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Pre-Cardiac Dental Treatment Does Not Increase the Risk of Adverse Events

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Purpose: Elimination of dental sources of infection prior to cardiovascular surgery (CVS) is performed to reduce perioperative infection and complications. This study aims to evaluate if preoperative dental intervention is associated with increased risk of adverse events.

Methods: A retrospective medical record review of inpatient consultations (n = 1513) completed by the Hospital Dentistry Service at University of California Los Angeles Medical Center from January 2011 to December 2020 was performed. Seven hundred thirty-eight consults met the inclusion criteria and were divided into 4 groups: Group A were patients that were dentally unhealthy and received surgical dental intervention (n = 265), Group B were patients that were dentally unhealthy and underwent non-surgical dental treatment (n = 14), Group C were patients that were dentally unhealthy and did not receive the recommended dental treatment (n = 29), and Group D were patients that were dentally healthy requiring no intervention (n = 430). They were evaluated for major adverse events in 3 categories: dental complications, medical adverse events and death.

Results: Dental complications were only experienced in Group A, all of which were bleeding. Only 2 patients were found to have major bleeding, which was more likely due to anticoagulation and CVS rather than dental extractions. There was no significant difference in the number of medical adverse events or number of deaths during the postoperative period between groups.

Conclusions: The results of this study suggest that elimination of oral infection prior to CVS does not increase the risk of morbidity or mortality.

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Cardiovascular disease is the leading cause of death globally.[1] For patients who undergo cardiac surgeries, postoperative infection increases morbidity and mortality rates as well as cost of the treatment.[2] While many variables can contribute to an increased risk for infection, including age, body mass index, and diabetes, multiple studies have elucidated a connection between infectious oral pathogens and their potentially negative effect on cardiovascular tissue.[2-5] Untreated infection, including those originating from dentition or the oral cavity, can contribute to an increased risk of peri- and postoperative infections in patients undergoing major cardiovascular surgery (CVS)[2,6,7] Eliminating the sources of infection, such as diseased teeth, prior to cardiac surgery may help to reduce perioperative infection and complications associated with CVS.[7] A comprehensive dental exam and treatment is a common part of presurgical

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protocols at many hospitals and facilities.[8-12] Not only does pre-cardiac dental clearance reduce the risk of postoperative infection seeding from the oral cavity, but it also reduces the need for dental treatment in the postoperative period.[7] The majority of patients who present for CVS at the University of California Los Angeles (UCLA) Ronald Reagan Medical Center are required to undergo multiple areas of evaluation and clearance prior to their surgical procedure. Many times, the urgency of patients requiring CVS will necessitate the dental team to complete evaluation and treatment within 24 hours of the planned surgery.

Unfortunately, there is limited data available to determine whether treatment of oral infection and diseased teeth before CVS is beneficial because the literature available is inconclusive.[6,12,13] A retrospective study by Smith et al demonstrated an increased risk of delaying CVS and postoperative adverse events in patients undergoing dental extractions prior to CVS.[13] However, this study only included patients that underwent dental treatment, while failing to use a control group to evaluate the rate of adverse events in patients undergoing CVS without having completed dental extractions.[13] A systematic review that evaluated health outcomes post-CVS concluded that there is uncertainty as to whether performing dental treatment prior to CVS results in a better or worse postoperative outcome as compared to no dental treatment.[6] This study took into account mortality, infective endocarditis (IE), infection and length of admission; however, it did not evaluate a single cohort in 1 location.[6] Wu et al compared the risk of developing IE among patients who were dentally healthy versus individuals with existing chronic oral infection.[12] This study found that there was no significant difference in the development of IE within 6 months after surgery between the 3 groups: dentally unhealthy and untreated, dentally unhealthy and treated, and those who were considered dentally healthy and underwent CVS.[12] The small group of patients (n = 98) makes it difficult to report these findings as statistically significant.[12]

This study aims to evaluate the incidence of adverse events in patients undergoing CVS, who have received dental treatment as compared to those who have not received dental treatment. It is hypothesized that there is no increased risk of adverse events when patients receive dental treatment to eliminate acute and chronic infection prior to CVS.

Methods

A retrospective medical record review of the inpatient dental consultations completed by the Hospital Dentistry Service at UCLA Ronald Reagan Medical Center was performed from January 2011 to December 2020. This study has been approved by the UCLA IRB (#20-000114). This study included in-patients, who were admitted for CVS and underwent a dental examination as part of the presurgical clearance protocol during this 10-year period. Patients that did not end up undergoing CVS and those that did not receive CVS within 31 days of their dental consultation were excluded from this study. Patients that met inclusion criteria were divided into 4 groups: Group A were patients that were dentally unhealthy and received surgical dental treatment; Group B were patients that were dentally unhealthy and received non-surgical dental treatment; Group C were patients that were dentally unhealthy and did not receive the recommended dental treatment; and Group D were patients that were dentally healthy and did not require any dental treatment, serving as a control. Surgical dental treatment was defined as at least 1 tooth extraction, while non-surgical dental treatment referred to caries excavation, application of silver diamine fluoride (SDF) to halt caries progression, and/or placement of a temporary restoration. Demographics were recorded at time of the dental consult.

Patients were evaluated for major adverse events in 3 categories: dental complications, adverse medical events and death. Dental complications include problems related to the dental procedure, major bleeding from dental treatment, or issues that required additional evaluation or an additional procedure to be completed. Major bleeding was defined as a greater than 2.0g/dL decrease in hemoglobin (Hgb) in the 3 days after completing the dental procedure.[14] Adverse medical events were defined as acute coronary syndrome (ACS), stroke, renal failure requiring dialysis, postoperative mechanical ventilation, cardiogenic shock or cardiac arrest, sepsis or IE, multi-system organ failure, need for blood transfusions, delay of CVS, intraoperative death, postoperative bleeding requiring exploratory surgery, complications leading to increased length of admission or re-admission, and if the patient was deemed too medically compromised for treatment and placed on comfort care. Dental complications, adverse medical events, and deaths occurring from time of dental consultation until 31 days post-CVS were included. Additional dental consultation requests and entries into the patient's medical record were used to detect complications.

THE UCLA HOSPITAL DENTISTRY SERVICE DENTAL CLEARANCE PROTOCOL

When a patient is designated for CVS, the dental service is contacted by the cardio-thoracic surgery team. A resident from the dental service responds and arranges a time to evaluate the patient at bedside. Comprehensive dental evaluation includes a review

of the medical history and medications (at-home and in-house), bloodwork/lab evaluation, dental history review, clinical exam, and a full set of intraoral radiographs completed bedside in the hospital. After data collection, the patient is reviewed with the on-call attending faculty and a treatment plan is formulated. It may be determined that the patient is cleared for surgery, when there is no oral source of infection, or a treatment plan is formulated to be completed bedside. Teeth with major chronic and/or acute infections are treatment planned for extraction. This includes teeth with severe decay extending to the pulp, teeth that pose an imminent risk of infection, periapical disease or abscess within the bone, teeth or gingiva with active suppuration, or severe periodontal disease. Caries excavation with SDF placement with or without temporization is recommended in cases where there are large caries that pose a risk of infection but are not in close enough proximity to the pulp where extraction would be preferred. Once formulated, the treatment plan is discussed with the medical team and an informed consent is obtained from the patient. Close consultation with the medical team is required in order to monitor anticoagulation and provide antibiotics and anxiolytics preoperatively. Typically, anticoagulants are not discontinued with cardiology oversight; however, if the patient is receiving a heparin drip, it is recommended that the medication is held 3 hours prior to the extraction and re-initiated as close to 24 hours postextraction. Local anesthetic is used (2% lidocaine with 1:100k epinephrine, 3% mepivacaine without epinephrine, or 4% septocaine with 1:200k epinephrine). Based on individual patient need, collagen hemostatic agents and/or 4-0 chromic gut sutures are used to assist with hemostasis. Once treatment is complete, the medical team is notified and recommendations are provided regarding postoperative care and pain management. The dental service follows the patient 24 hours after dental treatment and additional follow-up is provided as needed.

STATISTICAL ANALYSIS

Statistical analysis of variables was performed with 1-way ANOVA. The probability for significance was set *a priori* at $P = .05$.

Results

During January 2011 to December 2020 the UCLA Hospital Dentistry Service was consulted on 1,513 cases for dental clearance prior to CVS. Based on exclusion criteria 775 cases were eliminated. Orthotopic heart transplant (OHT), ventricular assist device (VAD) or total artificial heart (TAH) procedures were performed in 327 cases, 402 cases did not ultimately undergo CVS, and 46 cases did not receive CVS within 31 days of the dental consult (Fig 1). While 738 consults met the inclusion criteria, 7 patients were consulted on twice during this 10-year period for multiple CVS and as such there were 731 individuals comprising these 738 dental consults. Two hundred sixty-five patients underwent surgical dental treatment (Group A) and 14 patients received non-surgical dental treatment (Group B). Due to various reasons, 29 patients did not receive their recommended dental treatment (Group C). At time of consultation 430 patients were deemed dentally healthy and served as a control group (Group D).

Demographics are depicted in Table 1. Patients ranged from 15 to 99 years of age, with no significant difference in age between groups ($P = .288$, 95% confidence interval [CI]). The majority of CVS procedures performed included surgical valve replacement (VR),

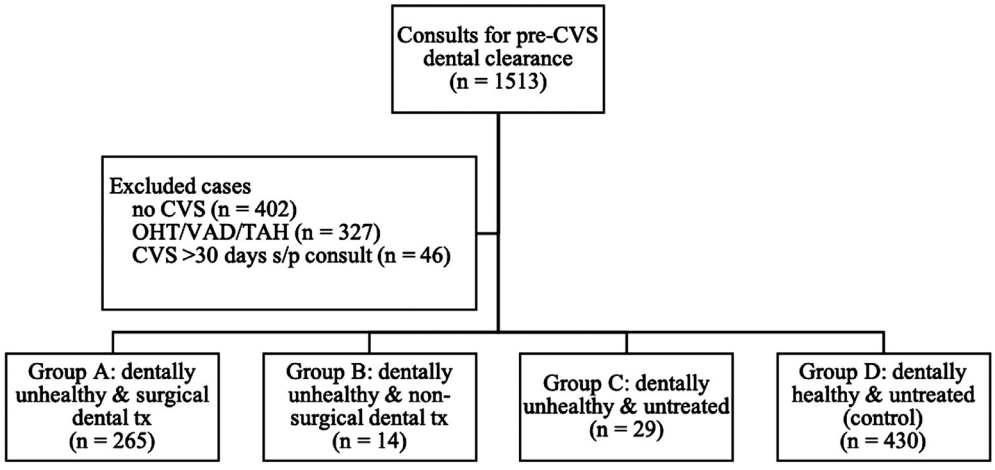

FIGURE 1. Study selection criteria

Table 1. DEMOGRAPHICS

	Group A (n = 265)	Group B (n = 14)	Group C (n = 29)	Group D (n = 430)
Gender M, F (%)	184 (69.4%), 81 (30.6%)	8 (57.1%), 6 (42.9%)	22 (75.9%)	258 (60.0%), 172 (40.0%)
Mean Age ± SD (years)	65.46 ± 16.01	57.14 ± 14.86	64.76 ± 14.61	64.11 ± 17.87
Age Range	18 - 97	32 - 76	30 - 93	15 – 99

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Table 2. CARDIOVASCULAR PROCEDURES PERFORMED

	Group A (n = 265)	Group B (n = 14)	Group C (n = 29)	Group D (n = 430)
Surgical valve replacement	152	8	1	245
Transcatheter valve replacement	70	4	5	103
Coronary artery bypass graft	25	0	8	36
Other	18	2	15	46

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transcatheter VR, and coronary artery bypass graft (CABG). Less commonly performed procedures include pacemaker placement, implantable cardioverter defibrillator (ICD), mass resection, endomyocardial biopsy, and septal defect repair (Table 2).

Complications and deaths are shown in Table 3. Only 14 patients (5.3%) in Group A experienced bleeding related dental issues. No other groups had any dental complications. For all 14 patients prolonged bleeding after dental treatment was managed using direct finger pressure and placement of hemostatic agents. However, 3 patients required fabrication of a pressure stent to further assist with hemostasis. Of the 14, 2 patients experienced major bleeding, defined as a greater than 2.0g/dL decrease in Hgb within 3 days of dental treatment, but only 1 required a pressure stent.

Fifty-nine patients experienced post-CVS medical adverse events (Fig 2). Twenty-one patients in Group A (7.9%), 1 patient in Group B (7.1%), 1 patient in Group C (3.4%), and 36 patients in Group D (8.4%) experienced medical complications. There was no significant difference in the number of major medical adverse events experienced between groups (P = .715, 95% CI). Nine patients in Group A (3.4%), 1 patient in Group C (3.4%), and 16 patients in Group D (3.7%) expired within 31 days of their dental consultation. Twelve patients in Group A (4.5%), 1 patient in Group C (3.4%), and 20 patients in Group D (4.7%) died within 31 days of CVS. No patients in Group B died during the time interval. There was no significant difference between groups in the number of deaths within 31 days of dental consult or CVS (P = .909, P = .849, 95% CI)

Discussion

A comprehensive dental examination is commonly part of CVS workup; however, there is limited data regarding the benefits of performing dental treatment

Table 3. DENTAL COMPLICATIONS, MEDICAL ADVERSE EVENTS AND DEATHS

	Group A (n = 265)	Group B (n = 14)	Group C (n = 29)	Group D (n = 430)
# dental complications within 31 days of dental consultation	14 (5.3%)	0	0	0
# medical complications within 31 days of dental consultation	21 (7.9%)	1 (7.1%)	1 (3.4%)	36 (8.4%)
# of deaths within 31 days of dental consultation / dental treatment	9 (3.4%) / 11 (4.2%)	0	1 (3.4%)	16 (3.7%)
# of deaths within 31 days of CVS*	12 (4.5%)	0	1 (3.4%)	20 (4.7%)

* CVS, cardiovascular surgery.

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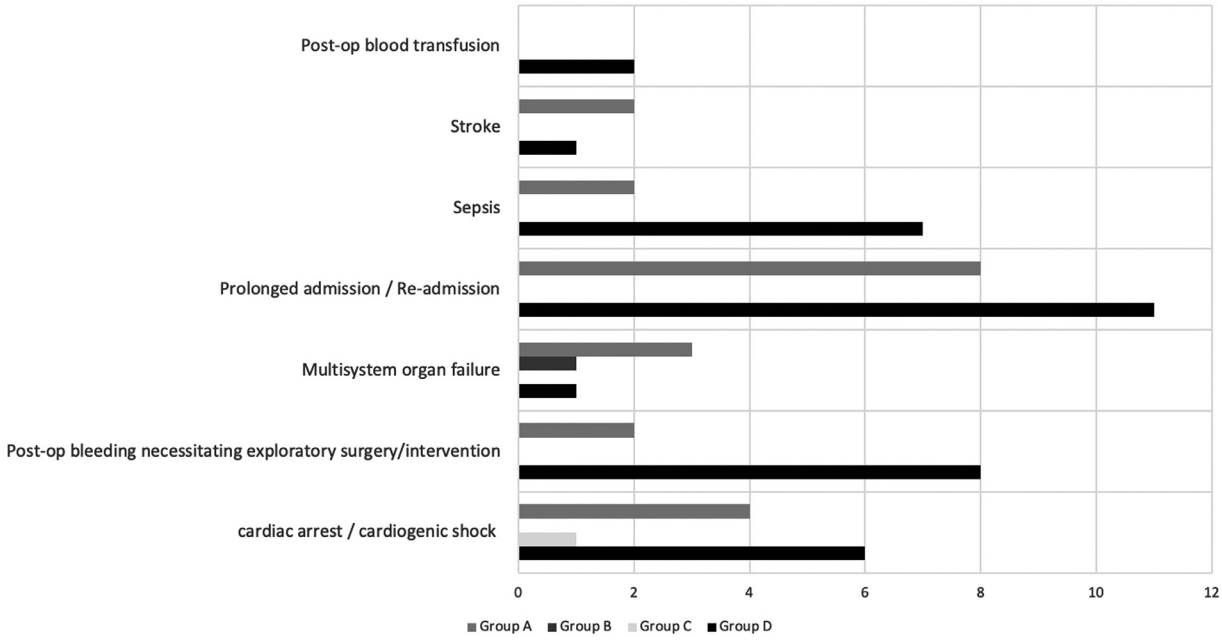

FIGURE 2. Medical adverse events experienced by all groups post-CVS

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prior to CVS.[6,8-13] This study sought to determine if dental treatment completed on patients prior to CVS is associated with an increased risk of dental complications, medical adverse events, and death. The results of this study suggest that medical adverse events and deaths are comparable between groups and as a result dental treatment prior to CVS should not put the patient at increased risk of morbidity or mortality.

Bleeding was the only dental complication experienced; however, in all instances the bleeding was managed during subsequent follow-up visits by the dental service. Hemostasis was achieved using finger pressure and hemostatic agents, with the exception of 3 patients that required fabrication of pressure stents to further assist with hemostasis. One of these individuals experienced postoperative bleeding at days 2 and 4 status postextractions; however, this was a combined heart-liver patient, who was awaiting a liver transplant. It is more likely that the bleeding experienced in his postoperative course was attributed to coagulopathy and the inability to maintain his platelets as opposed to a dental complication. Only 1 of the individuals requiring a pressure stent experienced major bleeding, notable for a 3.3g/dL decrease in Hgb 2 days after dental intervention. Of note, this patient resumed heparin and underwent his cardiac procedure on this same day. This adverse event is more likely a result of the heparin resumption and blood loss during CVS rather than dental extractions 2 days prior. The other patient that experienced major bleeding was managed with pressure hemostasis. None of the patients that experienced dental complications expired.

Post-CVS medical complications, number of deaths within 31 days of dental consultation and number of deaths within 31 days of CVS experienced did not differ significantly between groups (P = .715, P = .909, P = .849, 95% CI). Using a control group of dentally healthy patients that did not require any dental intervention, a clear comparison can be made between those that underwent dental treatment versus those that did not. Our findings demonstrate no increased risk of morbidity or mortality in those that underwent dental treatment prior to CVS. On the other hand. Smith et al did not use a control group, yet stated an increased risk of medical complications, using the reported guidelines by the American College of Cardiology (ACC)/American Heart Association (AHA), which states that there is a 1% risk of death or myocardial infarction due to dental extractions.[13]

Patients that did not complete their recommended dental treatment prior to CVS (Group C) were either a result of patient refusal, urgency of CVS, patients being too medically unstable to tolerate dental treatment, or patients being discharged between dental consult and CVS. Patients discharged after dental consult and prior to CVS may have not followed up with

our service. These individuals may have received dental treatment with another dentist during their time as an outpatient prior to readmission for CVS. If dental treatment was done by another dentist but not recorded into the patient's medical record, these patients remained in Group C. We did not note an increased risk of IE or sepsis in Group C, but this sample size was small (n = 53). Therefore, it is difficult to conclude that there is a lack of infection if chronic dental infection is present during CVS.

The chart review for adverse events was completed from the time of dental consultation until 31 days post-CVS, which is significantly less than the 6 months follow-up performed by Wu et al, who evaluated the risk of developing IE among patients who were dentally healthy versus individuals with existing chronic oral infection.[12] While their study has a long follow-up period of 6 months, the sample size is quite small (n = 98). Wu et al reported a small number of postoperative septicemia and IE among all 3 groups (dentally healthy, dentally unhealthy and treated, dentally healthy and untreated); however, they stated that it is challenging to conclude a statistically significant occurrence of infection or lack thereof based on the small numbers.[12] The follow-up period for this study was much shorter than Wu et al, however there was no significant difference between groups in the number of patients that experienced sepsis within the 31 day follow-up period. It can be inferred that there is minimal septicemia and IE in these patients, but without a longer follow-up period it cannot be ruled out. If the patients were re-admitted to UCLA Ronald Reagan Medical Center for sepsis or IE, the dental service would have been re-consulted. However, if the patient was admitted to an outside hospital, information may not have been available for this study.

This study presents a large population treated in a single hospital over a period of 10 years. There are many different dental and cardiothoracic providers, whose opinions and treatment plans may slightly differ. As this is a retrospective chart review, it is often difficult to ascertain why CVS was postponed or cancelled and there may be omissions in patient charts. Furthermore, if patients expired prior to receiving CVS, it is difficult to definitively attribute this to dental treatment or medical issues.

All patients undergoing CVS should be consulted by the dental service preoperatively, where an individualized treatment plan will be developed based on their medical and dental health. The risk profile of patients who require dental extractions should be carefully evaluated on an individual basis and the procedure should be planned appropriately. A medical risk assessment in this patient population involves gathering information about the level of cardiac disease (NYHA Class I to IV; ACC/AHA Class A to D), cardiac function (ejection fraction), and comorbidities especially including the history of organ failure. The dental evaluation should include a comprehensive clinical and radiographic exam and the decision for treatment is isolated to those teeth with the highest infective risk, such as acute infection, chronic symptomatic infection, and severe periodontal bone disease. If dental treatment is warranted, a multi-disciplinary discussion prior to dental treatment is crucial. Emphasis is placed on patient education and consent, stress-reducing measures, antibiotic prophylaxis, pain control and management of potential bleeding complications. Dental treatment can be performed bedside in the hospital where sedative medications can be administered to assist with anxiolysis. After the dental procedure, close follow-up is needed to detect and manage early on any potential complications related to the dental treatment. This study suggests that there is no increased risk of major medical adverse events or death when dental treatment is provided prior to CVS in order to eliminate oral infection when compared to those not receiving dental treatment.

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