in the implant, the decayed tooth must first be removed and then a new tooth should be placed in its place [23]. Implant is more invasive than composite. Because it involves gum surgery, but the composite does not require any incision in the gum. In terms of price, the implant is considered one of the most expensive dental services, while the composite has a more affordable price, and sometimes you can do 10 composite units for the price

of one dental implant. Composite is a fast, affordable and practical way to restore teeth, but it does not have the efficiency of an implant, and if the tooth is damaged, it cannot be used [24].

Complications of dental implants

- ✓ Nerve damage that leads to a change in sensation in the surgical area.
- ✓ Opening the incision site after surgery.
- ✓ implant movement
- ✓ Exposure of the implant screw or abutment above the gum line.
- ✓ Implant infection.

Mobile and fixed prostheses

With the introduction of movable and fixed prostheses, a big step was taken to restore toothless areas. Of course, these primary prostheses, which practically have no direct connection with the jaw bone, have problems and shortcomings, the most important of which are the loss of the jaw bone, the high probability of mucosal irritation, and the need to repair and renew the prosthesis. Dental implants are one of the most interesting treatment methods that have largely eliminated the problems and complications of previous generations of prostheses and have created a great revolution in dental treatments [25-27]. Of course, these treatments are not without problems and different issues should be considered in the treatment plan of patients. Among them, we can refer to the number of implants needed to restore lost teeth, the appropriate place for placing the implants, the design of the prosthesis in terms of how the implants are connected to each other, the appropriate diameter and length of the implants, the materials used to make the prosthesis, and the type of contact between the teeth [28]. These issues have been discussed by researchers for years and different and sometimes conflicting opinions have been presented about them. Implants are usually implemented as a single tooth, but in some cases, they are also used in other ways. Cantilever-based systems are one of these methods. Implant-based cantilever prostheses include one or more base implants on one side and the pontic remains unattached on the other side. The first rule in the key positions of the implant is not to design any contours in the prosthesis. Cantilevers cause a disproportionate increase in force on implants, implant screws, and bone-implant contact surface due to the creation of a lever arm. In the ideal treatment plan, the cantilever should be removed [29-31]. However, in some clinical situations the use of cantilever is the most conservative treatment choice, such as insufficient bone in the posterior regions, aesthetic considerations, teeth alignment problems, failed implants, or poor bone quality. The average bone loss of the crest around the neck of the functional implant in the first year of placement is about 1 mm, and the average bone loss in the following years is about 0.1 mm per year. After years, the aggregate analysis function developed may cause concern [32-34]. Because healthy and living bone is needed to prevent failure of the prosthetic system. The two factors of bone loss around the implants are: tissues supporting the implant and traumatic forces that cause too much tolerable tension in the bone and implant complex (Figure 4). Numerous researches have shown that stress

and pressure concentration in cantilever supporting implants is higher than implants without cantilever [35].

Figure 4. Dental Implant Components

It has also been reported that this pressure is mainly concentrated in the crest of the alveolar bone and in the vicinity of the distal surface of the implant to which the cantilever prosthesis is attached. Although another group of research emphasizes the practical and clinical success of implant-based cantilever prostheses and believes that there is no significant difference in the performance of these prostheses compared to prostheses without cantilever [36]. Considering that in some patients, the implant may be placed in a cantilever form and inappropriate forces are applied to its supporting bone, by determining the amount of alveolar crestal bone loss around cantilever base implants and comparing it with single tooth restorative implants new angles of how this treatment plan is effective will be clarified [37-39]. The purpose of this study is to conduct a scientific and research investigation on the analysis of alveolar crestal bone around cantilever base implants using scientific sources [40].

Materials and Methods

In this research, 55 patients with cantilever base implant treatment plan participated as the experimental group. Participating patients generally used implants of two common brands in implant surgery. Considering that most of the bone loss around the implant occurs in the first year after surgery and especially in the first months, in order to achieve a more accurate comparison and closer to reality, patients who are less than one month after their surgery. It was past, they were not included in the study [41-43]. To accurately calculate the amount of bone loss after collecting the samples, the primary and secondary periapical radiograph images were scanned at the time of implant placement and the time of the study. In this research, all radiographic images were

evaluated by a periodontal surgeon and after calculating the amount of alveolar crestal bone loss around cantilever base implants and conventional implants, the results were compared using appropriate statistical tests. Before performing any analysis on the data, the normality hypothesis of the distribution of quantitative variables was checked using the Kolmogorov-Smirnov test. Based on this test, none of the variables had a normal distribution. Therefore, appropriate non-parametric tests were used to perform all analyses. Wilcoxon test was used to compare bone resorption near the cantilever and bone resorption due to paired data [44].

Findings

The results obtained from the comparison of the distribution of the variables of bone type, force of the opposite jaw, implant system, implant length and duration of implant placement between the two groups are as follows.

1- Bone type variable: Bones are divided into three categories D1 to D3 based on density based on Misch's classification. Chi-square test was used to check the homogeneity of distribution of bone type variable in two groups. According to the results of this test shown in Table 1, no significant difference was observed in the variable distribution of bone type in the case and control groups. This means that the two groups of case and control were similar in terms of variable distribution of bone type, or in other words, bone type could not have a confounding effect [45]. The variable distribution of opposite jaw force in the case group and the control group is shown in table two.

Table 1: Variable distribution of bone type in people

Test result	the entire	type of bone			treatment plan	
		D_3	D_2	D_1		
X=20.325 *P=0.821*	55	23	11	21	Number	**Experiment**
	100	39.4	48.7	11.9	Percentage	
	55	13	21	21	Number	**Control**
	100	25.0	55.8	19.2	Percentage	
	55	18	64	18	Number	**Total**
	100	27.9	53.8	18.3	Percentage	

Table 2: Variable distribution of the force of the opposite jaw

Test result	Total	Type of opposite jaw					Group	
		implant	Tooth		Movable prosthesis	toothless		
X=25.311 *P=0.822*	26	2	71	15	0	12	Number	**Experiment 1**
	100/0	50.5	20.3	16.2	1	13	Percentage	
	26	15	55	16	2	14	Number	**Experiment 2**

	100/0	47	20.5	17.5	3	15	Percentage	
	52	18	12	54	4	16	Number	**Total**
	100/0	49.2	20.9	12.9	5	17	Percentage	

According to the results of this test, no significant difference was observed in the variable distribution of the opposite jaw force. This means that the two groups of case and control were similar in terms of the variable distribution of the front jaw force, or in other words, the front jaw force could not have a confounding effect [46].

2- Implant system variable: Due to the frequency of zero in some houses in the table, Fisher's exact test was used instead of chi-square test, the results are shown in table 3. According to the results of this test, no significant difference was observed in the variable distribution of the implant system in the sample and control groups. This means that the two case and control groups were similar in terms of variable distribution of the implant system, or in other words, the implant system could not have a confounding effect.

Table 3: Variable distribution of the implant system

Test result	Implant system						Group	
	Total	Neo-Biotech	Ritter	IDI	Dentis	Dio		
X= 24.39 P= 0.822	55	22	40	18	15	5	Number	**Experiment 1**
	100	42.2	16.3	15.3	14.9	11.3	Percentage	
	55	20	38	19	16	7	Number	**Experiment 2**
	100	35.34	18.9	16.8	14.66	14.3	Percentage	
	55	3	39	32	17	9	Number	**Total**
	100	23	25.3	17.9	17.9	15.9	Percentage	

3- Implant length variable: The descriptive values of the implant length in each group are shown in table 4. The two case and control groups were compared in terms of the implant length variable using the non-parametric Mann-Whitney test.

4- Duration variable: The two case and control groups were compared in terms of the duration of implant placement until the study time using non-parametric Mann-Whitney test. As can be seen in Table 4, there was no significant difference between the two experimental and control groups in terms of the duration of the implant placement until the study time, or in other words, the average ranking of the duration in the two groups of the case and the control had a significant difference.

Table 4: Mean, median and standard deviation of the duration variable

The result of the Mann-Whitney test	Time (month)		Group	Variable
Z=0.687 P-Value=0.442	50.36	Average	Experiment 1	period of time
	17.20	standard deviation		
	20.96	Average	Experiment 2	
	10.34	standard deviation		

Discussion

Bone resorption around implants has always been one of the main concerns of experts since the introduction of this technique in dentistry, and many researchers have tried to answer this problem. Implant-based cantilever prostheses are one of the used treatment methods. Some previous research points to a greater concentration of pressure on the bone in these prostheses, although a group of studies emphasize their clinical success. Dental implant is the best treatment for replacing lost teeth, the results of which are very predictable and its long-term success rate has been evaluated very well in various researches, however, there is always the possibility of implant complications or treatment failure. The success and predictability of dental implant implantation has been evaluated over 90% over the years of research, but this high success rate is presented according to older criteria [47].

Success criteria of dental implant treatment

Absence of implant pain, movement, permeability, or 1 mm of bone resorption during the first year after implantation and 2 mm after this time of implant placement. A recent review of extensive bone loss as another measure of implant failure states that overall implant success and survival rates may be less than 80%. In addition to these, the ratio of the increase in the volume of dental implants that are placed with the adverse effects that occur is also important. Two recent meta-analysis and systematic reviews reported the incidence of peri-implantitis within eight to ten years after implant placement in approximately 10% of implants and 20% of patients. Considering the number of implant placement or the decision to implant it from 2013 to 2017 in America alone, this percentage of peri-implantitis means that more than 1.2 million implants should be treated. Some complications of implants may be relatively mild and easily treated or corrected, but some of these complications are significant and may lead to the loss of the prosthesis or implant [48].

Complications of implants

Implant complications are usually classified into two groups of short-term complications and long-term complications based on time sequence. Short-term or early complications of implants are problems that occur before the completion of the bone integration process in the implant. If long-term complications occur after the integration of the bone and the connection of the final artificial prosthesis (Figure 5). In addition, problems related to implants can be divided into the sub-groups

of biological complications and mechanical complications. Biological complications are those problems that involve the soft and hard tissues around the implant. Mechanical complications occur when the dental implant or prosthesis It exceeds the fatigue resistance and collapses.

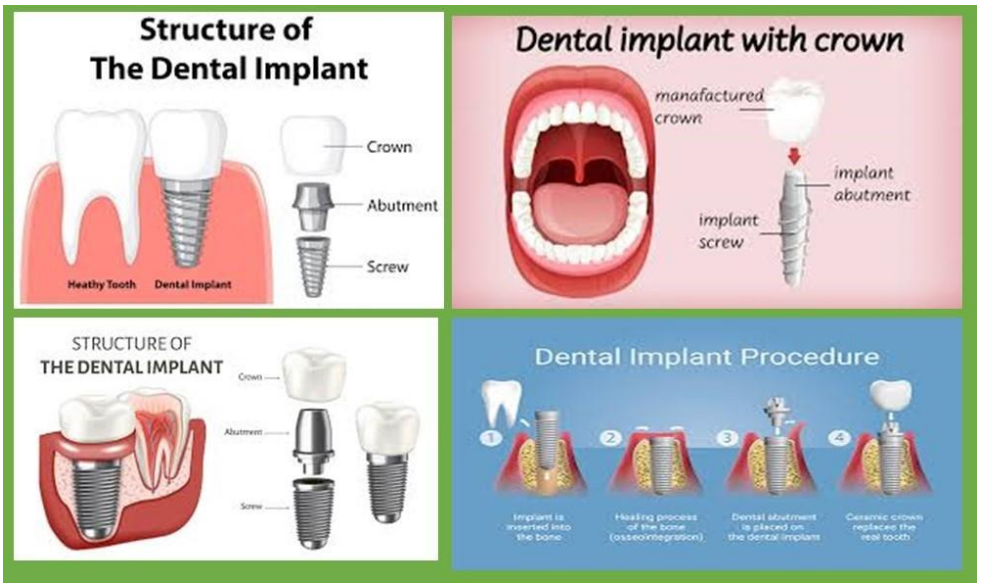


Figure 5. Complications of implants

1- Short-term complications of the dental implant: Early complications of the implant occur before its fusion with the jawbone and are often the result of short-term problems after surgery or during surgery. Usually, short-term complications include problems during surgery, such as bleeding, damage to adjacent teeth, nerve sensor disorders, jaw fractures, and manipulation of the maxillary sinus. Other short-term implant complications during implant placement include over-preparation of the implant osteotomy or under-preparation. Poor implant site preparation leads to bone overheating and bone necrosis. This can happen if the dental drill or implant reaches a critical threshold of more than 47 degrees Celsius. Contamination of the surgical site or the surface of the implant with harmful bacteria may happen during the implantation of the implant base. In this case, the dental implant cannot fuse with the jaw bone. Lack of initial stability of the implant (when the implant has just been placed in the alveolar bone and integration has not yet occurred), leads to micro-scale movements of more than 100 microns, resulting in implant loss due to fibrous tissue attachment.

2- Long-term complications of dental implants: Long-term complications occur after the integration of the implant with the bone and installation of the final prosthesis. Identifying these problems through clinical analysis and radiography is very important, because many of these events can be corrected and treated if identified in time (Figure 6 & 7). On the other hand, if the problem progresses and is not treated, a minor complication can lead to the loss of the implant or prosthesis. The long-term complications of dental implants are divided into two categories: biological and

mechanical. Biological complications are problems that involve soft and hard tissues around the implant. Studies show that the prevalence of peri-implant mucositis covers 50-80% of implanted implants. Various studies have been conducted that point to greater bone loss in the cantilever region. Among these, we can mention the study of Barbier and his colleagues. The results of their research indicated that in the vicinity of the cantilever area, the increase in the number of osteoclasts and the presence of inflammatory lesions will be more than the fixed prostheses that are supported on both sides by implants, and also the cantilever prosthesis increases the density of trabecular bone and it increases the thickness of the cortical layer adjacent to the alveolar ridge. Rangert and his colleagues also point out in their research that the presence of cantilever will cause more destructive forces and bone loss. Of course, it should be noted that these two researches have commented more generally and about the forces that are applied to the implant in an unprincipled way, and not a specific clinical examination on patients.

These studies concluded that despite the higher possibility of technical problems such as abutment and screw loosening or treatment complications, the cantilever treatment plan can be considered as a reliable and durable method. One of the most important studies that has a positive view of implant-based cantilever prostheses is a ten-year review of 60 cantilever prostheses by Becker and his colleagues. The result of their research indicated that none of the implants failed after this period and the results of the work were completely successful. They also stated that the long-term results of implant-based cantilever prostheses have not yet been fully determined and the poor results of tooth-based cantilever prostheses should not be attributed to these prostheses.

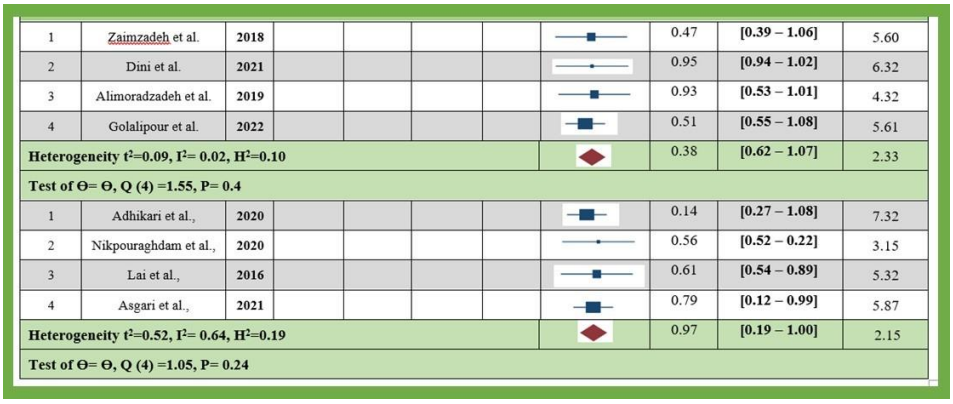
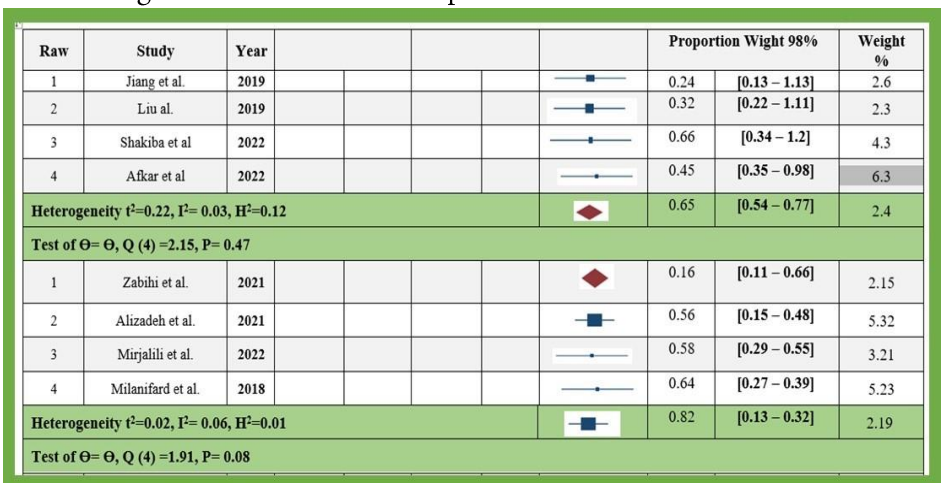


Figure 6. Forest plot showed Analysis of Alveolar Crestal Bone



Raw	Study	Year						Proportion Wight 98%		Weight %
1	Jiang et al.	2019						0.24	[0.13 – 1.13]	2.6
2	Liu al.	2019						0.32	[0.22 – 1.11]	2.3
3	Shakiba et al	2022						0.66	[0.34 – 1.2]	4.3
4	Afkar et al	2022						0.45	[0.35 – 0.98]	6.3
Heterogeneity t^2=0.22, I^2= 0.03, H^2=0.12								0.65	[0.54 – 0.77]	2.4
Test of Θ= Θ, Q (4) =2.15, P= 0.47										
1	Zabihi et al.	2021						0.16	[0.11 – 0.66]	2.15
2	Alizadeh et al.	2021						0.56	[0.15 – 0.48]	5.32
3	Mirjalili et al.	2022						0.58	[0.29 – 0.55]	3.21
4	Milanifard et al.	2018						0.64	[0.27 – 0.39]	5.23
Heterogeneity t^2=0.02, I^2= 0.06, H^2=0.01								0.82	[0.13 – 0.32]	2.19
Test of Θ= Θ, Q (4) =1.91, P= 0.08										

Figure 7. Forest plot showed Cantilever Base Implants Using Scientific Sources

Conclusion

The results indicated that there was no significant relationship between the amount of alveolar crestal bone loss around cantilever base implants and single tooth restorative implants. Bone loss around the base of the implant can be due to early pressure or force on the base and repeated and excessive force on the base. Vertical or oblique and angular analysis is usually characteristic of occlusal trauma. When concentrated traumatic occlusal pressure is accompanied by osteoclast activity, bone resorption begins. In natural teeth, bone repair and replacement begin when stress or traumatic pressures are reduced. But this does not happen in the bone that allows the implant, and the bone destruction is not repaired or compensated. Due to the fact that implant bases withstand vertical pressures much better than lateral forces. Therefore, side pressures on the implants should be reduced as much as possible. Lateral forces on the posterior teeth have a more destructive effect than on the anterior teeth. If the lateral destructive forces cannot be completely eliminated, it is better to transfer these forces to more bases. Placement of implants with non-parallel axes causes more destructive lateral forces to be transmitted with the bases. Such forces will usually be more than the ability of the adjacent bone to bear. The connection of the bridge from the implant to the natural tooth introduces more cantilever forces with the bases, and the reason for this is the stability and immobility of the metal base of the implant in the bone compared to the natural movement of a natural tooth with periodontal tissue. When the force is applied to the surface of the bridge, the natural tooth has a movement equal to the movement of the periodontal fibers. This movement introduces a force twice the vertical force in the neck area of the implant. Replacement teeth are made to match your natural teeth, which makes the implant look like your own teeth in terms of color, size and shape. The appearance of the implant is so natural that hardly anyone can notice that you have an implant. Once the implant stays completely in place and has a high durability if it is well welded to the jaw bone. If the bone volume in this area is not enough, the implant cannot be a successful treatment. Therefore, when the jawbone is depleted, bone grafting is necessary. This process is usually done before dental implants or when bone loss has

negatively affected the adjacent teeth. In some situations, the dentist may combine the dental bone grafting process with platelet-rich plasma. Plasma is taken from a person's own blood sample and used to promote healing and tissue regeneration. Cantilever is one type of bridge. In this method, the pontic is attached to only one natural tooth. This method is used when there is a natural tooth on only one side of the existing gap or when one of the teeth is not healthy and strong enough to hold the bridge. A bridge is a cheaper and faster process than an implant, but if not properly cared for, it will last a short time and may fall out. The success of the dental implant largely depends on the fusion of the bone. Factors that interfere with the bone fusion process act as a general threat to the implant. Osteoporosis also affects the jaw bones and therefore it is considered as a suspicious and questionable condition for dental implants. Dental implants are fixtures in the bone that replace missing teeth. There are different ways to replace a missing tooth, but an implant is the best way. Implants usually have a high success rate and are a durable choice for people who have lost teeth. Implant has many advantages, but it also requires a lot of patience. Depending on the condition of the patient's jaw, it takes between 3 and 6 months to complete the implant. The process of doing the implant is that the surgeon first cuts the gum and places the implant in the jawbone. Then some time should pass until the jaw bone grows around the implant and so-called fusion. Then the abutment part must be connected, which again requires surgery. Then you have to give two weeks for the jaw to heal. In the last step, the artificial tooth is connected to the abutment and the implant work is completed.

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