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A retrospective chart review evaluating pre-operative dental extractions on patients with end-stage heart failure undergoing advanced surgical cardiac therapies

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Objectives. End-stage heart failure patients are functionally compromised by multiple physiologic mechanisms, placing them at increased risk of peri- and post-operative complications. This study aimed to evaluate if dental treatment performed before advanced cardiac interventions, including orthotopic heart transplant and mechanical circulatory support, increases the risk of adverse events.

Study Design. A retrospective chart review spanning January 2011 to December 2020 was performed. Inpatients with end-stage heart disease were evaluated by the hospital dentistry service at UCLA Ronald Reagan Medical Center. Three hundred and five consults met the inclusion criteria. The patients were divided into 2 groups: those who underwent dental treatment and those who did not require dental treatment. The wait time from dental consultation to cardiac intervention (days), dental complications, medical adverse events, and deaths were evaluated.

Results. Dental complications were only experienced in the form of intraoral bleeding. There was no significant difference in the number of medical adverse events or deaths between groups.

Conclusions. The elimination of oral infection before advanced cardiac interventions does not increase the risk of morbidity or mortality. (Oral Surg Oral Med Oral Pathol Oral Radiol 2022;134:702−707)

Heart failure (HF) is a leading cause of morbidity and mortality in the United States, affecting approximately 6 million people.[1] It is characterized by peripheral hypoperfusion, which leads to end-organ dysfunction and/or vascular congestion.[2,3] Clinically, this is manifested by dyspnea, edema, and exercise intolerance.[2,3] HF etiologies include idiopathic cardiomyopathy, coronary artery disease, hypertension, or valvular disease.[3,4] The treatment of HF is focused on delaying the progression to end-stage organ dysfunction by managing the underlying cause of HF with methods like oral medications, valve replacement surgery, and coronary bypass surgery.[2,5] In more severe cases, advanced therapies may be considered; these include orthotopic heart transplant (OHT) and mechanical circulatory support (MCS) such as ventricular assist devices (VADs) or total artificial hearts (TAHs).[5] Approximately 500,000 Americans present with end-stage HF; however, limited heart donor availability allows only an average of 2,500 individuals in the United States to receive cardiac transplants each year.[1,6] Given this shortage, MCS devices play a crucial role as a bridge to transplant, as well as a form of long-term destination therapy by mechanically pumping blood through the circulation when the heart is not pumping effectively.[7-9]

Many forms of VADs have been developed for implantation.[10] Right ventricular assist devices (RVADs) and left ventricular assist devices (LVADs) are employed in cases of single ventricular HF.[10] In the individuals with biventricular HF, a biventricular assist device (BiVAD) or TAH can be used.[10] TAHs are also used in cases of cardiac transplant rejection.[10] According to the Interagency Registry for Mechanically Assisted Circulatory Support, more LVADs have been implanted as long-term destination therapy rather than as a bridge to OHT.[11] Using VADs as a bridge to OHT is more effective than therapy with oral drugs and has greatly improved the survival rates during long wait times for OHT.[1,6] Some studies have stated that there is no difference in the post-transplant survival rates between the patients who were bridged with BiVADs vs TAHs, whereas other studies have suggested that TAHs have a better survival rate than BiVADs.[7,10,11] However, the patients with biventricular HF are more compromised compared with those with a single ven-

Statement of Clinical Relevance

As advanced cardiac therapies are becoming more commonplace, it is important that oral health care providers understand that these patients can be managed safely preoperatively in order to reduce postoperative morbidity.

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tricular failure, and as a result, the TAHs have lower long-term survival rates compared with LVADs.[10]

Organ rejection and infection are the main causes of mortality post-OHT.[7,9,12] Similarly, infection is one of the major adverse events associated with MCS.[7,9,12] Therefore, infection prevention protocols commonly include a preoperative dental examination to reduce the oral sources of infection.[12,13] In 1990, Boraz and Myers performed a nationwide survey at 62 institutions that were involved in cardiac transplant; 61% of these institutions reported that a dental consultation was routinely requested.[12] In 2005, Guggenheimer et al. performed a survey of 294 US transplant center directors, of which 80% claimed to routinely request pre-transplant dental evaluation.[13] Of note, 27% reported post-transplant sepsis from a suspected dental source and 38% stated that a pre-OHT dental infection resulted in the postponement or cancellation of their procedure.[13] Organ transplant patients require antirejection medications, which induce a state of immunosuppression, placing these individuals at increased risk of systemic complications from dental infections post-OHT.[14,15] The goal of a dental consultation is to identify and recommend the removal of active dental infection in order to decrease the risk of cardiac surgery failure and device infection when applicable, as well as reduce the need for dental treatment in the postoperative period.[15]

Our recent study reviewed dental treatment before cardiac surgery over the period of January 2011 to December 2020 and concluded that dental intervention before cardiovascular surgeries (e.g., valve replacements and coronary artery bypass grafts) can be performed safely and does not increase the risk of medical adverse events or death.[16] However, limited studies exist regarding precardiac dental consultation in this more complex patient population. Meyer et al. and Sung et al. have evaluated dental treatments in the OHT and VAD populations, respectively; however, the sample sizes were small.[17,18] The TAH is a newer and less common procedure compared with OHT or VAD. As a result, there are currently limited studies regarding the impact of dental treatment in this patient population. This study aimed to evaluate the effects of preoperative dental treatment before OHT or MCS placement.

MATERIALS AND METHODS

This study was a retrospective chart review of dental consults performed by the University of California, Los Angeles (UCLA) hospital dentistry service before cardiovascular surgeries at the UCLA Ronald Reagan Medical Center (RRMC) from January 2011 to December 2020.[16] This study has been approved by the UCLA Institutional Review Board (#20-000114). In order to concentrate on the most medically compromised cardiovascular patients, this paper only included the individuals with end-stage HF who were in need of OHT, VAD, or TAH procedures, while excluding the patients who received any other cardiac interventions. Furthermore, the individuals who did not end up undergoing cardiovascular surgery were excluded.

As with many centers servicing this population, at the UCLA RRMC, an extensive multidisciplinary evaluation process for possible OHT or MCS candidates includes dentistry. If a patient presents with teeth that pose an imminent risk of infection, dental treatment to remove those infections will be recommended before listing for OHT. Surgical dental treatment was defined as extracting a minimum of 1 tooth, which was recommended in the presence of major chronic/acute infections, including teeth with large caries extending to the pulp, symptomatic teeth, teeth presenting with periapical disease, teeth with associated abscess, teeth or gingiva with active suppuration, and severe periodontal disease. Non-surgical dental intervention referred to caries excavation, application of silver diamine fluoride to prevent caries progression, and/or placement of a temporary restoration. This would be recommended in the case of large caries that were not close enough to the pulp to warrant an extraction. The consults that met the inclusion criteria were divided into 2 groups: the patients who required dental intervention (dental) and a control group of patients who did not require dental intervention (non-dental). We excluded individuals who received non-surgical dental intervention or did not undergo the recommended dental intervention. As a result, all of the individuals in the dental group received surgical dental intervention. We recorded the demographic characteristics of the patients at the time of their dental consultation.[16]

Dental complications, adverse medical events, and death were evaluated during two 31-day periods. First after dental intervention—either dental treatment (dental) or dental consultation (non-dental)—and again after cardiac intervention. The dental complications included those during the dental procedure, problems necessitating an additional dental follow-up, and major bleeding. Major bleeding was considered a $\geq$2.0 g/dL decrease in hemoglobin within 3 days of dental intervention.[16,19] The adverse medical events included acute coronary syndrome, stroke, renal failure requiring dialysis, postoperative mechanical ventilation, cardiogenic shock or cardiac arrest, sepsis or infective endocarditis, multisystem organ failure, intraoperative death, postoperative exploratory surgery, rejection, graft dysfunction, complications leading to increased length of admission or readmission, and complications judged to be irreversible requiring comfort care. Deaths were recorded for all patients. A statistical analysis of

variables was performed with one-way ANOVA. The level of significance was set a priori at $\alpha = .05$.

RESULTS

From January 2011 to December 2020, 1,513 inpatient cardiac consultations were performed by the hospital dentistry service. The patients who underwent less invasive cardiovascular surgery were excluded from this study. The patients who did not receive cardiovascular intervention due to denial for OHT listing, death, or patient refusal were not included in this study.[16] The patients who underwent non-surgical dental treatment and those who did not receive the recommended dental treatment were excluded from this study. 305 individuals with end-stage HF who underwent dental consultation before receiving OHT or MCS were included in this study (Table I).

Surgical dental treatment was performed on 114 patients (dental), and 191 patients did not require any dental treatment (non-dental). The patients ranged from 12 to 76 years of age, and the mean age differed significantly between the groups ($P = .000004$, 95% CI). Both of the groups consisted of more males than females; however, there were a significantly greater proportion of females in the group who did not require dental intervention ($P = .021$, 95% CI) (Table II). As patients often undergo MCS more emergently, compared with OHT where they can be on a waitlist for years, the average number of days between dental consultation and cardiac intervention were compared for OHT and MCS cases separately for each group. The average number of days between the dental consultation and cardiac intervention did not differ significantly between the groups according to those who underwent OHT and MCS ($P = .067$, $P = .228$, 95% CI) (Table III).

As expected, the patients who underwent surgical dental intervention (dental group) were at a greater risk of dental complications ($P = .001$, 95% CI) (Table IV). The only dental complication was intraoral bleeding, which occurred in 8 (7.0%) individuals in the dental group after dental extractions and a single person (0.5%) in the non-dental group. That individual presented with intraoral bleeding at the initial dental consultation. Application of pressure and the use of hemostatic agents were sufficient to achieve hemostasis in all cases, with the exception of 1 patient in the dental group, who required the fabrication of a pressure appliance to assist with hemostasis.

The number of medical complications within 31 days of dental intervention did not differ significantly between groups ($P = .358$, 95% CI), and similarly, the number of medical complications within 31 days of cardiac intervention did not differ significantly between groups ($P = .881$, 95% CI). Figure 1 depicts adverse medical events experienced in each group within 31 days of cardiac intervention. Twelve patients experienced adverse medical events within 31 days of dental intervention: 6 (5.3%) in the dental group and 6 (3.1%) in the non-dental group. Thirty-nine patients experienced adverse medical events within 31 days of cardiac intervention: 15 (13.2%) in the dental group and 24 (12.6%) in the non-dental group. The number of deaths within 31 days of dental consultation did not differ significantly between groups ($P = .403$, 95% CI) and similarly the number of deaths within 31 days of cardiac intervention did not differ significantly between groups ($P = .992$, 95% CI). Five (4.4%) patients in the dental group and 5 (2.6%) patients in the non-dental group died within 31 days of dental intervention. Six (5.3%) patients in the dental group and 10 (5.2%) patients in the non-dental group died within 31 days of cardiac intervention.

Table I. Number of OHT, VAD, and TAH procedures performed in each group

	Dental group n = 114	*Nondental group n = 191*
OHT	75	142
VAD	39	47
TAH	0	2

OHT, orthotopic heart transplant; *VAD*, ventricular assist device; *TAH*, total artificial heart.

Table II. Demographic characteristics

	Dental group n = 114	*Non-dental group n = 191*
Sex M, F (%)	94 (82%), 20 (18%)	135 (71%), 56 (29%)
Mean age ± SD (y)	56.42 ± 11.05	48.31 ± 16.39
Age range (y)	22−74	12−76

DISCUSSION

Infection is a common complication associated with advanced cardiac therapies.[7,9,12] Previous studies have

Table III. Average wait time between dental consultation and cardiac intervention (average # days ± SD)

	Dental group n = 114	*Non-dental group n = 191*
OHT	50.01 ± 59.28	74.00 ± 103.99
MCS	19.87 ± 22.22	14.88 ± 16.41

OHT, orthotopic heart transplant; *MCS*, mechanical circulatory support.

Table IV. Dental complications, medical adverse events and deaths

	Dental group n = 114	*Non-dental group n = 191*
# dental complications within 31 days of dental intervention	8 (7.0%)	1 (0.5%)
# medical complications within 31 days of dental intervention	6 (5.3%)	6 (3.1%)
# medical complications within 31 days of cardiac intervention	15 (13.2%)	24 (12.6%)
# of deaths within 31 days of dental intervention	5 (4.4%)	5 (2.6%)
# of deaths within 31 days of cardiac intervention	6 (5.3%)	10 (5.2%)

demonstrated that oral pathogens can infect the cardiovascular tissue.[20,21] As such, many institutions commonly recommend or require a dental evaluation before major cardiac surgeries.[12,13,15] At UCLA RRMC, an extensive evaluation process for possible OHT candidates involves numerous teams including cardiology, cardiovascular surgery, infectious disease, social work, psychiatry, pharmacology, dentistry, nutrition, and transplant coordination. Based on the patient's health status, as well as various factors evaluated by these services, the patient will be accepted or denied for OHT listing.

Unlike other studies, this study combined OHT, VAD, and TAH candidates, as these individuals have similar presentations of end-stage HF. A study evaluating precardiac dental intervention by Smith et al. included the patients who underwent OHT, VAD, and TAH procedures, though this represented a small percentage of their total study population.[22] They reported an increased risk of medical complications in patients who received pre-operative dental treatment, though these patients had a higher Society of Thoracic Surgeons estimated surgical risk of mortality than the overall study population.[22] There was no control group of patients who did not receive dental treatment; rather a comparison was made with the reported 1% risk of death or nonfatal myocardial infarction by the American College of Cardiology/American Heart Association.[22] In order to address these concerns, we included a control group of patients who did not undergo dental treatment, allowing for a clear comparison between those who received pre-operative dental treatment versus those who did not.

In patients receiving OHT, Meyer et al. found no difference in rejection, infection, or mortality between those who underwent dental treatment versus those who did not have their oral infection removed.[17] This study included a total of 74 patients, 43 of whom underwent dental treatment and 31 who did not undergo dental treatment to eliminate known dental infection, which they defined as periapical infected teeth, semi-impacted teeth, or marginally infected teeth.[17] Sung et al. reported on 13 patients who underwent emergent VAD implantation, 9 of whom required dental treatment on an average of 22 days post-VAD placement.[18] No oral complications, medical adverse outcomes, or device infection occurred within 30 days of treatment.[18] Although the aforementioned studies demonstrated encouraging findings, their small sample

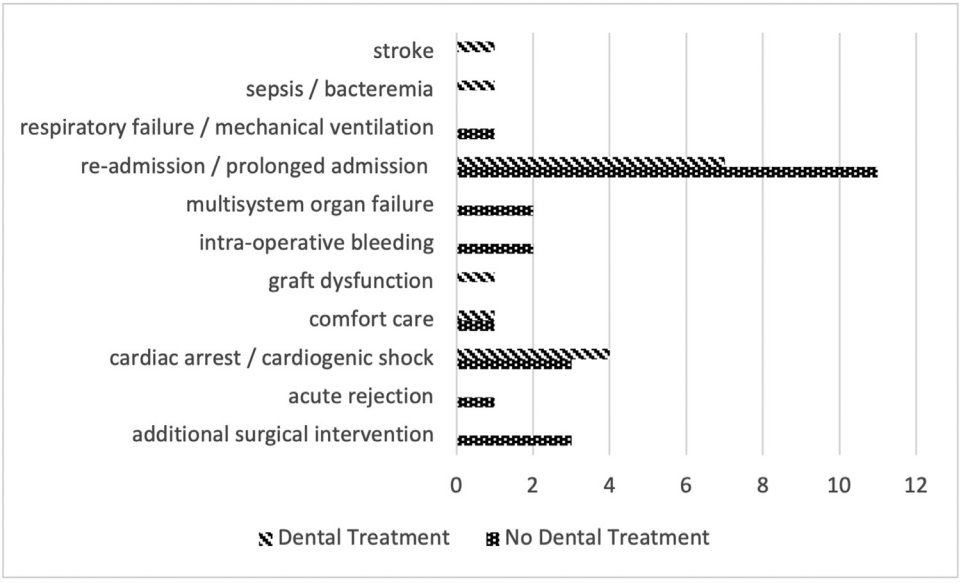

Fig. 1. Number of adverse medical events experienced in each group within 31 days of cardiac intervention.

sizes make it difficult to generalize this data. To our knowledge, there are currently no studies on the impact of dental treatment in patients receiving a TAH.

There are often concerns that completing dental treatment before cardiac intervention will delay cardiac surgery. However, in our study, the dental treatment did not delay cardiac treatment compared with those who did not undergo any dental intervention. There was no significant difference in average wait times from dental consultation and cardiac intervention between the groups. The wait times for OHT or MCS did not differ significantly between groups, suggesting that dental treatment can be performed effectively without delaying necessary cardiac care.

Great care and close communication with the patient's medical team are essential when performing surgical dental intervention on this patient population. These patients are often receiving a heparin drip, which is recommended to be held 3 hours before the extraction and reinitiated as close to 24 hours after the extraction as possible. An evaluation of the patient's lab values and close cardiology oversight is essential in these situations. Collagen hemostatic agents and/or 4-0 chromic gut sutures were used to assist with hemostasis as needed on a per patient basis. An average of 3.87 teeth were extracted per patient. In the 8 individuals who experienced postoperative intraoral bleeding, an average of 1.89 teeth were extracted per patient. This suggested that these individuals did not experience these dental complications due to multiple extractions, rather it was likely a result of their overall medical status.

The individuals who underwent dental treatment did not experience more adverse medical events or deaths compared with those who did not undergo dental treatment, suggesting that these individuals were not at an increased risk of complications, contrary to the conclusions of previous studies.[22] Furthermore, all adverse medical events or deaths that occurred within 31 days of dental intervention also occurred within 31 days of cardiac intervention, as all adverse medical events and deaths that occurred within our study population were after cardiac intervention. This further suggested that any adverse events were likely not related to dental treatment, but instead to the cardiac intervention itself.

There were several individuals who failed to undergo the recommended dental treatment for reasons such as medical fragility necessitating urgent MCS placement or discharge after dental consultation, among other reasons. Although we excluded this group due to a low *n* of 16, it is important that future research evaluates this population in order to determine if cardiac intervention in the presence of a known dental infection is detrimental to the overall health and surgical outcome of the patient. Another population to be evaluated in future research are those individuals who received non-surgical dental interventions. However, they were excluded in this study, as this group only consisted of 6 individuals, making it difficult to draw any significant comparisons among patients who needed surgical dental treatment versus less invasive dental treatment.

This study evaluated a fairly significant population size at a single hospital center. Although this sample size is much larger than those of similar studies carried out previously, a larger group of patients with end-stage HF undergoing advanced cardiac therapies would enhance the conclusions. Based on design, this study only looked at the individuals who received an OHT or MCS. This precluded us from considering the individuals who ultimately did not receive a cardiac intervention, possibly because they were too medically compromised to undergo surgical intervention, though they may have undergone dental consultation and possibly treatment. As this is a retrospective record review, it is possible that dental complications or adverse medical events may have been overlooked due to omissions from the medical chart. Additionally, if the patients were readmitted to a different medical center, this would likely not come to our attention. Many patients with end-stage HF present with such poor health that they may require immediate intervention. In this case, the cardiac team may have omitted consulting the dental service as they had more urgent cardiac needs to address in a limited time frame. It would be beneficial to account for the patients with advanced cardiac disease who did not receive a dental evaluation. Additionally, evaluating oral health status as an indicator of systemic comorbidities would also provide further useful information. The individuals who present with dental infection (dental group) may be in worse overall health, as oral health has been correlated to systemic health and noncompliance with oral health care may be indicative of an overall lack of chronic disease self-management.[23]

End-stage HF patients in need of advanced therapies such as OHT, VAD, or TAH are significantly more compromised than the average cardiac patient and must be managed with great care. The management of these patients may entail interdisciplinary communication in regard to obtaining a complete blood count, potential antibiotic prophylaxis, the use of local anesthesia without vasoconstrictors and appropriate anxiolysis, and postoperative pain management. It is recommended that the precardiac dental consultation and treatment focus on the removal of sources of active infection.[24] The lack of increased medical adverse events or deaths in those who underwent dental intervention (dental) has suggested that the removal of dental infection can be performed safely in patients with

end-stage HF in order to help optimize these individuals for cardiac intervention. Although we have suggested that dental intervention in this population can be performed safely, future research should examine whether pre-surgical intervention is warranted.

DISCLOSURE

None.

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