Circulatory dynamics during dental extractions in normal, cardiac and transplant patients

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ABSTRACT

Background. The authors conducted a study to evaluate the relationship between the circulatory dynamics of patients with heart disease and these patients' cardiac status when undergoing dental extractions.

Methods. Subjects with minimal heart disease, or MHD; with severe heart disease, or SHD; or who received a heart transplant, or TRAN; as well as control, or NOR, subjects were enrolled in the study. The authors recorded subjects' systolic blood pressure, or SBP; diastolic blood pressure, or DBP; and heart rate, or HR, while they were under basal conditions and during postanesthesia and dental extraction periods. The authors estimated a general linear model and performed analysis of variance.

Results. Under basal conditions, MHD subjects did not show significantly different mean blood pressure values compared with NOR subjects but did show slightly significantly higher mean HR values. Mean DBP and HR values were significantly higher in SHD and TRAN subjects than in MHD and NOR subjects, while SBP values in SHD subjects were significantly lower than those in MHD, TRAN and NOR subjects. During dental extraction sessions, SBP, DBP and HR mean values increased significantly compared with basal conditions and postanesthesia periods in MHD and NOR subjects. SHD and TRAN subjects showed no significant time-dependent variation during dental extraction sessions in any circulatory parameter.

Conclusions. MHD subjects had cardiovascular responses to stress similar to those of NOR subjects, while SHD and TRAN subjects had similar slight and dulled cardiac responses.

Clinical Implications. Patients with SHD may not be able to adapt their cardiac performance to an emotional stress such as a dental appointment, while it seems to be easier for MHD and TRAN patients. Managing TRAN patients is relatively easier than managing SHD patients.

Patient survival after being diagnosed with cardiovascular disease has increased measurably as a result of improved medical management.[1] Patients who have heart disease now represent a high percentage of the general population.[1,2] Although patients can limit their exposure to physical stress, they still may experience psychological stress and be susceptible to its adverse sequelae.[3,4]

The management of patients who have received a heart transplant is relatively uncomplicated and is easier than the treatment of patients who have heart disease.

Dental appointments can be stressful. The literature has mentioned the great increase in circulatory dynamics that occurs during different dental procedures, which may place subjects who have cardiac impairment at high risk of experiencing heart failure.[5-7] People who have heart disease, however, do not represent a unique category of dental patients, since they include subjects who have minimal heart disease, or MHD, and severe heart disease, or SHD, as well as those who received a heart transplant, or TRAN.

There are no data available in the literature on the relationship between cardiovascular status and circulatory dynamics in subjects who have heart disease and who are undergoing dental procedures. Therefore, in this investigation, we studied the hemodynamic changes that occur during dental extractions in MHD, SHD and TRAN subjects and compared them with those that

occur in control, or NOR, subjects.

MATERIALS AND METHODS

Eighty subjects requiring dental extractions were enrolled in the study. The New York Heart Association, or NYHA, Classification of Cardiac Patients categorizes cardiac patients by four functional classes, depending on their cardiocirculatory status during ordinary life.[8] In our study, 20 subjects (11 men and nine women) with a mean age of 42.1 ± 15.3 standard deviation, or SD, years had minimal heart disease, or MHD, with good tolerance to physical and psychological stress (NYHA functional class I or II); 20 subjects (12 men and eight women) with a mean age of 45.6 ± 17.0 SD years had SHD with very low tolerance to physical and psychological stress (NYHA functional class III or IV, undergoing heart transplantation evaluation); 20 subjects (14 men and six women) with a mean age of 44.7 ± 16.5 SD years had received a heart transplant; and 20 subjects (10 men and 10 women) with a mean age of 43.7 ± 17.5 SD years had no heart disease and acted as NOR subjects.

All of the teeth that were to be extracted had a mobility of no higher than 1 according to the Miller Index (range 0-3),[9] and an independent dentist performed all of the extractions in the morning with the patient in a sitting position. We used mepivacaine 3 percent as the anesthetic to ensure the absence of any pain during all dental procedures.

Using an automatic, noninvasive blood pressure monitor, we recorded systolic blood pressure, or SBP; diastolic blood pressure, or DBP; and heart rate, or HR, in all subjects who were in a sitting position after five minutes of relaxation (basal), three minutes after the administration of the local anesthetic (postanesthesia) and three minutes after the beginning of the dental extraction (extraction). We also calculated myocardial oxygen consumption, or MVO_2, indirectly as the product of SBP and HR.[10] Further, we monitored all of the subjects continuously during the entire procedure by electrocardiogram; we recorded ventricular dyshythmias when they were present.

For the statistical analysis, we estimated a general linear model and performed analysis of variance, or ANOVA, for repeated measures with split-plot design to evaluate differences between cardiac status, time-related variations during dental procedures and the interaction between cardiac status and hemodynamic changes with time. We applied the Bonferroni *t* test for significant values such as a multiple comparison *t* test.

We recorded systolic blood pressure, diastolic blood pressure and heart rate in all subjects who were in a sitting position after five minutes of relaxation, three minutes after the administration of the local anesthetic and three minutes after the beginning of the dental extraction.

RESULTS

The results of estimating a general linear statistical model relating SBP, DBP and HR to three predictive factors (cardiac status, time and the interaction between cardiac status and time) showed a statistically significant relationship between all circulatory parameters and all three predictive variables at the 99 percent confidence level.

Figure 1, Figure 2 and Figure 3 (page 471) show the time-dependent variation of each of the circulatory parameters considered (HR, SBP and DBP) during dental sessions.

Basal conditions. Under basal conditions, MHD subjects did not show mean blood pressure values significantly different from those of NOR subjects (129.2 ± 5.7 SD vs. 132.2 ± 6.2 SD, respectively, for SBP and 77.0 ± 5.7 SD vs. 77.5 ± 7.5 SD, respectively, for DBP), and showed mean HR values slightly significantly higher than those of NOR subjects (84.1 ± 5.9 SD vs. 75.2 ± 4.3 SD, respectively) ($P < .05$).

Conversely, SHD subjects showed lower SBP mean values (115.2 ± 17.3 SD) and higher DBP values (89.5 ± 4.3 SD) and HR mean values (94.5 ± 6.5 SD) compared with both NOR subjects and MHD subjects.

TRAN subjects had SBP mean values (127.0 ± 7.3 SD) that were significantly higher than those of SHD subjects (115.2 ± 17.3 SD) and that were not statistically different from those of MHD subjects (129.2 ± 5.7 SD) and NOR subjects (132.2 ± 6.2 SD). TRAN subjects had DBP mean values (88.3 ± 4.8 SD) that were not significantly different from those of SHD subjects (89.5 ± 4.3 SD), but that were significantly higher than those of MHD subjects (77.0 ± 5.7 SD) and NOR subjects (77.5 ± 7.5 SD). Similar to those

found for DBP, HR mean values (97.9 ± 6.1 SD) among TRAN subjects were not significantly different from those reported in SHD subjects (94.5 ± 6.5 SD) but were significantly higher than those in MHD subjects (84.1 ± 5.9 SD) and in NOR subjects (75.2 ± 4.3 SD).

Circulatory dynamics during dental sessions. We found no significant differences between mean values for SBP, DBP or HR under basal conditions and at the postanesthesia period in any group. During dental extractions, we did not find significant increases in SBP, DBP and HR values compared with basal and postanesthesia periods in both MHD and NOR subjects. Conversely, we found that both SHD and TRAN subjects showed no significant time-dependent variation during dental sessions in any circulatory parameter.

We found a significant mean percentage increase in MVO_2 values during dental extractions compared with basal values in MHD and NOR subjects (+ 22.2 percent ± 10 SD and + 31.2 percent ± 17 SD, respectively), while we found no significant increase in TRAN subjects and SHD subjects (+ 2 percent ± 5 SD and + 7 percent ± 8 SD, respectively).

In five SHD subjects, more than five ventricular extrasystoles per minute were recorded by ECG monitoring during dental extractions.

DISCUSSION

When managing patients who have a history of heart disease, it is recommended that dentists schedule these patients for short appointments early in the day, and that dentists use stress- and anxiety-reduction techniques and complete pain-control methods.[11] These approaches offer reasonably prudent risk management, but in some patients (such as those who have severe cardiac impairment for which any minimal increase HR and blood pressure will place them at risk of experiencing heart failure), these methods may not be enough. In such patients, even minimal increases in HR and blood pressure could result in undesirable and potentially complicated demands on their hearts.[12,13]

NYHA provides a clinical classification to identify cardiac patients who are at high risk of experiencing heart failure on the basis of their tolerance to physical and psychological stress. Data, however, are not yet available in the literature that clarify the relationship between the degree of the cardiac impairment and the cardiovascular reaction to dental stress.

The results of this present study give more insight into circulatory dynamics in cardiac patients undergoing minor dental surgery and show that MHD patients have a similar circula-

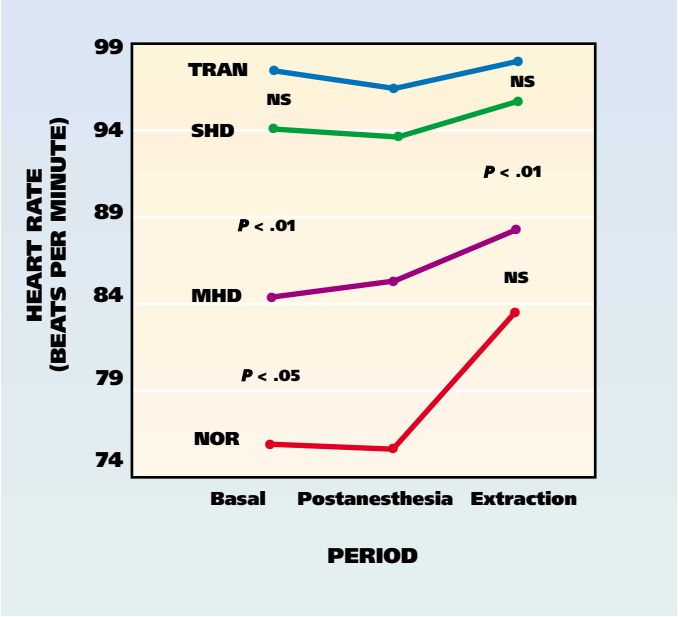

Figure 1. Time-dependent variation of heart rate during dental sessions in normal, or NOR, subjects; subjects who had minimal heart disease, or MHD; subjects who had severe heart disease, or SHD; and subjects who received a heart transplant, or TRAN. Significance is referred to between-groups differences. NS: Not significant.

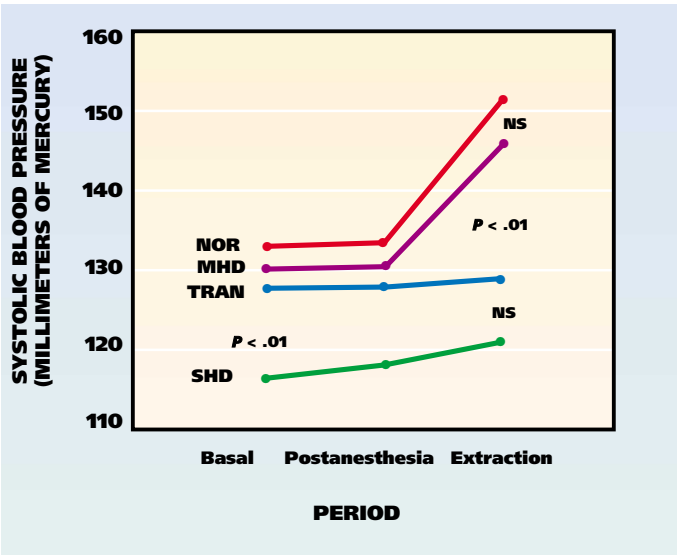

Figure 2. Time-dependent variation of systolic blood pressure during dental sessions in normal, or NOR, subjects; subjects who had minimal heart disease, or MHD; subjects who had severe heart disease, or SHD; and subjects who received a heart transplant, or TRAN. Significance is referred to between-groups differences. NS: Not significant.

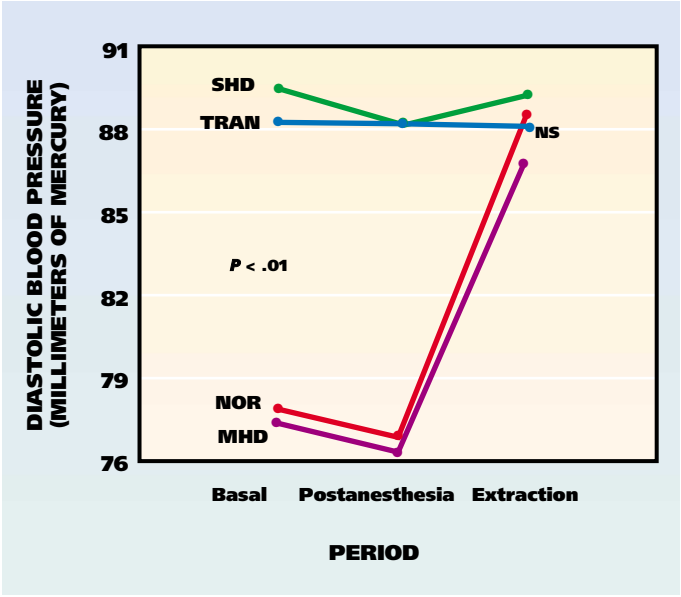

Figure 3. Time-dependent variation of diastolic blood pressure during dental sessions in normal, or NOR, subjects; subjects who had minimal heart disease, or MHD; subjects who had severe heart disease, or SHD; and subjects who received a heart transplant, or TRAN. Significance is referred to between-groups differences. NS: Not significant.

tory response to dental stress to that found in NOR patients. All circulatory parameters considered in this study for MHD and NOR patients, including MVO_2, increased significantly during dental extractions, which reflected a still-good cardiac performance that permits these patients to undergo even highly stressful situations without any circulatory impairment. This means these patients are not necessarily at risk of experiencing heart failure during dental sessions.

A different situation develops as the heart disease gets worse. The results from this study demonstrate that SHD subjects and those who have reduced cardiac performance have some trouble facing stressful situations such as dental extractions. The results agree with numerous earlier studies and show low SBP levels under basal conditions that reflect a reduced cardiac function even before the dental session begins; this is partially compensated for by a strong increase in the sympathetic activity at rest producing a marked increase in DBP and HR basal values.[14-16] Despite an acute excitatory stimulus that occurs after dental extraction, the sympathetic nerve activity is not able to increase further and adapt circulatory dynamics to the ongoing stressful situation, and the blunted response of all circulatory parameters (including MVO_2) in these subjects during stress is nothing but its consequence.[17] The sudden appearance of ventricular dysrhythmias in five SHD subjects during dental extractions probably was the result of a ventricular ischemia related to the increased work of the heart.[18,19] The subjects were continuously close to heart failure and probably would have been unable to withstand the rigors of even minor surgical intervention. It follows that a reduced cardiocirculatory response during stress in subjects who have heart disease can be interpreted as a negative factor due to a subsevere cardiac impairment.

The results from our study agree with those of a 1997 study that also showed a blunted cardiovascular response to mental stress in SHD subjects.[17]

Another important finding of our study is that TRAN subjects had a hemodynamic pattern to stress that is more similar to that found in SHD subjects than to that found in NOR subjects or MHD subjects. The cardiovascular reaction of TRAN subjects to analogous dental situations was, in fact, slight and dulled, and the maximal values recorded during stress were not significantly different from the basal values. These results are in accordance with those of a previous study.[20] And, contrary to what has been described about SHD patients, the results are the consequence of the complete denervation of the transplanted heart, which deprives it of any sympathetic effects that normally would elicit the strong cardiovascular response in NOR patients during a stressful situation. This situation is welcomed, since it reduces the strong negative impact that the sympathetic system has on the transplanted heart under normal conditions.

The results of this present study give more insight into circulatory dynamics in cardiac patients undergoing minor dental surgery.

CONCLUSIONS

The data from this study agree with those of a recent report suggesting that the management of patients who have heart disease can differ depending on the cardiac status of the patent.[21] The decision to proceed with dental treatment should be based on a comprehensive assessment of the cardiovascular condition of each patient. MHD

patients can tolerate even highly stressful situations since their circulatory dynamics adapt well to ongoing situations, while SHD patients who fail to adapt well to ongoing circumstances are at high risk of experiencing heart failure at any time during all dental procedures.

The management of TRAN patients is relatively uncomplicated and is easier than the treatment of patients who have heart disease. These patients, however, require individualized, comprehensive assessment for cardiovascular and other health risks. ■

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