The Influence of Marital Adjustment on 3-Year Left Ventricular Mass and Ambulatory Blood Pressure in Mild Hypertension

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Background: Of psychosocial stressors, job strain has been associated with a sustained increase in blood pressure. The impact of marital factors on blood pressure and target organ has not been explored.

Objectives: To evaluate whether marital adjustment, measured at baseline by self-report (Dyadic Adjustment Scale) influences left ventricular mass index (LVMI) and ambulatory blood pressure measured over 3 years in patients with mild hypertension.

Methods: A prospective cohort study was conducted on 103 cohabiting males or females, including 72 with technically adequate echocardiograms, who at baseline were unmedicated, employed, and living with a significant other, all for a minimum of 6 months and had repeated elevated office diastolic blood pressure.

Main Outcome Measures: Left ventricular mass by M-mode echocardiography indexed to body surface area and blood pressure were measured by ambulatory blood pressure every 15 minutes (daytime) and hourly between 11 PM and 7 AM.

Results: Marital adjustment, smoking, drinking, and baseline LVMI contributed significantly to the prediction of 3-year LVMI (semipartial correlation, $r^2=0.04$, 0.07, 0.03, and 0.22; $P=.03$, .008, .08, and <.001, respectively) together accounting for 36% of the total variability in follow-up LVMI. Three-year ambulatory blood pressure measures were not significantly related to marital adjustment but there were correlations with Dyadic Adjustment Scale subscales. Low or high levels of spousal contact during 3-year ambulatory blood pressure monitoring were associated with an increase or decrease of 3-year, 24-hour diastolic blood pressure, consistent with the quality of marital adjustment ($P=.04$) or marital satisfaction (Dyadic Adjustment Scale subscale, $P=.008$).

Conclusions: In a cohort of subjects with mild essential hypertension, marital adjustment had an influence on 3-year LVMI. Depending on the quality of marital adjustment, spousal contact at 3 years was associated with an increase or decrease of 3-year diastolic blood pressure. Confirmation of these results, including objective marital assessment and the participation of normotensive subjects, is required.

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Marital disharmony is common and adversely affects emotional and physical health, whether like job strain, it is associated with an increased prevalence of systemic hypertension and an increase in left ventricular mass index (LVMI) is unknown. Accordingly we examined the relationship between marital adjustment and 3-year LVMI in subjects with mild essential hypertension.

RESULTS

OVERALL RESULTS

Of the 205 baseline subjects, 30 refused to participate, there was 1 death, for 32 the reason was not given, and for 24 the reason was recorded as “unable to contact.” Of the remaining 118 subjects, 15 had incomplete data (from questionnaires or procedures), resulting in 103 subjects with complete data. Of the 176 subjects who had technically adequate echocardiograms, there were 72 such subjects at 3-year follow-up with complete data. The participants and nonparticipants were compared on baseline measures; of the whole group there were no differences, except nonparticipants had lower night-time SBPs and DBPs than participants ($128±14.5$ mm Hg vs $131.9±13$ mm Hg, $P=.047$; $79.4±10.5$ mm Hg vs $82.6±9.4$ mm Hg, $P=.02$, respectively). Of those with technically adequate echocardiograms, there were no statistically significant differences between participants and nonparticipants.
SUBJECTS AND METHODS

STUDY SUBJECTS
From August 1993 to March 1996 subjects participated in a study to examine the association of marital factors with LVMI and ambulatory blood pressure (ABP) (baseline) and another study to examine the association of marital factors with LVMI and ambulatory blood pressure (ABP) some months later. They were males or females aged from 20 to 65 years, with no clinical evidence of coronary artery disease, who for 6 months were employed, receiving no antihypertensive medication, and living with their significant other. On 3 separate occasions subjects had had office diastolic blood pressure (DBP) between 90 and 105 mm Hg. Variables elicited under supervision included sex, age, ethnic background, family history of essential hypertension (first-degree relative), educational level, body mass index, smoking, alcohol use, regular practice of relaxation techniques, regular exercise, previous use of antihypertensive medication (up to 6 months prior to baseline), job strain (measured using the Job Content Questionnaire) and total Dyadic Adjustment Scale (DAS) or DAS subscales (ie, Satisfaction, Cohesion, Consensus, and Affectional Expression).

The DAS is a 32-item self-report questionnaire to indicate marital adjustment, marital satisfaction, and marital distress. It is reported to be the most widely published instrument of marital adjustment and to be a widely used instrument as evidenced by its mention in more than 1000 published studies by 1989. The DAS has high internal consistency (alpha reliability coefficient, .84-.96, .96) and test-retest reliability (.69-.90 between 2 weeks and 12 months). It has clearly discriminated between married and divorced subjects and has been predictive of various outcomes; in particular, it has been used to indicate marital distress (positive predictive value, 0.70 for men and 0.73 for women). High correlations have been shown with other commonly used marital measures and newly developed instruments. In our baseline study of subjects with mild hypertension, lower marital cohesion (DAS subscale) was related to elevated nighttime ABP and 24-hour DBP. The 7.3% of subjects with very low marital cohesion demonstrated approximately 6-mm Hg elevation of all ABP variables, controlling for other significant variables (P<.05, except nighttime systolic blood pressure [SBP]). Almost all studies show that the DAS is as it was developed, a multidimensional construct termed “marital adjustment,” and not a unidimensional one such as marital satisfaction (for exception and response). This was demonstrated in an analysis of archives of 1307 men and 151 women from the community and 140 couples from a clinic setting where marital satisfaction only accounted for 19% to 25% of the variance. Cross-culturally, a study of 1501 married couples in China showed the 4 factors (ie, satisfaction, cohesion, consensus, and affectional expression) and no sex difference in the results between men and women. In our own study at baseline, factor analysis showed virtually an exact replication (with the exception of 1 item) of the 4 subscales confirming the multidimensional construct.

Ambulatory blood pressure on a usual working day, according to research protocol, was measured using an ambulatory monitor (model 90207; Spacelabs, Redmond, Wash) with blood pressure (BP) recorded every 15 minutes (during the day) and hourly between 11 AM and 7 AM (during the night). Left ventricular mass, indexed to body surface area, was measured by 2-dimensional–guided M-mode echocardiography and calculated by the modified American Society of Echocardiography formula.

Subjects had been recruited from family practitioners, local businesses, and in response to newspaper advertisements. Two hundred five subjects were enrolled in the study, 176 of whom had technically adequate M-mode echocardiograms. All subjects gave informed consent after reviewing written and oral information and discussing the protocol with study personnel. Subjects were informed that they may be contacted in the future in relation to the baseline study. Both of the studies were approved by the Human Subjects Review Committee of the University of Toronto, Toronto, Ontario.

Between 1996 and 1999 at the 3-year anniversary of their initial enrollment in the cross-sectional study, subjects were contacted and invited to participate in the follow-up study. If consent was given, the aforementioned procedures were repeated (on a usual working day, if currently employed) and information elicited (with the addition of medication history, if relevant) at the 3-year anniversary (±1 month of allowable follow-up evaluation of 35-37 months) of the baseline measures.

STATISTICAL ANALYSIS
Stepwise multiple regression analyses were performed with LVMI and ABP measurements as dependent variables. The independent variables from the baseline assessment were sex, age, body mass index, smoking status (smoking or not smoking), alcohol use (drinking vs not drinking), practice of relaxation techniques (regular or not), exercise (regular or not), previous antihypertensive medication (at least 6 months before baseline), and total DAS score. From the follow-up data we also controlled for current antihypertensive medication use. Baseline measures of LVMI and ABP were used as covariates in each model to determine the predictive value of marital strain variables on LVMI and ABP change over time.

To test the hypothesis that spousal contact differentially affects ABP depending on the quality of marital adjustment, a 2×2 factorial analysis of variance was performed on 24-hour DBP and SBP. Spousal contact at follow-up was divided into high spousal contact (≥4 hours) vs low spousal contact (<4 hours) reported during ABP monitoring. The second factor was marital distress using the cutoff of total DAS score of 100 or more vs less than 100 or marital satisfaction (DAS subscale) using the quartile cutoff of 35 (≤35 vs >35). All values are expressed as mean±SD.

At baseline, the mean age of the group (n=103) was 47.2±8.2 years, 64% were male, and 74% were white. The mean body mass index was 26.5±3.0 kg/m² and 20% had previously been receiving antihypertensive medication. At 3-year follow-up, 52% were receiving antihypertensive medication, 15% were smokers, and 20% reported having job strain.

Table 1 gives the ABP, LVMI, and marital adjustment measures comparing male and female subjects with the total sample. At baseline, male subjects had higher
daytime diastolic ABP and greater LVMi and, at 3 years, higher daytime and nighttime ABP and greater LVMi than female subjects.

Table 2 gives significant variables from the multiple regression analysis on 3-year LVMi. Baseline LVMi, alcohol use, smoking, and marital adjustment contributed significantly to the model, together accounting for 36% of the total variability in follow-up LVMi. The semipartial correlation ($sr^2$) was 0.04, 0.07, 0.03, and 0.22, respectively ($P = .03$, $P = .008$, $P = .08$, and $P < .001$). Every point of diminution of the DAS total score was associated with a 0.3-g/m² increase in LVMi.

To ascertain whether there was any effect of degree of alcohol intake, frequency of exercise, or level of BP elevation, a further analysis was performed. Alcohol consumption was stratified into whether the subject consumed alcohol (ie, drink or did not drink) or was a regular drinker, defined as more than 2 drinks 5 times per week (see baseline study). Exercise was graded according to how frequently the subject exercised per week. Ambulatory blood pressure was stratified based on daytime SBP higher than 140 mm Hg, nighttime SBP higher than 125 mm Hg, daytime DBP higher than 90 mm Hg, and nighttime DBP higher than 80 mm Hg, according to American Society of Hypertension guidelines.

In the multiple regression analysis, baseline LVMi, smoking, exercise, and total DAS contributed significantly to the model, constituting 38.8% of the total variability in follow-up LVMi. The semipartial correlation was 0.196, 0.08, 0.046 and 0.06, respectively ($P < .001$, .008, .04, and .01, respectively).

Marital adjustment alone was not significantly related to any of the 3-year ABP measures. Those subjects with poor marital cohesion and/or satisfaction (lowest quartile on either satisfaction or cohesion, DAS subscales) had increased 24-hour diastolic and systolic ABPs at 3-year follow-up ($sr^2 = 0.045$ and 0.024; $P = .01$ and $P = .05$, respectively).

The Figure shows the relation between spousal contact and ABP. Low or high current spousal contact was associated with an increase or decrease of 3-year, 24-hour DBP, depending on the quality of baseline marital adjustment (marital distress or not, $P = .04$) and controlling for sex and years of marriage. This interaction was more pronounced with marital satisfaction (DAS subscale, $P = .008$).

To examine the association between subjective and objective ratings of the marital relationship, a substudy was performed. Couples who had previously participated in the main study and who gave consent completed self-report questionnaires (the DAS and Areas of Change Questionnaire) and each partner was interviewed separately. Thereafter, they were videotaped while discussing a previously determined problem area of conflict for 10 to 15 minutes. This had been preceded by a neutral discussion and was followed by a discussion of a pleasant topic, both for 10 minutes. Blood pressure was recorded on both partners every 3 minutes through all discussion periods. The videotape was sent to an inde-

### Table 1. Ambulatory Blood Pressure, Left Ventricular Mass Index, and Marital Adjustment Measures*

<table>
<thead>
<tr>
<th></th>
<th>Male Subjects (n = 66)</th>
<th>Female Subjects (n = 37)</th>
<th>Total No. of Subjects (n = 103)</th>
<th>Male vs Female Subjects†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Values</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DBP, mm Hg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daytime</td>
<td>91.7 ± 5.9</td>
<td>88.5 ± 7.7</td>
<td>90.6 ± 6.7</td>
<td>.02</td>
</tr>
<tr>
<td>Nighttime</td>
<td>83.8 ± 9.4</td>
<td>80.4 ± 8.8</td>
<td>82.5 ± 9.3</td>
<td>.084</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daytime</td>
<td>140.8 ± 8.8</td>
<td>139.2 ± 12.7</td>
<td>140.3 ± 10.4</td>
<td>.452</td>
</tr>
<tr>
<td>Nighttime</td>
<td>132.4 ± 12.7</td>
<td>130.8 ± 14.0</td>
<td>131.8 ± 13.2</td>
<td>.564</td>
</tr>
<tr>
<td>LVMI, g/m²</td>
<td>97.0 ± 15.9</td>
<td>83.7 ± 19.18</td>
<td>91.5 ± 18.5</td>
<td>.000</td>
</tr>
<tr>
<td>Left ventricular hypertrophy, % of subjects‡</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>.632</td>
</tr>
<tr>
<td>White-coat hypertension, % of subjects§</td>
<td>9</td>
<td>30</td>
<td>17</td>
<td>.012</td>
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<tr>
<td>Total DAS score</td>
<td>107.2 ± 17.2</td>
<td>110.5 ± 13.9</td>
<td>108.4 ± 16.1</td>
<td>.345</td>
</tr>
<tr>
<td>DAS score =100, % of subjects</td>
<td>32</td>
<td>24</td>
<td>29</td>
<td>.501</td>
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<tr>
<td><strong>3-Year Follow-up Values</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DBP, mm Hg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daytime</td>
<td>87.7 ± 8.2</td>
<td>81.8 ± 6.9</td>
<td>85.5 ± 8.3</td>
<td>.000</td>
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<tr>
<td>Nighttime</td>
<td>75.0 ± 8.0</td>
<td>67.6 ± 7.3</td>
<td>72.3 ± 8.5</td>
<td>.000</td>
</tr>
<tr>
<td>SBP, mm Hg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daytime</td>
<td>137.7 ± 11.4</td>
<td>132.8 ± 11.9</td>
<td>135.9 ± 11.8</td>
<td>.042</td>
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<tr>
<td>Nighttime</td>
<td>121.8 ± 11.5</td>
<td>114.6 ± 12.2</td>
<td>119.2 ± 12.2</td>
<td>.005</td>
</tr>
<tr>
<td>LVMI, g/m²</td>
<td>93.0 ± 18.5</td>
<td>81.0 ± 18.2</td>
<td>88.5 ± 19.2</td>
<td>.006</td>
</tr>
<tr>
<td>Left ventricular hypertrophy, % of subjects‡</td>
<td>4</td>
<td>10</td>
<td>6</td>
<td>.354</td>
</tr>
<tr>
<td>Total DAS score</td>
<td>107.8 ± 17.5</td>
<td>111.1 ± 15.1</td>
<td>109.0 ± 16.7</td>
<td>.319</td>
</tr>
<tr>
<td>DAS score =100, % of subjects</td>
<td>27</td>
<td>24</td>
<td>26</td>
<td>.818</td>
</tr>
</tbody>
</table>

* All values are expressed as mean ± SD unless otherwise indicated. DBP indicates diastolic blood pressure; SBP, systolic blood pressure; LVMI, left ventricular mass index; and DAS, Dyadic Adjustment Scale.
† P value obtained by t test.
‡ Values used were more than 131 g/m² for men and more than 100 g/m² for women.
§ Less than 85 mm Hg daytime DBP.
Table 2. Final Regression Model of Marital Factors and Patient Characteristics on Left Ventricular Mass Index (LVMI)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter Estimate</th>
<th>P</th>
<th>Partial $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>76.36</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Baseline LVMI</td>
<td>-0.48</td>
<td>&lt;.001</td>
<td>0.22</td>
</tr>
<tr>
<td>Smoke</td>
<td>-17.43</td>
<td>.006</td>
<td>0.07</td>
</tr>
<tr>
<td>Total Dyadic Adjustment Scale score at baseline</td>
<td>-0.24</td>
<td>.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Drink</td>
<td>-7.65</td>
<td>.08</td>
<td>0.03</td>
</tr>
</tbody>
</table>

The main finding from this study is that marital adjustment was one of the factors associated with left ventricular mass over 3 years in subjects with mild hypertension. In comparison with a factor such as baseline LVMI, the contribution of marital adjustment to the model is modest. A 3-g/m$^2$ increase in LVMI would require a 10-point diminution in DAS score where a 10-point change may be associated with an observable effect in marital counseling.47

There is no comparable follow-up study for job strain and left ventricular mass. In a case-control study of 149 men from 8 work sites in New York the effect of job strain was 7.3 g/m$^2$.11,12 In both our cross-sectional and follow-up studies, we found no association between job strain and LVMI; however, job strain is not a fixed construct and it is possible that other formulations may have yielded an association with LVMI.10,38 As with the evaluation of work factors, marital assessment is complex and will depend on the purpose of the evaluation.39 The inclusion of both objective assessment in addition to subjective measures would contribute to a more comprehensive evaluation of marital functioning to further clarify the role of marital factors on the course of early hypertension.18,34,39

Results of our marital interaction substudy confirm that there is a relation between the DAS (a self-report questionnaire) and the RMICS (an objectively measured system). The negative code of the RMICS of Distress Maintaining Attribution has been related to outcome in marital therapy.40 This substudy is limited by having a small sample of subjects and, in particular, of those with marital problems as measured by the DAS and RMICS. The DAS total scores reflect high mean marital adjustment and the RMICS reveals that the vast majority of interactions (>95%) were positive. Ewart et al41 showed in a study of 24 females with essential hypertension that hostile marital interaction and marital dissatisfaction were associated with increased BP response but not supportive or neutral interactions. To further investigate objective and subjective marital ratings and BP response, larger studies of subjects with marital distress are warranted.

Psychosocial factors may have their most salient effects on early hypertension.42 This sample was composed of subjects with mild essential hypertension who responded to medication over a 3-year period with reduction of ABP and LVMI. Despite this, at 3 years,
LVMI correlated with baseline marital adjustment. Left ventricular mass is partially determined by the cumulative effect of fluctuations in systemic BP.\textsuperscript{13} The single study examining job strain in men and its relation to LVMI revealed a significant relationship only when 3 subjects with a history of antihypertensive medication use were included in the analysis.\textsuperscript{12} Marital disharmony, by causing periodic increases in systemic BP, could result in increased left ventricular mass and possible vascular remodeling and yet not cause a sustained increase in BP over the course of a single 24-hour ABP recording. This may relate to the amount of contact between partners and the duration of time it takes an at-risk individual to develop sustained hypertension. We did not find that there was a direct association between baseline marital adjustment and 3-year ABP; however, in those with baseline marital distress or low marital satisfaction there was an association of current spousal contact and a significant increase in 3-year DBP. Conversely, in those who were not distressed or dissatisfied in their marriages at baseline, current spousal contact was associated with a protective effect on 3-year, 24-hour DBP.

Job strain has been linked to sustained BP during and after a usual workday in normotensive subjects and with subjects with essential hypertension, especially in males.\textsuperscript{8-11,44} Job strain or marital factors may be viewed as initiating and aggravating factors in essential hypertension, but it is unlikely that psychosocial factors alone can sustain BP elevation. It is more likely that job and/or marital factors modify existing biologic factors in the context of the person’s unique genetic predisposition. This effect is expected to occur in early hypertension before compensatory changes caused by elevations in BP become established. This study population of subjects with early hypertension was ideal for exploring this hypothesis; however, this study is not generalizable in that normotensive subjects were excluded; thus, there is the possibility that our results are skewed due to a biased sample.\textsuperscript{45} In comparing subjects from baseline and follow-up studies for baseline variables, participants in the follow-up study were similar to nonparticipants (subjects from the baseline study who did not participate in the follow-up study). This applied to those with technically adequate echocardiograms and for the whole group, except in the whole group nonparticipants had lower nighttime ABP than participants. However, after adjusting the significance level for multiple testing, no variable would have been significant.

In our study the levels of marital distress (based on DAS scores) are 29% at baseline and 26% at 3-year follow-up that is only slightly higher than the general population norms of 16% to 20%.\textsuperscript{21,46} This suggests that the subject with mild hypertension may not experience much more marital distress than in the general population; however, the presence of a comparative normotensive group would have been helpful to clarify whether marital distress is common in the subject with hypertension.

These are initial results showing a relation between marital factors, LVMI, and ABP. Further confirmation using objective and self-report measures of marital functioning and with normotensive subjects as well as subjects with mild hypertension are required.

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