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An analysis of the Clinical Parameters of Implant Site Grafting Using Allografts and Xenografts in Dental Implant Therapy

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ABSTRACT
Prior to the implantation of dental implants, grafting influences the periodontal clinical parameters. This study looked into and contrasted several clinical parameters in dental implants using allografts and xenografts. In this cross-sectional study, a total of 188 patients', male 103 (54.8%) and 85 (45.2%) female aged between 19 to 79 years (mean age=47.7±8.6 years) were included, at King Saud University's Dental College in Saudi Arabia, were carried out. Dental appointments were scheduled for patients. A thorough clinical and radiological evaluation of the implants was completed throughout these sessions. Analysing and contrasting the clinical parameters Allograft and Xenograft bleeding on probing, Probing depth, and Attached gingiva in the two types of grafting procedures, Bone Level and Tissue Level implants, when the two types of final restorations (cement retained and screw retained) were placed, the four types of grafting materials (Bioss, Cortical, Cancellous, and Mixed), and the three oral hygiene groups (fair, good, and poor) of the patients did not exhibit statistically significant differences in mean values. Based on the frequency of implant thread exposures observed in the radiographs, patients treated with xenografts (35.1%) and allografts (31.8%), respectively, showed one to four thread exposures. Allografts and Xenografts materials resulted in predictable outcomes as effective graft materials in terms of dental implant site development. The study found no significant differences in clinical parameters such as bleeding on probing, probing depth, attached gingiva, and oral hygiene between allografts, bone level, tissue level, cement retained, and screw retained restorations.

KEY WORDS: PERI-IMPLANTITIS; DENTAL IMPLANTS; IMPLANTS; IMPLANT PROSTHESIS; IMPLANT HEALTH; IMPLANT PARAMETERS.,

INTRODUCTION

Because of their excellent success rate, dental implants are becoming a more common and widely accepted choice for replacing lost teeth in professional dentistry practices. Nevertheless, peri-implant tissue health is being jeopardized by certain risk factors that result in peri-implantitis, which has led to an increase in implant failure rates recently (Beschnidt et al., 2018). Peri-implant mucositis and peri-implantitis are problems that reduce the overall success rate of dental implants.

Numerous factors affect the quality and health of the soft tissues surrounding implants. The primary factor influencing the soft tissue health surrounding an implant is the amount of keratinized mucosa surrounding it, (Benedek et al., 2024).

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Since peri-implantitis is still a condition that is difficult to cure and is not well understood, it is imperative that treatment phases be carefully controlled during the whole course of therapy in order to better prevent the condition. The significance of implant-supported appliances for oral restoration is increasing (Rokaya et al., 2020). Over the past ten years, the survival rate of these implants has increased dramatically to >90% at 10 years after implant therapy, which has had a beneficial effect on patient satisfaction. However, implant success rates are hampered by inadequate bone volume and quality. Dental implant delivery might be complicated by bone loss brought on by numerous jaw diseases, periodontitis, and trauma (van Velzen et al., 2015).

To solve this problem and raise the success rate of treatment, bone augmentation is usually recommended before implant insertion. Allografts, xenografts, autogenous bone grafts, and alloplastic materials are utilized in bone grafting. Each has benefits and drawbacks of its own. Because autogenous bone has osteoconductivity, osteoinductivity, and osteogenecity, it is the most commonly utilized and gold standard material (Ferraz, 2023).

Osteoinductive and osteoconductive allografts are obtained from donors within the same species. Donors for xenografts come from several animals, and they have osteoconductive qualities. Alloplastic sources are solely osteoconductive and can come from natural or manmade materials such calcium sulfate, hydroxyapatite, tricalcium phosphate, or ceramics. In dentistry, bone regeneration is frequently performed, particularly to support the growth of dental implant sites (Möhlhenrich et al., 2021, Ashfaq et al 2024).

The risk factors linked to implant failures must be taken into account and assessed both before and after implant loading in order to reduce the possibility of peri-implant illnesses. As far as we are aware, not many research have examined the two distinct graft types-allografts and xenografts-in relation to implant site development (Kochar et al., 2022; DO TA et al., 2020). We hypothesize that there are no appreciable variations in the clinical parameters of dental implant therapy when applying the two kinds of grafts to the development of implant sites.

Probing-induced bleeding, periodontal pocket depth, and connected gingiva were among the clinical parameters that were investigated. Consequently, the purpose of this retrospective secondary analysis was to examine how dental implant therapy was affected by allografts and xenografts by tracking changes in a number of periodontal parameters over the course of two to three years following implantation and functional loading.

MATERIAL AND METHODS

Patients who had titanium dental implants (Straumann, Switzerland) at King Saud University's College of Dentistry in Riyadh, Saudi Arabia, between 2015 and 2018 were the subjects of the study. Periodontal clinical parameters were gathered during routine implant maintenance visits from June 2018 to September 2019 for the patients who were selected at random and made dental appointments. To further rule out any operator-dependent bias, each clinical measurement was performed by a single, blinded, trained, and calibrated researcher.

Patients in the study were systemically healthy but partially edentulous, with one or more missing teeth being replaced by a single crown implant-supported restoration that required intraoral care for a minimum of one to three years at the time of the evaluation session. The same facility was used for prosthesis restorations as well as implant surgery. The exclusion standards were; (1) uncontrolled systemic diseases (e.g., diabetes [HbA1c > 7], osteoporosis); (2) smoking; (3) pregnancy or nursing in women; (4) medication intake that affects bone turnover and mucosal healing (e.g., steroids, anti-resorptive therapy); (5) use of antibiotics for medical or dental purposes within two months of the examination; (6) any restorations that do not allow for the calculation of periodontal pocket depths (PPD); (7) inability or refusal to sign the informed consent form and (8) lack of base line radiographs taken at the time of implant or final crown.

The study variables assessed at the time of examination were; (1) gender., (2) Implant type (Bone Level vs Tissue Level), (3) Type of Graft (Allograft vs Xenograft), (4) Restoration Type (Cement Retained vs Screw Retained), (5) Subtype of Graft (Bioss, Cancellous, Cortical, Mixed), (6) Oral Hygiene (Fair, Good, Poor), and (7) Timing of Graft (With Implant, 2 months before, 4 months before, 5 months before, 6 months before, 7 months before, 12 months before).

The following clinical parameters were evaluated for every implant: Bleeding on probing (BOP) was measured by looking for bleeding at the probing site immediately following the evaluation of periodontal pocket depth, and classifying it as either (+) or (−). Using a plastic probe (11 Colorvue Probe, Hu-Friedy), the periodontal probing depth (PPD) was measured by gently applying pressure (less than 0.25 Ncm) around the neck of an implant at three buccal and three lingual points. The probe was positioned parallel to the implant's crown at the mid-buccal and mid-lingual points, and tilted inward by 10 degrees at the proximal points to the nearest mm.

From the peri-implant marginal mucosa to the muco-gingival junction (MGJ) at the buccal and lingual side of each implant, attached gingiva was evaluated. The attached gingiva was measured using a periodontal probe around the implant. The measurement was made by subtracting the probing depth from the distance between the buccal and lingual marginal portions of the implant's mucosa and the peri-implant marginal mucosa at the muco-gingival junction (MGJ).

In order to confirm the bone level at the same facility, standardized periapical radiographs were taken during the clinical evaluation using the long cone paralleling technique and film holders. These radiographs were then compared to a baseline radiograph taken during prosthesis installation. In order to account for any radiography distortion, the implant's length was used as a fixed reference point during the pixel/mm ratio calibration process. The radiographic distance measured mesially and distally, parallel to the implant's long axis, between the implant shoulder level and the highest coronal bone-to-implant contact level was used to estimate bone loss. The radiography measures were all done by the same blinded examiner.

Data Analysis: The software SPSS 24.0 (IBM Inc., Chicago, USA) was used to analyze the data that was obtained. The variables bleeding on probing, probing depth, and attached gingiva, as well as other categorical study variables like patients, gender, implant type, type of graft, restoration type, subtype of graft, oral hygiene, and timing of graft, were described using descriptive statistics like mean, standard deviation, frequencies, and percentages. The means of the quantitative outcome variable were compared to the categorical study variables using the Student's t-test for independent samples and one-way ANOVA. The results have been reported with statistical significance at a P-value of less than 0.05.

Ethical Statement / Informed consent: The study was approved by the Institutional Review Board of King Saud University Medical City, Riyadh, KSA (IRB Approval of Research Project No E:87-563).

RESULTS

A total of 188 patients, 103 male (54.8%) patients and 85 (45.2%) female patients aged between 19 to 79 years (mean age=47.7±8.6 years) were included due to sufficient clinical data available. Amongst these 188 patients, total of 151 (80.3%) patients received Allografts and 37 (19.7%) patients received Xenografts. Amongst these selected patients, total of 177 dental implants including 145 (81.9%) implants were Bone level implants and 32 (18%) implants were Tissue level implants. The restoration type placed included 42 (29.3%) as Cement retained and 101 (70.6%) cases had Screw retained final restorations. For the rest of the cases the data was not available regarding the restoration type. Regarding the Sub type of graft materials, Oral hygiene status and Timing of the placement of graft materials are presented in Table 1.

Table 1. Demographic data of the participants of the study.

Gender	Male	Female	Total					
	85 (45.2%)	103 (54.8%)	188 (100%)					
Implant Type	Bone level	Tissue level	Total					
	145 (81.9%)	32 (18.0%)	177 (100%)					
Type of Graft	Allograft	Xenograft	Total					
	151 (80.3%)	37 (19.7%)	188 (100%)					
Restoration type	Cement Retained	Screw Retained	Total					
	42 (29.3%)	101 (70.6%)	143 (100%)					
Sub Type of Graft	Bioss	Cancellous	Cortical	Mixed	Total			
	54 (30.5%)	14 (7.9%)	17 (9.6%)	92 (51.9%)	177 (100%)			
Oral Hygiene	Fair	Good	Poor	Total				
	75 (39.9%)	103 (54.8%)	10 (5.3%)	188 (100%)				
Timing of Graft	With Implant	2 months before	4 months before	5 months before	6 months before	7 months before	12 months before	Total
	62 (33.0%)	7 (3.7%)	9 (4.8%)	1 (.5%)	50 (26.6%)	46 (24.5%)	13 (6.9%)	188 (100%)

Comparison of the clinical parameters, Bleeding on probing (P=0.062), Probing depth (P=0.225) and Attached gingiva (P=0.835) within the two types of grafting procedures (Allograft and Xenograft), by independent samples T test revealed non-significant differences among their means values (Table 2).

The independent samples T test revealed non-significant differences between the means values of the clinical parameters, bleeding on probing (P=0.921), probing depth (P=0.889), and attached gingiva (P=0.906), within the two types of implants (Bone Level and Tissue Level) (Table 3).

When the two types of final restorations (cement retained and screw retained) were compared using the independent samples T test, non-significant differences were found between the means of the clinical parameters of bleeding on probing (P=0.177), probing depth (P=0.897), and attached gingiva (P=0.629) (Table 4).

Comparison of the clinical parameters, Bleeding on probing (P=0.018), Probing depth (P=0.027) within the four types of grafting materials used (Bioss, Cortical, Cancellous and Mixed), by One way Anova test revealed significant differences among their means values. While for the Attached gingiva (P=0.896) the statistical differences were non-significant (Table 5).

A one-way Anova test comparing the clinical parameter, bleeding on probing (P=0.831), among the patients' three oral hygiene groups (fair, good, and poor) showed no statistically significant variations in mean values. However, there were statistically significant differences for the probing depth (P=0.000) and attached gingiva (P=0.000) (Table 6).

Table 2. Comparison of the clinical parameters within the type of graft.

	Type of Graft	N	Mean	Std. Deviation	Std. Mean Error	Mean Difference	*Sig. (2-tailed)
Bleeding on Probing	Allograft	138	1.40	.884	.075	-0.304	0.062
	Xenograft	37	1.70	.845	.139		
Probing Depth	Allograft	151	4.56	2.087	.170	0.455	0.225
	Xenograft	37	4.11	1.807	.297		
Attached Gingiva	Allograft	148	1.62	.936	.077	-0.036	0.835
	Xenograft	35	1.66	.765	.129		

*P value was significant at P<0.05.

Table 3. Comparison of the clinical parameters within the type of Implant.

Type	Implant	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	*Sig. (2-tailed)
Bleeding on Probing	Bone Level	135	1.46	.870	.075	-0.016	0.921
	Tissue Level	40	1.48	.933	.148		
Probing Depth	Bone Level	145	4.46	2.075	.172	-0.050	0.889
	Tissue Level	43	4.51	1.932	.295		
Attached Gingiva	Bone Level	141	1.62	.899	.076	-0.019	0.906
	Tissue Level	42	1.64	.932	.144		

*P value was significant at P<0.05.

Table 4. Comparison of the clinical parameters within the type of Final Restoration.

	Type of Restoration	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	*Sig. (2-tailed)
Bleeding on Probing	Cement Retained	84	1.37	.954	.104	-0.180	0.177
	Screw Retained	91	1.55	.806	.085		
Probing Depth	Cement Retained	87	4.49	2.085	.224	0.039	0.897
	Screw Retained	101	4.46	2.008	.200		
Attached Gingiva	Cement Retained	86	1.66	.835	.090	0.065	0.629
	Screw Retained	97	1.60	.965	.098		

*P value was significant at P<0.05.

According to the frequency of implant thread exposures (Table 7) found in the radiographs, patients treated with allografts (31.8%) and xenografts (35.1%), respectively, exhibited thread exposures ranging from one to four. The findings were essentially identical, with 4 (10.8%) cases exhibiting 3 thread exposures in xenografts and 14 (9.3%) cases in allografts.

DISCUSSION

For oral rehabilitation operations including implants in edentulous parts of the dental arches, the bone grafting technique is considered the gold standard (Debbarma, 2024; Schwarz et al., 2021). Various graft materials, including autogenous graft, allograft, and xenograft, are available for this purpose. Each graft material has special qualities of its own, and the materials work well for the intended use depending on the specifications. Nonetheless, the long-term prognosis of the procedure varies depending on the grafting material used (Ferraz, 2023; Gallo et al., 2022). Numerous investigations have been carried out to evaluate the effectiveness and efficiency of different graft materials in relation to implant survival and success rate (Win et al., 2024).

Table 5. Comparison of the clinical parameters within the sub type of Graft material.

	Sub Type of Graft	N	Mean	Std. Deviation	Std. Error Mean	*Sig.
Bleeding on Probing	Bioss	41	1.61	.862	.135	0.018
	Cortical	20	.95	.945	.211	
	Cancellous	22	1.73	.827	.176	
	Mixed	92	1.45	.856	.089	
Probing Depth	Bioss	54	3.93	1.703	.232	0.027
	Cortical	20	3.90	2.174	.486	
	Cancellous	22	4.77	2.137	.456	
	Mixed	92	4.85	2.096	.219	
Attached Gingiva	Bioss	52	1.62	.867	.120	0.896
	Cortical	19	1.68	.946	.217	
	Cancellous	22	1.50	1.058	.226	
	Mixed	90	1.66	.889	.094	

*P value was significant at P<0.05.

Table 6. Comparison of the clinical parameters for the Oral Hygiene of the participants.

	Oral Hygiene	N	Mean	Std. Deviation	Std. Error Mean	*Sig.
Bleeding on Probing	Fair	69	1.46	.867	.104	0.831
	Good	96	1.48	.894	.091	
	Poor	10	1.30	.949	.300	
Probing Depth	Fair	75	6.03	2.033	.235	0.000
	Good	103	3.27	1.148	.113	
	Poor	10	5.20	.422	.133	
Attached Gingiva	Fair	73	1.44	1.080	.126	0.000
	Good	103	1.67	.692	.068	
	Poor	7	3.00	.000	.000	

*P value was significant at P<0.05.

188 patients who received allografts and xenografts prior to implant placement at various intervals and who had their implants serviced for two to three years were enrolled in the current retrospective research study. The patients were screened, examined, and compared for the effects of these graft materials on some of the critical clinical parameters, such as bleeding on probing, probing depth, and attached gingiva, which are important to the success of these dental implants.

For bone regeneration, graft materials such as allografts and xenografts are utilized. These two biomaterials have benefits as well as drawbacks (Ferraz, 2023; Gallo et al., 2022). The two types of freeze-dried bone allografts that are most commonly used are demineralized (DFDBA) and freeze-dried bone allografts (FDBAs) (Win et al., 2024).

Because DFDBAs are demineralized, it is believed that they contain bone morphogenetic proteins, which may have osteoinductive qualities (Grassi et al., 2020). Xenografts, which are derived from non-human animals, include osteoconductive qualities. Deproteinized bovine bone mineral (DBBM) is a frequently utilized xenograft, as it has a gradual replacement rate that helps preserve tissue volume during bone regrowth (Li et al., 2000; Rodriguez & Nowzari, 2019). Allografts possess osteogenic, osteoinductive, and osteoconductive properties; nevertheless, if utilized exclusively, bone remodelling may be substantial.

Additionally, because there are two surgical sites, there is a larger risk of morbidity, and there may be limited bone supply (Baldwin et al., 2019). Consequently, a few of the physicians combine various kinds of bone grafts. The most popular combination combines the biological characteristics of an autogenous graft with the gradual resorption of mineralized xenografts; this is achieved by using mixed autogenous bone and xenograft material (Janjua et al., 2022).

In the present study, the clinical outcomes and radiographic findings acquired using the two types of allografts i.e., allografts and xenografts in patients who received dental implants revealed comparable results. This has also been reported in some previous research studies (Ferraz, 2023; Gallo et al., 2022; Janjua et al., 2022; Zhao et al., 2021). However, some studies have reported more new bone formation and less residual graft for allografts as compared to the xenografts cases. The difference between the allografts as compared to the xenografts resorption depends on the pore size, pore morphology, pore percentage, connection between pores, pore connectivity, and granulometry (Janjua et al., 2022; Zhao et al., 2021).

When compared with naturally healed sockets, grafting bone decreased the relative proportion of vital bone, but enhanced new bone formation. It is possible to shorten the treatment time between bone grafting and prosthetic completion in implant-site development using grafted bone (Chang, 2021).

Recently performed randomized controlled clinical trials (RCTs) using allografts for dental implants revealed a great regenerative potential and resulted in 38.42% of newly formed mineralized tissue in sites treated with demineralized freeze-dried bone allograft (DFDBA) (Stumbras et al., 2020). Meanwhile the same study using mineralized freeze-dried bone allograft (FDBA) for post-extraction sockets resulted in 24.63% of newly formed bone months after grafting. Another RCT analyzing FDBA with 38 extraction sockets showed favorable and similar regenerated bone results after 6 months (Stumbras et al., 2020).

In the present study three and a half percent of the patients treated with allografts and xenografts, respectively, had implant thread exposures ranging from one to four. This information was obtained from the frequency of implant thread exposures detected using the radiographs. With 14 (9.3%) cases in allografts and 4 (10.8%) cases in xenografts exhibiting 3 thread exposures, the results were almost the same. However, more research is needed to compare the correlation between different grafting materials and the thread exposure of the dental implants (Azadi et al., 2025).

The current study has a number of limitations, the most significant of which are the inherent restrictions of retrospective research and the uneven outcomes resulting from the use of various methodology tools and indices. Furthermore, the absence of surveillance resulting from the retrospective design may impede the identification of a genuine correlation between the variables under investigation and the outcomes being assessed. Further limitations can be attributed to the fact that the current sample was drawn from a single institution, making it impractical to extrapolate the results to the entire implanted patient population. The analysis might have been impacted by the various grafting materials used. Lastly, there were no data on bone morphology, which could have influenced how the implant site remodeled during grafting and, ultimately, how the implant procedure turned out. Future research should also look into the impact of additional variables on implant site development when employing xenografts of different origins. Additionally, more research is required to determine how the variations found in this study would affect the longevity of dental implants.

CONCLUSION

Both grafting materials i.e., Allografts and Xenografts, are suitable graft materials for grafting of the implant site before implant placement. This means that both graft materials resulted in predictable outcomes and effective graft materials in terms of dental implant site development. Analysing and contrasting the clinical parameters bleeding on probing, probing depth, and attached gingiva in Allograft and Xenograft, Bone Level and Tissue Level implants, cement retained and screw retained final restorations, four types of grafting materials (Bios, Cortical, Cancellous, and Mixed), and the three oral hygiene groups (fair, good, and poor) of the patients did not exhibit statistically significant differences in mean values.\\Nevertheless, given the limitations of this retrospective investigation, these findings should be interpreted cautiously. In the future, a clinical trial will need to be used to investigate the connection between additional variables and transplant materials. By lowering the risk of peri-implant illness, we can provide a satisfactory implant outcome through meticulous treatment planning, ideal restoration design, and frequent follow-up visits.

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