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ORIGINAL ARTICLE

Periodontal status and dental behaviour of heart transplant recipients and healthy controls

Yasemin Sezgin[a] and Atila Sezgin[b]

[a]Department of Periodontology, Faculty of Dentistry, Baskent University, Ankara, Turkey; [b]Department of Cardiovascular Surgery, Faculty of Medicine, Baskent University, Ankara, Turkey

ABSTRACT

Objective: The aim of this study was to compare the periodontal status and dental behaviour of heart transplant recipients with systemically healthy controls.

Material and Methods: Forty heart transplant recipients and 40 systemically healthy patients were included. A questionnaire was used to record demographic, systemic health and dental behaviour data, and the following clinical parameters were recorded: plaque index, bleeding on probing, probing depth, gingival recession, and clinical attachment level.

Results: Mean probing depth ($p = .045$), mean gingival recession ($p = .016$), mean clinical attachment level ($p = .021$) and mean plaque index scores ($p = .001$) were higher in heart transplant recipients than the systemically healthy group. However, bleeding on probing was similar in both groups ($p > .05$). Tooth brushing frequency and number of participants who used dental floss/interdental brush was lower in the heart transplant group.

Conclusion: Considering the poor oral hygiene and high clinical periodontal parameters of heart transplant recipients, periodontal evaluation should be done regularly before and after transplantation. The patient's daily oral hygiene regimens should be evaluated carefully in this evaluation session and modified based on their gingival health, manual skill and motivational levels. The importance of oral health and its effects on systemic health should also be explained to the transplant recipients in detail.

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Introduction

Barnard performed the first heart transplantation (HT) in 1967, and it is a life-saving procedure for patients with end stage heart failure [1,2]. The survival rates of heart transplant recipients have increased with the development of immunosuppression drugs and strategies [3]. Immunosuppression drugs improve graft survival, but these agents also leave the patient susceptible to infectious complications [4]. Notably, odontogenic infections are a serious risk for secondary infections in immunosuppressed patients. The increase of the risk was not documented, but case reports suggest that focal dental infections likely cause secondary bacterial infections of organ systems [5,6].

Periodontitis is a chronic multifactorial inflammatory disease that is caused by microorganisms, and it is characterized by the progressive destruction of supporting structures of the teeth [7–9]. Periodontal disease results from an inflammatory response to specific bacterial colonisation and invasion, and it is not limited to periodontal tissue, but causes systemic inflammation and bacteraemia [10–13]. Based on the proven systemic effects, periodontitis is associated with the development of various systemic conditions, such as cardiovascular disease, diabetes, adverse pregnancy outcomes, and osteoporosis [14–17].

Although maintaining good oral health in transplant recipients is very important, only limited data exist on this topic. Some studies evaluated the oral and periodontal status of solid organ transplant recipients, but most of these studies focussed on liver and kidney recipients. The results of these studies showed that transplant recipients exhibited similar or worse dental behaviour and periodontal conditions [18–23]. To the best of our knowledge, no study compared the periodontal status and dental behaviour of heart transplant recipients with systemically healthy patients. It was hypothesized that heart transplant recipients would exhibit poor oral hygiene and worse periodontal condition compared to systemically healthy patients. Therefore, the present study assessed the periodontal status and the dental behaviour of heart transplant recipients and compared these patients to an age- and gender-matched systemically healthy group.

Materials and methods

Study design and subject recruitment

The Institutional Review Board and Ethics Committee of the Baskent University reviewed and approved the study design (approval no: 18/76). This cross-sectional clinical trial is

CONTACT Yasemin Sezgin yasemin_tocak@hotmail.com Department of Periodontology, Faculty of Dentistry, Baskent University, Ankara, Turkey

registered at ClinicalTrials.gov (NCT03809676), and it was performed in full accordance with the Helsinki Declaration of 1975, as revised in 2000. This study is reported in accordance with the Analysis Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement [24]. The patients were informed of the aims of the study and included into the study after signing an informed consent. Patients who had heart transplantation surgery at Baskent University Hospital Cardiovascular Surgery Department between 2003 and 2017 were screened during routine outpatient visits. The following inclusion criteria were used for heart transplant recipients: (1) clinically stable; (2) at least 1 year post-transplant. The exclusion criteria of patients were history of periodontal treatment within the previous year, history of antibiotic use during the preceding 6 months, and clinically nonstable patients. Forty cardiac transplant patients who met these criteria were included in this study. Each member of the transplant group was matched by age, gender and smoking status with a patient in the systemically healthy control group whose systemic status was approved by his/her medical data. Forty systemically healthy subjects who were referred to the Periodontology clinic with no history of periodontal treatment within the previous year and no history of antibiotic use during the preceding 6 months were recruited.

Medical data

Hospital records were reviewed and data were collected using a standardized form that included demographic information (age, gender) and medical information, such as history, presence of systemic disease, post-transplant time, and medication regimen/dosages.

Assessment of oral hygiene behavior

Patients were also asked to complete a standardized anamnestic questionnaire. Questions were asked about their personal oral hygiene behaviours (toothbrush, dental floss, etc.) and whether their dental visit was routine or complaint-oriented. For the transplant group, one more question about whether a dental check-up or comprehensive dental treatment had occurred before transplantation was added.

Clinical examination

A single calibrated periodontist at the Department of Periodontology, Baskent University performed all periodontal examinations in both groups. All subjects received a comprehensive periodontal examination, including plaque index (PI) [25]; gingival recession (GR); bleeding on probing (BOP); probing depth (PD); and clinical attachment level (CAL).

Patients were categorized based on their periodontal status. The patients were diagnosed as periodontally healthy, gingivitis or periodontitis. Patients were diagnosed as periodontally healthy if they had $<10\%$ bleeding sites with probing depths ≤ 3 mm. Patients who exhibited $>10\%$ bleeding sites with probing depths ≤ 3 mm were diagnosed with gingivitis. Patients who had probing depths ≥ 4 mm, interproximal, CAL of ≥ 2 mm or ≥ 3 mm at ≥ 2 non-adjacent teeth were diagnosed with periodontitis [9,26,27].

Intra-examiner calibration

Calibration of the examiner was checked before the beginning of the study. Full mouth PD and CAL were recorded in four patients at 48-hour intervals. The kappa coefficient was controlled between two measurements, and the difference was set to ± 1 mm. The kappa values were 0.82 for PD measurements and 0.78 for CAL measurements ($p < .05$).

Statistical analyses

Data analysis was performed using SPSS for Windows, version 21 (SPSS Inc., Chicago, IL, United States). The Shapiro-Wilk test was used to determine the normality of the distributions of continuous variables. Categorical data are shown as number of cases and percentages. Otherwise, descriptive statistics for continuous variables are expressed as means $\pm$ standard deviation (SD) and medians. For numerical data, comparison of mean values was performed using the Mann–Whitney *U* test, and the Chi-squared test was used for categorical data. A *p*-value less than .05 was considered statistically significant in all tests.

Results

Population characteristics

Forty-four patients in the heart transplant group were examined, and 40 patients were included in this study. Three of the 44 patients were excluded because of a history of antibiotic use during the preceding 6 months, and one patient was excluded due to the requirement of treatment for rejection at the time of oral examination. During the same period, 62 age- and gender-matched patients were examined. Thirteen of these patients were excluded due to the presence of systemic disease, 3 patients were excluded due to a history of antibiotic use, and 6 patients were excluded due to history of periodontal treatment within the previous year. Participant flow is shown in Figure 1.

Table 1 shows the demographic characteristics of both groups. Sixty percent of the patients were male in both groups. One patient in the HT group was a smoker, and two patients in the control group were smokers. There was no difference between groups in age, gender or smoking status ($p > .05$).

Table 2 shows the medical data of the transplant population. Four (10%) of the 40 HT recipients had ischaemic cardiomyopathy, 3 (7.5%) recipients had valvular cardiomyopathy, 2 (5%) recipients had congenital cardiomyopathy, 23 (57.5%) recipients had dilated cardiomyopathy, 7 (17.5%) recipients had restrictive cardiomyopathy, and 1 (2.5%) recipient had toxic cardiomyopathy. Most of the HT patients (90%) were taking mycophenolate mofetil, tacrolimus and azathioprine as immunosuppressive therapy, and

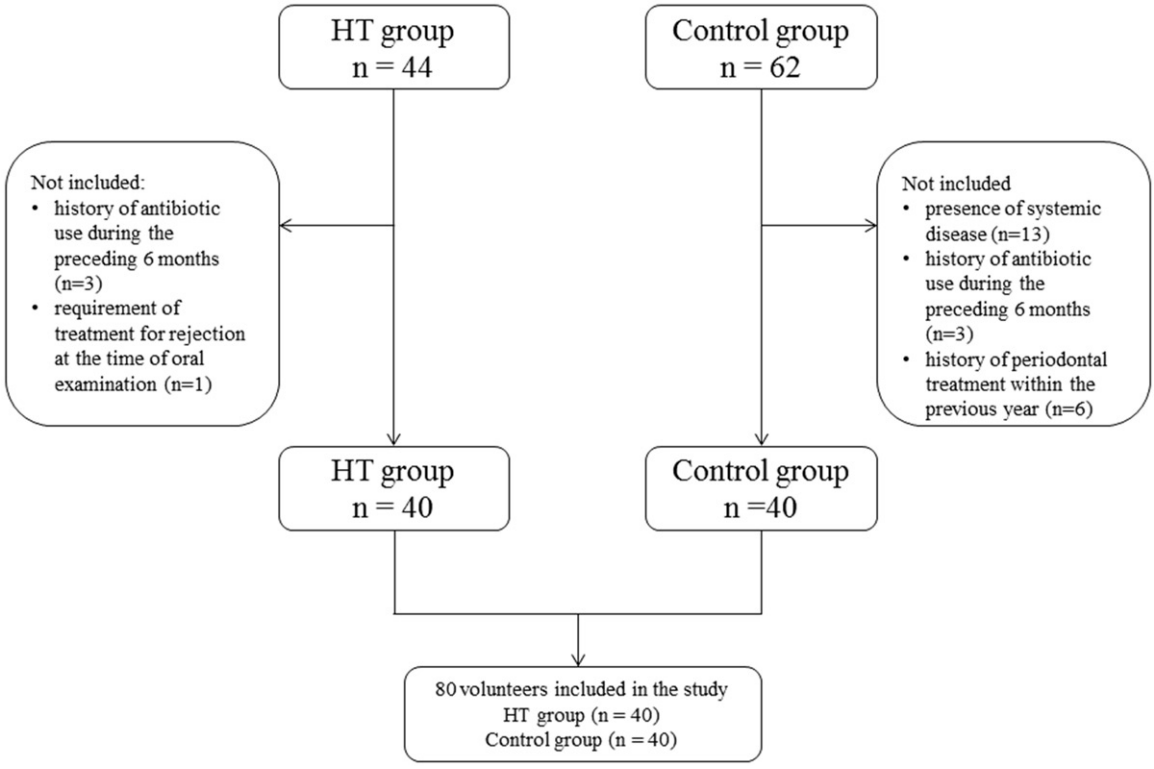

Figure 1. Participant flow.

Table 1. Demographic characteristics of both groups.

	HT group		Control group		
Variable	Mean ± SD	Median (IQR)	Mean ± SD	Median (IQR)	*p*-value
Age (years)	31.5 ± 14.2	26.0 (25.0)	32.22 ± 13.72	26.5 (24.0)	.69
Gender (male) (*n*,%)	24 (60%)		24 (60%)		
Smokers (*n*,%)	1 (2.5%)		2 (5)		.99

HT: heart transplantation; *n*: number; IQR: interquartile range.

Table 2. Medical data of the heart transplant population.

Variable	Heart Transplant Subjects $n = 40$ (*n*,%)
Medicine	
Tacrolimus	36 (90)
Mycophenolate mofetil	40 (100)
Azathioprine	40 (100)
Sirolimus	4 (10)
Cause of heart failure	
Ischaemic cardiomyopathy	4 (10)
Valvular cardiomyopathy	3 (7.5)
Congenital cardiomyopathy	2 (5)
Dilated cardiomyopathy	23 (57.5)
Restrictive cardiomyopathy	7 (17.5)
Toxic cardiomyopathy	1 (2.5)
Post-transplant months (mean ± SD)	66.9 ± 41.2
Comorbidity	
Hypertension	6 (15)
Diabetes mellitus	7 (17.5)
Hyperlipidaemia	6 (15)

n: number.
Data are given as *n* (%).

10% of patients were taking mycophenolate mofetil, sirolimus and azathioprine. Six (15%) patients had hypertension, 7 (17.5%) patients had diabetes mellitus, and 6 (15%) patients had hyperlipidaemia.

Patient questionnaire

The results of the patient questionnaire for assessment of their oral hygiene behaviour are shown in Table 3. The number of participants who regularly visited a dentist were similar in both groups ($p = 1$). However, tooth brushing frequency and the number of participants who used dental floss/interdental brush were significantly higher in the control group than the transplant group ($p = .0001$ and $p = .001$, respectively.) A total of 27.5% patients received dental examination and/or comprehensive dental treatment before transplantation.

Periodontal findings

Periodontal clinical findings are shown in Table 4. The HT group exhibited higher mean PD ($p = .045$), gingival recession ($p = .016$), CAL ($p = .021$) and plaque index scores (0.001) than the systemically healthy group. BOP was similar in both groups ($p = .282$).

Patient categorisation according to periodontal status is shown in Table 5. In the HT group, 10% of patients were diagnosed as periodontally healthy, 22.5% of patients were diagnosed with periodontitis, and 67.5% of patients were diagnosed with gingivitis. In the systemically healthy group, 27.5% of patients were diagnosed as periodontally healthy, 12.5% of patients were diagnosed with periodontitis, and 60% of patients were diagnosed with gingivitis. However, periodontal status was not related to history of heart transplantation ($p > .05$).

Table 3. Questionnaire data obtained for assessment of oral hygiene behaviour.

Variable	HT Group (%)	Control Group (%)	χ^2	*p*-value
Reason for visiting a dentist				
Control	5 (12.5%)	6 (15%)	0	.99
Complaint	35 (87.5%)	34 (85%)		
Tooth brushing frequency				
Less than once daily	15 (37.5%)	2 (5%)		
Once daily	16 (40%)	14 (35%)	16.8	.0001
Twice or more than twice daily	9 (22.5%)	24 (60%)		
Using dental floss/interdental brush				
Yes	1 (2.5%)	13 (32.5%)	10.4	.001
No	39 (97.5)	27 (67.5)		
Dental examination/comprehensive dental treatment before transplantation				
Yes	11 (27.5%)			
No	29 (72.5%)			

HT: Heart transplantation.
Data are given as *n* (%). The significance level was $p < .05$.

Table 4. Periodontal clinical parameters in both groups.

	HT Group n = 40				Control Group *n* = 40				
Variable	Mean ± SD	Median (IQR)	Minimum	Maximum	Mean ± SD	Median (IQR)	Minimum	Maximum	*p*-value
PD (mm)	2.02 ± 0.53	2.06 (0.49)	1.02	3.90	1.85 ± 0.61	1.79 (0.79)	1.02	3.92	.045*
GR (mm)	0.18 ± 0.29	0.05 (0.25)	0.00	1.24	0.06 ± 0.11	0.00 (0.08)	0.00	0.50	.016*
CAL(mm)	2.20 ± 0.75	2.10 (0.65)	0.79	4.56	1.91 ± 0.65	1.82 (0.79)	1.02	4.02	.021*
PI	1.06 ± 0.51	1.12 (0.70)	0.09	1.92	0.43 ± 0.34	0.36 (0.43)	0.01	1.23	.001*
BOP (%)	18 ± 8.1	16 (9)	3	39	20 ± 10.22	20 (21)	7	42	.282

HT: heart transplantation; *n*: number; PD: probing depth; GR: gingival recession; CAL: clinical attachment level; PI: plaque index; BOP: bleeding on probing; IQR: interquartile range.
*Significant at $\alpha = 5\%$.

Table 5. Categorisation of patients according to their periodontal status.

Periodontal status	HT group *n* = 40 (*n*,%)	Control group *n* = 40 (*n*,%)	χ	*p*-value
Periodontally healthy	4 (10)	11 (27.5)	4.7	.094
Gingivitis	27 (67.5)	24 (60)		
Periodontitis	9 (22.5)	5 (12.5)		

n: number, HT: heart transplantation.

Discussion

This study assessed the periodontal status and dental behaviour of heart transplant patients and compared them with an age- and gender-matched systemically healthy group. Although a previous study [23] investigated the oral health status of adult heart transplant recipients, the control group consisted of patients with and without other systemic diseases that could affect the periodontal status. Systemic diseases, such as diabetes [28], osteoporosis [29], and obesity [30], affect the course and outcome of periodontal diseases, and the present study used systemically healthy controls for comparison. Therefore, this report is the first study to compare the periodontal parameters and dental behaviours of heart transplant recipients with systemically healthy patients. The present results showed that plaque index, mean probing depth, gingival recession, and clinical attachment level were significantly higher in the HT group compared to the control group. However, bleeding on probing was similar in both groups. The number of participants who regularly visited a dentist were also similar in both groups, but tooth brushing frequency and the number of participants who used dental floss/interdental brush were significantly lower in the HT group.

Referral for dental examination and treatment is a recommended policy before heart, kidney and liver transplantation in our transplant centre, but only 27.5% of the patients in this study population were referred for dental examination and treatment before transplantation. These low rates likely depend on the fact that most patients were on an urgent or emergency list before transplantation. Therefore, patients were hospitalized in intensive care units and could not be directed for dental examination and treatment before transplantation. Kauffel et al. [18] performed a study on liver transplant recipients and reported that 75% of patients received dental treatment before transplantation. Considering the different study populations of these studies, it is not an unexpected result to obtain lower values in the present study, which was performed on heart transplant recipients.

The number of participants who regularly visited a dentist were similar in both groups, but tooth brushing frequency and the number of participants who used dental floss/interdental brush were significantly lower in the HT group. Heart transplantation is the optimal surgical approach to increase the survival of patients with refractory end-stage heart disease, but many of these patients have other problems that affect their functional abilities after this surgery [1,31]. These patients also experience physiological and psychological changes, and both of these factors may be responsible for their inadequate daily oral hygiene activities.

Consistent with their oral hygiene behaviours, the plaque index scores, mean PD, GR and CAL were higher in the HT group compared to the systemically healthy group. Microbial dental plaque accumulation and poor oral hygiene are major risk factors of periodontitis [32]. Therefore, if the oral hygiene habits of these patients are not reviewed, and proper oral

hygiene instructions are not prescribed, then most of these patients become candidates for periodontitis at a later age.

The present results showed that periodontal status was not related to history of heart transplantation. A previous study of adult heart transplant recipients observed an association between periodontal health condition and history of heart transplantation [23]. One possible explanation for the different results in the present study may be the selection of systemically healthy patients who were referred to Periodontology department for treatment as the control group. Another cause may be the younger age of the participants in this study. Use of the CPITN index to measure the level of periodontal disease and the absence of bleeding on probing scores in the previous study may be another reason for this discrepancy. Nevertheless, this result should be interpreted with caution. Considering the slow progressing nature of periodontitis, poor oral hygiene behaviour and life-long immunosuppression together, the increased risk of developing periodontitis in HT recipients compared to the systemically healthy group should not be overlooked.

Another important finding in our study was that bleeding on probing scores were similar in the HT and systemically healthy groups despite the high plaque index scores in the HT group. This observation is consistent with previous studies, which also observed reduced gingival inflammation in transplant recipients [19,33]. One possible reason for the similar bleeding on probing scores in both groups is that the immunosuppressive therapy reduces the periodontal inflammation.

The practical implications of the present findings are that periodontal evaluations should be done regularly before and after transplantation considering the poor oral hygiene and high clinical periodontal parameters of the HT group. Patients' daily oral hygiene regimens should be evaluated carefully during this evaluation session and modified based on their gingival health, manual skill and motivational levels. Numerous studies reported [7,34] that periodontal pathogens may enter the bloodstream from the inflamed and ulcerated gingival epithelium and cause systemic infections. Consequently, periodontal care plays an important role in the management of transplant recipients. The importance of oral health and its effects on systemic health should also be explained to the transplant recipients in detail.

As a cross-sectional study, the present research has some limitations. First, due to the difficulties of accessing the HT recipients study population, this study included a relatively small sample. Future studies using multicenter designs may be helpful to increase the sample size and provide more information about this population. Second, systemically healthy controls were selected from patients who referred to our department for dental or periodontal therapy. This selection method may affect the results because the patients were referred to our clinic because of existing periodontal problems. To overcome this bias, patients outside of a dental clinic environment should be selected in future studies. Finally, because of its cross-sectional design, we did not evaluate the pretransplant periodontal status or dental behaviour of HT recipients in the present study. However, our study provides valuable information on the periodontal status of HT recipients. New studies are needed for further evaluations that consider the limitations of this study.

Conclusions

Within the limitations of the present study, considering the poor oral hygiene and high clinical periodontal parameters of heart transplant recipients, we can assume that periodontal evaluation should be done regularly before and after transplantation. The patient's daily oral hygiene regimens should be evaluated carefully in this evaluation session and modified based on their gingival health, manual skill and motivational levels. The importance of oral health and its effects on systemic health should also be explained to the transplant recipients in detail.

Disclosure statement

The authors declare that they have no conflict of interest related to this study.

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