Equation 3 can be solved for the amount of ischemic tissue as follows:

\[ IG = \frac{100 \text{NIVC} - 100 \text{CSC}}{(\text{IRFR} \times \text{CSC}) - \text{CSC} - (\text{IRFR} \times \text{IVC}) - \text{NIVC}} \]  

(4)

Assuming an arterial lactate concentration of 1 mM, then net lactate production will occur when the coronary sinus concentration (CSC) is greater than 1.0. Accordingly, the "critical ischemic fraction" (CIF) will be the amount of ischemic tissue (IG) when the CSC = 1. Thus, equation 4 can be rewritten as:

\[ CIF = \frac{100 \text{NIVC} - 100}{\text{IRFR} - 1 - (\text{IRFR} \times \text{IVC}) + \text{NIVC}} \]  

(5)

This equation was solved to determine the CIF for a variety of ischemic conditions. The NIVC varied from 0.9 to 0.4 mEq as would occur when the nonischemic regional rate of lactate extraction varied from 10% to 60% and the arterial lactate concentration was 1.0 mEq. Values for the IRFR and IVC were based on the lactate production data in the isolated rat and rabbit hearts. The results of these calculations of the CIF are presented in figure 7.

### Effect of Medical vs Surgical Treatment on Symptoms in Stable Angina Pectoris

The Veterans Administration Cooperative Study of Surgery for Coronary Arterial Occlusive Disease

**Prepared by Peter Peduzzi, Ph.D. and Herbert N. Hultgren, M.D.**

**SUMMARY** The comparative effect of medical vs surgical treatment on symptoms in patients with stable angina has been evaluated in a large-scale randomized study. We obtained systematic information regarding symptoms and medication requirements by questionnaire, and a scoring system was devised to provide an index of severity. Data are available on 384 patients who had an entry questionnaire, 639 with an annual questionnaire and 329 who had both an entry and a 1-year questionnaire. A severe degree of angina and associated symptoms were present at entry. Symptoms were similar in both treatment groups at entry. At 1 year, surgical patients had a significant improvement in symptoms. Approximately 60% had marked improvement or were free of angina, compared with 16% of patients treated medically. Only 14% of surgical patients were unchanged or worse at 1 year, compared with 56% of medical patients. These results are comparable to those reported by other studies that have examined the effect of surgical vs medical treatment of angina. Surgical patients in the Veterans Administration Study took substantially less daily medication at 1 year, while medical patients took moderately more. Relief of symptoms in surgical patients was related to graft patency, and patients who had all grafts patent had the most striking improvement. In 29 patients with all grafts closed, symptoms were significantly less severe at 1 year than in patients who took medical treatment. A placebo effect or an undetermined effect of surgery on pain may explain this phenomenon.

**AN IMPORTANT OBJECTIVE** of surgery for coronary artery disease is the relief of angina. In most studies, simple, descriptive methods of assessing severity or change in angina have been used. Angina may be described as severe, moderate, mild or absent on the basis of the number of episodes per day and the amount of disability produced. After treatment, angina may be described as absent, improved, unchanged or worse compared with the pretreatment status. Such methods are of limited value in systematic studies, because the frequency and severity of angina may be profoundly altered by the amount of daily physical activity, employment status and the use of prophylactic medications such as long-acting nitrates and β-blocking agents. The New York Heart Association (NYHA) functional classification is often used, but has several limitations, especially in the evaluation of angina. This classification system has recently been revised.

To assess more systematically the severity of angina and associated symptoms, a physician-administered questionnaire was developed and used in a large-scale prospective randomized study of the effect of medical vs surgical management of stable angina. In this paper we describe the questionnaire used to assess angina and present baseline and 1-year follow-up data on the Veterans Administration (VA) study patients.

**Materials and Methods**

The VA cooperative study of coronary artery bypass surgery is a controlled clinical trial of medical therapy vs surgical plus medical therapy for patients with coronary artery disease who have stable angina. This study began in 1970 and continued through 1974,
during which time 1015 patients from 13 hospitals were enrolled in the two treatment regimens (508 patients to medicine and 507 to surgery).

Entry Criteria

Major eligibility criteria consisted of: 1) male patient with angina pectoris of 6 months or longer duration with at least a 3-month trial of medical management; 2) angiographic evidence of at least a 50% luminal diameter reduction in one or more major coronary arteries and potentially graftable distal segments; 3) evidence of some ECG abnormality at rest or with exercise. Patients who had diffuse non-graftable coronary disease, ventricular aneurysm, or clinical evidence of persistent congestive failure refractory to treatment were excluded.

Baseline Descriptors

Clinical, angiographic and ventriculographic characteristics of the medical and surgical treatment groups, except for serum cholesterol, were similar at baseline and have been previously described.4 The study population had a relatively severe degree of coronary artery disease. Approximately 53% had triple-vessel disease, 32% had two-vessel disease and 14% had single-vessel disease. Twelve percent had left main coronary artery disease, and 78% had some abnormality of left ventricular function. Further details of the results of medical and surgical treatment have been previously reported.4

Angina Questionnaire

The angina questionnaire (AQ) was designed to elicit information about the frequency of angina, the type of activity that produced angina, the medications used, the level of daily physical activity and symptoms associated with angina. The AQ was given by a physician who was familiar with the symptoms of coronary artery disease. Data were recorded on the average daily symptoms over the preceding month. The questions were objective and did not include inquiries about whether the patient felt better or worse.

The questionnaire was designed and implemented in 1973.

Angina Score

A numerical scoring system was developed to evaluate overall symptoms (table 1). Two subscores were used to assess the severity of symptoms and the use of medication. Severity was scored (0-9) based on the frequency of angina or ischemic pain, presence of rest or nocturnal angina, and the amount of physical effort required to produce angina. The medication subscore (0-9) included information about the use of nitroglycerin, propranolol and long-acting nitrates. The total score (0-18) was the sum of the two subscores and was used as an index of the overall severity of symptoms. The scoring system was based on clinical judgment, and no attempt was made to weight these scores based on statistical considerations.

The daily level of physical activity was not used in the scoring system, because many VA study patients were unemployed, so this was not considered a reliable indicator of the status of symptoms.

Table 1. Angina Questionnaire Scoring Method

<table>
<thead>
<tr>
<th>Score</th>
<th>A. Frequency of angina</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4X/day or more</td>
</tr>
<tr>
<td>3</td>
<td>Once daily - 3X/day</td>
</tr>
<tr>
<td>2</td>
<td>Once weekly - not daily</td>
</tr>
<tr>
<td>1</td>
<td>Once a week or less</td>
</tr>
<tr>
<td>0</td>
<td>No angina at any time</td>
</tr>
</tbody>
</table>

B. Rest or nocturnal angina

Yes = 2
No = 0

C. Level of activity producing angina

Sedentary activity (climbing less than 2 flights and/or walking <2 blocks) = 3
Light activity (climbing 2-4 flights and/or walking 2-5 blocks) = 2
Heavy activity (climbing 4 or more flights and/or walking 1 mile or more) = 1
No angina even on heavy activity = 0

Severity of angina score = A+B+C
Range 0-9

2. Medication

A. Nitroglycerin

4X/day or more = 4
Once daily to 3X/day = 3
Once a week but not daily = 2
Once a week or less = 1
None for past 2 months = 0

B. Propranolol

240 mg/day or greater = 4
160 mg/day - 239 mg/day = 3
80 mg/day - 159 mg/day = 2
Less than 80 mg/day = 1
None = 0

C. Long-acting nitrates

Yes = 1
No = 0

Medication score = A+B+C
Range 0-9

3. Total score = severity score + medication score
Range 0-18

Statistical Methods

Statistical methods used in this paper included contingency table chi-square for discrete data (e.g., frequency of angina or ischemic pain and chest pain at rest) and the t-test for independent samples for continuous data (i.e., AQ score). Tests for linear trend among proportions were based on regression methods.9
To evaluate the effect of treatment on changes in the symptoms of angina between entry and 1 year, each patient's symptoms were classified as either improved, unchanged or deteriorated. Classification was based on two-way tables for each variable by treatment with the rows indicating the entry categories and the columns the 1-year categories ordered by increasing severity of symptoms. For example, chest pain at rest was a no/yes response variable. If a patient at entry had no chest pain at rest and had chest pain at rest 1 year later, the change from no to yes represented deterioration, while the patterns no/no and yes/yes represented no change. In the two-way table representation with no/yes row and column categories, the diagonal elements indicated no change, above the diagonal indicated deterioration and below the diagonal improvement. Classification for those variables with more than two response categories followed in a similar manner. The tendency toward improvement or deterioration in symptoms within each treatment group was evaluated by the matched pairs chi-square test ($\chi^2$). Between-treatment comparisons were based on scoring improvement as 1, no change as 0 and deterioration as -1, and applying the Mann-Whitney U test. This test compares the distribution of patients with improvement, no change and deterioration between the two treatments based on the above method of scoring.

Pairwise multiple comparisons between the medical group and surgical patency categories (0% patency, partial patency, 100% patency) on the 1-year AQ mean scores were based on the one-way analysis of variance method.

The data were analyzed according to treatment assigned at randomization.

Results

Since the questionnaire was implemented in 1973, not all patients in the study had an entry and 1 year evaluation. Because of this, three data bases were analyzed: patients with a baseline AQ ($n = 384$); patients with an annual AQ ($n = 639$) and patients with both a baseline and annual AQ ($n = 329$). Nearly twice as many patients were evaluated at 1 year as at entry, because many patients randomized before 1973 had their 1-year follow-up ($\pm 6$ months) after the questionnaire was instituted. The analyses of the AQ data and the AQ scores have been presented separately. Comparisons between the two treatments were made at entry and 1 year. Treatment comparisons based on the larger groups who had only baseline or annual data showed results similar to those in the smaller group who had both. Therefore, results from the larger groups are presented. Changes in symptoms between entry and 1 year have been evaluated both within and between treatments using patients with both AQs. Data on surgical patients were further analyzed according to the graft patency categories: no grafts patent (0% patency); at least one graft patent but not all grafts patent (partial patency); and all grafts patent (100% patency).

Angina Questionnaire

Baseline Comparisons

Three hundred eighty-four patients (201 medical and 183 surgical) had an entry AQ. A comparison of the entry data between the medical and surgical groups is summarized in table 2. Because some of the baseline data were unknown, percentages have been based on the number of responders to each question. The nonresponse rates were similar for each treatment. A relatively severe degree of angina was present in both groups at entry. Twenty-four percent had angina four or more times per day, while 51% had episodes of rest or nocturnal angina. Twenty-four percent used nitroglycerin four or more times per day, 35% used propranolol, and 48% were taking long-acting nitrates. Fifty-five percent of the patients were engaged in sedentary activity, while only 6% performed heavy work. Seventy-six percent of the patients were not working.

Symptoms other than angina were commonly observed. Seventy-six percent of the patients experienced dyspnea, and this symptom was usually associated with angina (86%). Dyspnea limited normal activity in 37% of the patients, while 20% had nocturnal dyspnea. Exertional fatigue limited activity in 28% and about 10% were limited by intermittent claudication. Only 29% had normal sexual activity, while more than 70% had either impaired or no sexual activity. Factors limiting sexual activity were angina in 50% of patients and inability to achieve an erection in about 14%.

The baseline distribution of AQ variables between the medical and surgical treatment groups did not reveal any significant differences ($p < 0.05$). Thus, the randomization process produced comparable groups of patients at entry.

One-year Comparisons

At 1 year, 639 patients (330 medical and 309 surgical) were evaluated. No inequalities were detected in the group of patients who had baseline AQs, so it is reasonable to assume that this larger group of patients was also comparable at entry because of the randomization process. At 1 year the two groups showed significant differences (table 3). $P$ values are given for the overall chi-square and for those categories which are significantly different between the two treatments. Percentages are based on the number of responders.

At 1 year, surgical patients had significantly fewer episodes of chest pain at rest (18.9% vs 34.9%). Angina produced by sedentary activity was less frequent in surgical patients than in medical patients (28.6% vs 37.1%). However, more surgical patients had angina associated with heavy activity than did medical patients (35.4% vs 21.6%). Frequency of angina pain was significantly lower for surgical therapy in all
categories except for angina once a week or less. The surgical group also had more patients who had no angina at any time at 1 year than did the medical group, 38.5% vs 8.8% (p < 0.001). Similar results were revealed in the frequency of use of nitroglycerin. About one-half of medical patients used at least 80 mg of propranolol per day, and nearly 60% were taking long-acting nitrates, while the same rates for surgical patients were 8% and 27%, respectively. Seven percent of the medical group and 43% of the surgical group used no medication at 1 year (p < 0.001), compared with 4% and 6%, respectively, at entry.

The proportion of patients with dyspnea, nocturnal dyspnea and angina limiting normal activity was significantly higher in medical patients. Impaired sexual activity and angina during sexual activity were also more prevalent in the medical group.

Thus, at 1 year, surgical patients had fewer symptoms of angina, used less medication, had more normal sexual activity and less dyspnea than medical patients. These differences were significant, but certain less extreme categories showed no significant differences between the groups.

Change in Symptoms

A comparison of tables 2 and 3 suggests that although both medical and surgical patients improved symptomatically at 1 year, surgical patients improved more. To examine this tendency, the data of the 329 patients (171 medical and 158 surgical) who had both an entry and 1-year AQ were analyzed. Since this subgroup of patients had both questionnaires, changes in symptoms during the first year of study could be directly evaluated both within and between treatments. Baseline distributions were similar between the treatment groups for these patients, except for chest pain at rest, which occurred more often in surgical patients, 55% vs 42% (p = 0.03).

The change in symptoms for each patient was classified as either improved, deteriorated or unchanged. The distribution of patients in each classification category for the variables that show significant differences between the two treatments are presented in table 4. The tendency toward improvement or deterioration of symptoms for each treatment was evaluated by the matched-pairs chi-square test. Comparisons between treatment groups were made by the Mann-Whitney U test.

Patients in both treatment groups tended to have less frequent angina or ischemic pain, but more surgical patients improved (76%) and fewer deteriorated (6%) than did medical patients (52% and 21%, respectively). Similar results were obtained for chest pain at rest, activity producing angina, usual activity and angina limiting normal activity. The medical group had no tendency toward improvement in sexual activity at 1 year, while the surgical group had nearly twice as many patients with improved sexual activity as patients whose activity deteriorated. While both treatment groups significantly increased the level of

<table>
<thead>
<tr>
<th>Variables</th>
<th>Medical (n = 201)</th>
<th>Surgical (n = 183)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>no.</td>
<td>%</td>
</tr>
<tr>
<td>Angina or ischemic pain</td>
<td>(n = 200)</td>
<td>(n = 183)</td>
</tr>
<tr>
<td>No angina at any time</td>
<td>11</td>
<td>5.5</td>
</tr>
<tr>
<td>Once/week or less</td>
<td>25</td>
<td>12.5</td>
</tr>
<tr>
<td>4×/week but not daily</td>
<td>46</td>
<td>23.0</td>
</tr>
<tr>
<td>1-3×/day</td>
<td>67</td>
<td>33.4</td>
</tr>
<tr>
<td>4×/day or more</td>
<td>72</td>
<td>36.0</td>
</tr>
<tr>
<td>Chest pain at rest</td>
<td>(n = 196)</td>
<td>(n = 178)</td>
</tr>
<tr>
<td>Yes</td>
<td>93</td>
<td>44.7</td>
</tr>
<tr>
<td>Yes</td>
<td>106</td>
<td>58.6</td>
</tr>
<tr>
<td>Yes</td>
<td>75</td>
<td>37.1</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>(n = 200)</td>
<td>(n = 182)</td>
</tr>
<tr>
<td>None for past 2 months</td>
<td>15</td>
<td>7.5</td>
</tr>
<tr>
<td>Once/week or less</td>
<td>45</td>
<td>22.5</td>
</tr>
<tr>
<td>4×/week but not daily</td>
<td>45</td>
<td>22.5</td>
</tr>
<tr>
<td>1-3×/day</td>
<td>49</td>
<td>24.5</td>
</tr>
<tr>
<td>4×/day or more</td>
<td>46</td>
<td>23.0</td>
</tr>
<tr>
<td>Propranolol (mg/day)</td>
<td>(n = 190)</td>
<td>(n = 174)</td>
</tr>
<tr>
<td>None</td>
<td>111</td>
<td>57.9</td>
</tr>
<tr>
<td>&lt;80</td>
<td>28</td>
<td>13.9</td>
</tr>
<tr>
<td>≥80</td>
<td>41</td>
<td>20.9</td>
</tr>
<tr>
<td>Nitrates</td>
<td>(n = 196)</td>
<td>(n = 194)</td>
</tr>
<tr>
<td>Yes</td>
<td>92</td>
<td>46.9</td>
</tr>
<tr>
<td>Yes</td>
<td>136</td>
<td>67.5</td>
</tr>
<tr>
<td>Nocturnal dyspnea</td>
<td>(n = 183)</td>
<td>(n = 178)</td>
</tr>
<tr>
<td>Yes</td>
<td>42</td>
<td>21.8</td>
</tr>
<tr>
<td>Yes</td>
<td>56</td>
<td>29.3</td>
</tr>
<tr>
<td>Digitalis or diuretics</td>
<td>(n = 191)</td>
<td>(n = 174)</td>
</tr>
<tr>
<td>Yes</td>
<td>56</td>
<td>29.3</td>
</tr>
<tr>
<td>Usual activity</td>
<td>(n = 197)</td>
<td>(n = 181)</td>
</tr>
<tr>
<td>Sedentary</td>
<td>103</td>
<td>52.8</td>
</tr>
<tr>
<td>Light</td>
<td>81</td>
<td>41.1</td>
</tr>
<tr>
<td>Heavy</td>
<td>12</td>
<td>6.1</td>
</tr>
<tr>
<td>Employment</td>
<td>(n = 200)</td>
<td>(n = 180)</td>
</tr>
<tr>
<td>None</td>
<td>151</td>
<td>75.5</td>
</tr>
<tr>
<td>Half-time</td>
<td>8</td>
<td>4.0</td>
</tr>
<tr>
<td>Full-time</td>
<td>41</td>
<td>20.5</td>
</tr>
<tr>
<td>Angina limiting normal activity</td>
<td>(n = 201)</td>
<td>(n = 180)</td>
</tr>
<tr>
<td>Yes</td>
<td>186</td>
<td>92.5</td>
</tr>
<tr>
<td>Leg cramps limiting normal activity</td>
<td>(n = 182)</td>
<td>(n = 175)</td>
</tr>
<tr>
<td>Yes</td>
<td>18</td>
<td>9.4</td>
</tr>
<tr>
<td>Dyspepsia limiting normal activity</td>
<td>(n = 194)</td>
<td>(n = 178)</td>
</tr>
<tr>
<td>Yes</td>
<td>70</td>
<td>39.1</td>
</tr>
<tr>
<td>Fatigue limiting normal activity</td>
<td>(n = 193)</td>
<td>(n = 179)</td>
</tr>
<tr>
<td>Yes</td>
<td>55</td>
<td>27.5</td>
</tr>
<tr>
<td>Sexual activity</td>
<td>(n = 191)</td>
<td>(n = 171)</td>
</tr>
<tr>
<td>Normal</td>
<td>56</td>
<td>29.3</td>
</tr>
<tr>
<td>Impaired</td>
<td>100</td>
<td>52.4</td>
</tr>
<tr>
<td>None</td>
<td>35</td>
<td>18.3</td>
</tr>
<tr>
<td>Sexual symptoms</td>
<td>(n = 187)</td>
<td>(n = 166)</td>
</tr>
<tr>
<td>None</td>
<td>54</td>
<td>28.9</td>
</tr>
<tr>
<td>Angina</td>
<td>94</td>
<td>50.3</td>
</tr>
<tr>
<td>No erection</td>
<td>14</td>
<td>7.5</td>
</tr>
<tr>
<td>Other</td>
<td>14</td>
<td>7.5</td>
</tr>
</tbody>
</table>

*The number of responders for each variable is given because some of the baseline data are unknown. Percentages are based on the number of responders.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Medical (n = 330)</th>
<th>Surgical (n = 309)</th>
<th>( \chi^2 ) p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angina or ischemic pain</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No angina at any time</td>
<td>29 (8.8$)</td>
<td>119 (38.5$)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Once/week or less</td>
<td>76 (23.1)</td>
<td>82 (26.5)</td>
<td></td>
</tr>
<tr>
<td>4×/week but not daily</td>
<td>86 (26.1$)</td>
<td>48 (15.5$)</td>
<td></td>
</tr>
<tr>
<td>1–3×/day</td>
<td>84 (25.5$)</td>
<td>42 (13.6$)</td>
<td></td>
</tr>
<tr>
<td>4×/day or more</td>
<td>54 (16.4$)</td>
<td>18 (5.8$)</td>
<td></td>
</tr>
<tr>
<td><strong>Chest pain at rest</strong></td>
<td>111 (34.9)</td>
<td>56 (18.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Activity producing angina</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedentary</td>
<td>115 (37.1\†)</td>
<td>59 (28.6\†)</td>
<td>0.003</td>
</tr>
<tr>
<td>Light</td>
<td>128 (41.3)</td>
<td>74 (35.6)</td>
<td></td>
</tr>
<tr>
<td>Heavy</td>
<td>67 (21.6$)</td>
<td>73 (35.4$)</td>
<td></td>
</tr>
<tr>
<td><strong>Nitroglycerin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None for past 2 months</td>
<td>43 (13.0$)</td>
<td>149 (48.7$)</td>
<td></td>
</tr>
<tr>
<td>Once/week or less</td>
<td>72 (21.8)</td>
<td>66 (21.6)</td>
<td></td>
</tr>
<tr>
<td>4×/week but not daily</td>
<td>85 (25.8$)</td>
<td>41 (13.4$)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1–3×/day</td>
<td>75 (22.7$)</td>
<td>33 (10.8$)</td>
<td></td>
</tr>
<tr>
<td>4×/day or more</td>
<td>55 (16.7$)</td>
<td>17 (5.6$)</td>
<td></td>
</tr>
<tr>
<td><strong>Propranolol (mg/day)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>101 (32.9$)</td>
<td>253 (85.8$)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;80</td>
<td>55 (17.9$)</td>
<td>18 (6.1$)</td>
<td></td>
</tr>
<tr>
<td>≥80</td>
<td>151 (49.2$)</td>
<td>24 (8.1$)</td>
<td></td>
</tr>
<tr>
<td><strong>Nitrates</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>192 (59.3)</td>
<td>83 (27.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Dyspnea</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>222 (74.2)</td>
<td>164 (56.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Nocturnal dyspnea</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>69 (21.8)</td>
<td>37 (12.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Angina limiting normal activity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>264 (80.5)</td>
<td>127 (42.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Sexual activity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>99 (32.1$)</td>
<td>131 (45.2$)</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Impaired</td>
<td>136 (44.2$)</td>
<td>96 (33.1$)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>73 (23.7)</td>
<td>63 (21.7)</td>
<td></td>
</tr>
<tr>
<td><strong>Sexual symptoms</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>91 (30.3$)</td>
<td>139 (49.8$)</td>
<td></td>
</tr>
<tr>
<td>Angina</td>
<td>135 (45.0$)</td>
<td>45 (16.1$)</td>
<td></td>
</tr>
<tr>
<td>No erection</td>
<td>50 (16.7)</td>
<td>58 (21.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Other</td>
<td>24 (8.0\†)</td>
<td>37 (13.3\†)</td>
<td></td>
</tr>
</tbody>
</table>

*The number of responders is given because some of the 1-year data are unknown. Percentages are based on the number of responders.

\( \$p <0.001 \)

\( \$^p <0.01 \)

\( \$^p <0.05 \)
### TABLE 4. Distribution of Symptom Categories for Significant Angina Questionnaire Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Medical (n = 171)</th>
<th>Surgical (n = 158)</th>
<th>Mann-Whitney p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of angina</td>
<td>no. (%)</td>
<td>no. (%)</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>88 (51.5)</td>
<td>120 (75.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unchanged</td>
<td>47 (27.5)</td>
<td>28 (17.7)</td>
<td></td>
</tr>
<tr>
<td>Deteriorated</td>
<td>36 (21.1)</td>
<td>10 (6.3)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Chest pain at rest</td>
<td>(n = 167)</td>
<td>(n = 153)</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>41 (24.6)</td>
<td>64 (41.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unchanged</td>
<td>106 (63.5)</td>
<td>83 (54.2)</td>
<td></td>
</tr>
<tr>
<td>Deteriorated</td>
<td>20 (12.0)</td>
<td>6 (3.9)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>0.009</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Activity producing angina</td>
<td>(n = 156)</td>
<td>(n = 103)</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>62 (39.7)</td>
<td>62 (60.2)</td>
<td></td>
</tr>
<tr>
<td>Unchanged</td>
<td>74 (47.4)</td>
<td>29 (28.2)</td>
<td>0.006</td>
</tr>
<tr>
<td>Deteriorated</td>
<td>20 (12.8)</td>
<td>12 (11.7)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>(n = 170)</td>
<td>(n = 156)</td>
<td></td>
</tr>
<tr>
<td>Decreased</td>
<td>67 (39.4)</td>
<td>116 (74.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unchanged</td>
<td>58 (34.1)</td>
<td>29 (18.6)</td>
<td></td>
</tr>
<tr>
<td>Increased</td>
<td>45 (26.5)</td>
<td>11 (7.1)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>0.04</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Propranolol</td>
<td>(n = 154)</td>
<td>(n = 150)</td>
<td></td>
</tr>
<tr>
<td>Decreased</td>
<td>10 (6.5)</td>
<td>45 (30.0)</td>
<td></td>
</tr>
<tr>
<td>Unchanged</td>
<td>66 (42.9)</td>
<td>94 (62.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Increased</td>
<td>78 (50.6)</td>
<td>11 (7.3)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Nitrates</td>
<td>(n = 167)</td>
<td>(n = 156)</td>
<td></td>
</tr>
<tr>
<td>Decreased</td>
<td>23 (13.8)</td>
<td>54 (34.6)</td>
<td></td>
</tr>
<tr>
<td>Unchanged</td>
<td>121 (72.5)</td>
<td>92 (59.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Increased</td>
<td>23 (13.8)</td>
<td>10 (6.4)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>NS</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Dyspnea</td>
<td>(n = 149)</td>
<td>(n = 136)</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>26 (17.4)</td>
<td>41 (30.1)</td>
<td></td>
</tr>
<tr>
<td>Unchanged</td>
<td>102 (68.5)</td>
<td>83 (61.0)</td>
<td>0.013</td>
</tr>
<tr>
<td>Deteriorated</td>
<td>21 (14.1)</td>
<td>12 (8.8)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>NS</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Usual activity</td>
<td>(n = 167)</td>
<td>(n = 156)</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>52 (31.1)</td>
<td>65 (41.7)</td>
<td></td>
</tr>
<tr>
<td>Unchanged</td>
<td>84 (50.3)</td>
<td>71 (45.5)</td>
<td>0.026</td>
</tr>
<tr>
<td>Deteriorated</td>
<td>31 (18.6)</td>
<td>20 (12.8)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>0.02</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Angina limiting normal activity</td>
<td>(n = 170)</td>
<td>(n = 153)</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>20 (17.1)</td>
<td>83 (54.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unchanged</td>
<td>135 (79.4)</td>
<td>67 (43.8)</td>
<td></td>
</tr>
<tr>
<td>Deteriorated</td>
<td>6 (3.5)</td>
<td>3 (2.0)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Sexual activity</td>
<td>(n = 161)</td>
<td>(n = 146)</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>37 (23.0)</td>
<td>47 (32.2)</td>
<td></td>
</tr>
<tr>
<td>Unchanged</td>
<td>84 (52.2)</td>
<td>72 (49.3)</td>
<td>0.026</td>
</tr>
<tr>
<td>Deteriorated</td>
<td>40 (24.8)</td>
<td>27 (18.5)</td>
<td></td>
</tr>
<tr>
<td>$\chi^2_m$ p</td>
<td>NS</td>
<td>0.02</td>
<td></td>
</tr>
</tbody>
</table>

*Some patients could not be classified at 1 year because of incomplete data. The number of patients classified is indicated for each variable.

Abbreviation: $\chi^2_m$ = matched pairs Chi-square.
Table 5. Distribution of 1-Year Angina Questionnaire Variables That Show a Significant Linear Trend Across Patency Categories*

<table>
<thead>
<tr>
<th>Variable</th>
<th>0% Patency (n = 29)</th>
<th>Partial patency (n = 76)</th>
<th>100% Patency (n = 147)</th>
<th>Linear trend p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitroglycerin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4X/day or more</td>
<td>(n = 29)</td>
<td>(n = 76)</td>
<td>(n = 144)</td>
<td>0.007</td>
</tr>
<tr>
<td>Nocturnal dyspnea</td>
<td>(n = 27)</td>
<td>(n = 75)</td>
<td>(n = 142)</td>
<td>0.014</td>
</tr>
<tr>
<td>Yes</td>
<td>6 (22.2)</td>
<td>11 (14.7)</td>
<td>11 (7.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Employment</td>
<td>(n = 29)</td>
<td>(n = 76)</td>
<td>(n = 145)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>26 (89.7)</td>
<td>61 (80.3)</td>
<td>94 (64.8)</td>
<td>0.004</td>
</tr>
<tr>
<td>Full-time</td>
<td>2 (6.9)</td>
<td>13 (17.1)</td>
<td>37 (25.5)</td>
<td>0.014</td>
</tr>
<tr>
<td>Angina limiting normal activity</td>
<td>(n = 29)</td>
<td>(n = 76)</td>
<td>(n = 140)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>21 (72.4)</td>
<td>35 (46.1)</td>
<td>40 (28.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dyspnea limiting activity normal</td>
<td>(n = 29)</td>
<td>(n = 75)</td>
<td>(n = 139)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>14 (48.3)</td>
<td>35 (46.7)</td>
<td>37 (26.6)</td>
<td>0.002</td>
</tr>
<tr>
<td>Sexual activity</td>
<td>(n = 27)</td>
<td>(n = 73)</td>
<td>(n = 137)</td>
<td></td>
</tr>
<tr>
<td>Impaired</td>
<td>14 (51.9)</td>
<td>23 (31.5)</td>
<td>40 (29.2)</td>
<td>0.05</td>
</tr>
<tr>
<td>Sexual symptoms</td>
<td>(n = 25)</td>
<td>(n = 71)</td>
<td>(n = 132)</td>
<td></td>
</tr>
<tr>
<td>Angina</td>
<td>9 (36.0)</td>
<td>8 (11.3)</td>
<td>11 (8.3)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*The number of responders is given because some of the 1-year data are unknown. Percentage are based on the number of responders.

daily activity, neither group had improved work status.

About 75% of surgical patients and 40% of medical patients used less nitroglycerin at 1 year than at entry. Fifty-one percent of the medical group used more propranolol, while both propranolol and nitrate medication use tended to decrease in surgical patients.

The improvement in symptoms for medical patients (table 4) was not associated with the change in propranolol medication. Thus, patients with a decrease or no change in propranolol medication improved as much as those who took more propranolol. The use of medication, especially nitroglycerin, was related to the severity of symptoms.

**GRAFT PATENCY AND SYMPTOMS**

![Figure 1. Six 1-year variables that show a linear trend related to graft patency. Unempl = unemployed; PND = nocturnal dyspnea; NG = nitroglycerin used four times per day or more. P values refer to test for linear trend among the proportions.](http://circ.ahajournals.org/)

* limits normal activity
To examine this question, 252 surgical patients with AQ and 307 medical patients were divided into three groups: no patent grafts (n = 29); at least one, but not all, grafts patent (n = 76); and all grafts patent (n = 147). Variables that had a significant linear trend across the patency groupings are summarized in table 5 and figure 1. The percentage of patients who used nitroglycerin more than four times per day decreased from 14% for 0% patency to 2% for 100% patency (p = 0.007). Similar decreasing trends were noted in presence of nocturnal dyspnea, no employment, angina limiting normal activity, impaired sexual activity and angina with sexual activity. Full-time employment increased with increasing degree of patency (7% for 0% patency, 17% for partial patency, and 26% for 100% patency). For these variables, surgical patients with no patent grafts were similar to the medical patients. Further comparisons between these two groups were made, and significant results are shown in table 6. Surgical patients with no patent grafts had less pain and dyspnea and used less medication at 1 year than medical patients. Surgical patients with all grafts patent and partial patency had similar results.

**Graft Patency**

We tried to determine if the improvement in surgical patients was due to revascularization of ischemic myocardium or to the nonspecific effects of surgery. To examine this question, 252 surgical patients with an AQ and shunt angiography at 1 year were divided into three groups: no patent grafts (n = 29); at least one, but not all, grafts patent (n = 76); and all grafts patent (n = 147). Variables that had a significant linear trend across the patency groupings are summarized in table 5 and figure 1. The percentage of patients who used nitroglycerin more than four times per day decreased from 14% for 0% patency to 2% for 100% patency (p = 0.007). Similar decreasing trends were noted in presence of nocturnal dyspnea, no employment, angina limiting normal activity, impaired sexual activity and angina with sexual activity. Full-time employment increased with increasing degree of patency (7% for 0% patency, 17% for partial patency, and 26% for 100% patency). For these variables, surgical patients with no patent grafts were similar to the medical patients. Further comparisons between these two groups were made, and significant results are shown in table 6. Surgical patients with no patent grafts had less pain and dyspnea and used less medication at 1 year than medical patients. Surgical patients with all grafts patent and partial patency had similar results.

**Angina Questionnaire Score**

**Entry and 1-year Comparisons**

This method provided an overall assessment of the symptoms of angina based on scoring the severity of symptoms and the use of medication. Mean scores on the 384 patients with a baseline AQ and of the larger group of 639 patients with a 1-year follow-up AQ are presented in table 7. The medication and total scores did not differ between the treatment groups at entry, but the severity score was higher for surgical patients.

---

**Table 6. Distribution of Significant 1-Year Angina Questionnaire Variables Between the Medical and 0% Patency Groups**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Medical (n = 330)</th>
<th>0% Patency (n = 29)</th>
<th>x² p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angina or ischemic pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No angina at any time</td>
<td>29 (8.8)</td>
<td>8 (27.6)</td>
<td>0.002</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None for past 2 months</td>
<td>43 (13.0)</td>
<td>10 (34.5)</td>
<td>0.003</td>
</tr>
<tr>
<td>Propranolol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>101 (32.9)</td>
<td>22 (78.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≥80</td>
<td>151 (49.2)</td>
<td>3 (10.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nitrates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>192 (59.3)</td>
<td>10 (35.7)</td>
<td>0.01</td>
</tr>
<tr>
<td>Dyspnea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>222 (74.2)</td>
<td>14 (51.9)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*The number of responders is given because some of the 1-year data are unknown. Percentages are based on the number of responders.

---

**Table 7. Entry and 1-Year Severity, Medication and Total Angina Questionnaire Score Means by Treatment**

<table>
<thead>
<tr>
<th>Entry</th>
<th>1-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medical (n = 330)</td>
</tr>
<tr>
<td></td>
<td>no.</td>
</tr>
<tr>
<td>Severity</td>
<td>193</td>
</tr>
<tr>
<td>Medication</td>
<td>179</td>
</tr>
<tr>
<td>Total</td>
<td>174</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Values are mean ± sd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Mean scores could not be computed for some patients because of incomplete data.</td>
</tr>
<tr>
<td>†p &lt; 0.05, medical vs surgical.</td>
</tr>
<tr>
<td>‡p &lt; 0.001, medical vs surgical.</td>
</tr>
</tbody>
</table>
(6.4 vs 6.0; p = 0.05). Although the severity score was only marginally significant, it did indicate that surgical patients had more severe symptoms of angina on the average than did medical patients at entry. At 1 year surgical patients had significantly lower severity (2.9 vs 4.9), medication (1.5 vs 3.9) and total (4.4 vs 8.7) mean scores, indicating that surgical patients had less severe symptoms, used less medication, and had fewer symptoms of angina than medical patients. These results are consistent with those presented for the univariate analysis of the AQ variables.

Change in Symptoms

To evaluate the change in score, the 329 patients who had both an entry and a 1-year AQ were analyzed. Change in score for each patient was classified as either increased, decreased or unchanged. Eighty-six percent of surgical patients and 56% of medical patients had a lower severity score (table 8). Most of the decrease in each case could be attributed to less frequent angina (table 4). Medical patients tended to use medication more frequently (54%), and surgical patients tended to use it less frequently (77%). The increase in medication score in the medical group was due primarily to an increase in use of propranolol, while the decrease in the surgical group was due to a decrease in the frequency of use of nitroglycerin (table 4).

The change in the severity score was positively correlated with the change in the medication score in both the medical (r = 0.54) and surgical (r = 0.66) groups. Thus, as the severity of symptoms increased, the use of medication increased. Hence, the change in the total score was an indicator of the overall change in symptoms. Eighty-six percent of surgical patients had a lower total score and only 7% had a higher score, while the same rates for medical patients were 44% and 47%, respectively.

Graft Patency

The angina scores of surgical patients were further evaluated at 1 year by patency groups (0% patency, partial patency, 100% patency). One-year mean scores for each patency category are presented in figure 2, along with the mean scores for medical patients. Analysis of variance was used to compare the mean scores between the medical group and each patency category, and within the patency groupings.

Table 8. Distribution of Change in Severity, Medication and Total Angina Questionnaire Score

<table>
<thead>
<tr>
<th>Score</th>
<th>Medical (n = 171)</th>
<th>Surgical (n = 158)</th>
<th>Mann-Whitney p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased</td>
<td>114 (67.0)</td>
<td>108 (68.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unchanged</td>
<td>37 (21.6)</td>
<td>32 (20.5)</td>
<td></td>
</tr>
<tr>
<td>Increased</td>
<td>18 (10.4)</td>
<td>18 (11.9)</td>
<td></td>
</tr>
<tr>
<td>Medication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased</td>
<td>126 (73.5)</td>
<td>103 (65.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unchanged</td>
<td>35 (20.4)</td>
<td>35 (22.3)</td>
<td></td>
</tr>
<tr>
<td>Increased</td>
<td>13 (7.5)</td>
<td>20 (12.7)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased</td>
<td>131 (76.7)</td>
<td>118 (75.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Unchanged</td>
<td>32 (18.7)</td>
<td>31 (19.8)</td>
<td></td>
</tr>
<tr>
<td>Increased</td>
<td>14 (8.4)</td>
<td>17 (11.1)</td>
<td></td>
</tr>
</tbody>
</table>

*Some patients could not be classified because of incomplete data. Percentages are based on the number of responders.

patency group. Within the patency groups, patients with no patent grafts had significantly higher medication and severity scores than patients with all grafts patent. No significant differences were found between 0% patency and partial patency, or between partial patency and 100% patency.

In general, medical patients at 1 year had more severe symptoms and used more medication than surgical patients with all grafts closed, suggesting a possible placebo effect due to surgery. Patients with all grafts open had fewer symptoms of angina than those patients with all grafts closed, while patients with partial patency had symptoms that are intermediate between those of patients with 0% and 100% patency.

Discussion

Since a major goal of coronary surgery is the relief of angina, an important objective of the present study was to develop an accurate method of assessing angina. Most studies have used the NYHA functional classification; others have used the Canadian Heart Association classification. These systems have serious limitations. For example, if a patient has symptoms at rest the functional class is usually IV, the most severe group. Clearly, many patients with angina may have excellent exercise tolerance, yet occasionally may experience rest angina during the day or night. Is it logical to classify these patients into the most severe group? Any classification system depends on the observer. A single observer using consistent criteria would produce the most reliable classification for statistical purposes. In the VA Coop Study, which involved many participants who were classifying patients, consistent evaluations were not possible due to individual differences in the interpretation of a disability.

Other systems classify angina as severe, moderate,
mild or absent. In evaluating the results of therapy for angina, it may be classified as markedly improved, moderately improved, unchanged or worse. These estimates are usually made on the basis of the number of episodes of angina per day or week and the amount of physical disability present. These systems, as well as the New York and Canadian Heart Association systems, do not evaluate the amount and type of medication taken daily nor the daily amount and type of physical activity. For example, a man engaged in heavy labor who is on no medication and who has one or two episodes of angina per day would be in the same class as a sedentary individual who has one or two episodes of angina per day despite optimal daily amounts of propranolol and long-acting nitrates. Therefore, it is not surprising that the total scores obtained by the AQ in the present study correlate poorly with the NYHA functional class (r = 0.13).

Questionnaires or scoring systems for the evaluation of angina have been used by several investigators. The Rose questionnaire was designed to diagnose angina and intermittent claudication in field surveys of population groups. Pipberger carried out a computer evaluation of questionnaires for various types of chest pain. Cohn developed a scoring system for patients with chest pain that was designed to identify patients with a high probability of coronary artery disease who should be studied by coronary arteriography. Feinstein proposed a system of evaluating changes in angina based on changes in daily physical activity. The questionnaire we used was designed to evaluate the severity of angina and the presence of associated cardiac systems in patients in whom the diagnosis of chronic stable angina had been established by clinical and arteriographic studies. The primary objective of the questionnaire was to evaluate the effect of medical therapy vs surgical and medical management. The use of subscores for frequency and severity of angina, and medications used was necessary, since each of these factors may vary. For example, the number of attacks of angina daily may be altered by surgical re-vascularization, changes in medication or changes in daily physical activity. The scoring system is arbitrary, and we made no attempt to weight individual scores.

Not all patients in the study had AQs at entry. However, the entry characteristics of patients who had AQs did not differ significantly from those of the entire study population; hence, the AQ study group appears to be representative of the entire study cohort. Furthermore, the baseline distributions of the AQ variables were similar in the two treatment groups. Thus, randomization succeeded in producing comparable groups at entry with respect to symptoms.

The surgical treatment group had significant improvement in most symptoms, and took less medication than before surgery. The medical treatment group had a modest improvement in symptoms and took more medication. At entry 23% of both groups were taking at least 80 mg/day propranolol, while at 1 year the rates were 40% and 8% for medicine and surgery, respectively.

To compare our results with results from other studies of angina, we determined the percentage of patients in the present study who had a score that decreased five or more units at 1 year; these patients...
were considered to have experienced substantial improvement in angina. In the surgical group 60% had this degree of improvement, compared with 16% in the medical group. In the surgical group at 1 year 39% of patients had no angina, compared with 9% of the medical group. Patients who had no change or an increase in their scores at 1 year were evaluated. In the surgical group 14% were unchanged or worse, compared with 56% in the medical group. These results are comparable to those reported by other workers.11,16-21

Dyspnea is a common symptom associated with angina. At entry, 76% of patients had dyspnea and 20% had nocturnal dyspnea. Significant improvement in dyspnea occurred only in the surgical group, with no improvement in nocturnal dyspnea for either treatment. During the myocardial ischemia associated with angina, the rise in left ventricular end-diastolic pressure probably results in pulmonary venous congestion and dyspnea. Previous studies have shown that bypass graft surgery reduces the exercise-induced rise in pulmonary artery wedge pressure, and this provides an acceptable explanation for the relief of dyspnea.22

The present study has shown that the degree of symptomatic improvement is related to graft patency, and the greatest improvement occurred in patients with all grafts open at 1 year. However, even patients with all grafts closed had less severe symptoms than the medical treatment group. The severity of angina in these patients was the same at entry as in the other study patients. Two explanations should be considered: 1) The effect of surgery on symptoms is not related entirely to improved myocardial blood flow via the graft. Interruption of nerve pathways has been suggested as a possibility.23 Other possibilities include the stimulation of noncoronary collaterals or a redistribution of blood flow in the native coronary circulation. 2) The effect is purely a placebo effect and is not associated with an improvement in treadmill performance. Block24 evaluated 23 patients who had coronary surgery but in whom all grafts were closed. Slightly more than 50% of these patients had symptomatic improvement, but no significant improvement in treadmill performance was noted in the group as a whole, although half of the patients had some increase in performance. A placebo effect is a common phenomenon after any type of coronary surgery. The early revascularization operations, including the Beck procedure, internal mammary ligation and the Vineberg procedure, resulted in improvement in angina in 60–80% of patients, yet little or no increase in myocardial blood supply resulted from these procedures.25

Part of the placebo effect may be due to the patient’s expectation that surgery will improve the symptoms and a consequent tendency to minimize symptoms and limitations in responding to the follow-up questionnaire. The surgically treated patient or his physician may decrease or stop medication with the expectation that it is no longer necessary. Thus, improvement in symptoms and decrease in medication may be unreliable indices of improvement. This will be evaluated in future studies of sequential treadmill tests performed in this study.

Despite substantial symptomatic relief in 60% of patients and improvement in daily physical activity after surgery, employment status changed only slightly. Similar data have been presented by Barnes and co-workers, who reported no overall improvement in return to work or hours worked in 350 patients who had coronary bypass surgery.26 Other investigators have pointed out that when the duration of cardiac disability has exceeded 6 months, a return to full-time work is rare even when physical working capacity is improved by cardiac surgery.27,28 Socioeconomic conditions, age, type of work, and the patient’s inability to change a lifestyle enforced by chronic illness are some of the factors.

Acknowledgments

The authors gratefully acknowledge the computational assistance of Barbara Wentworth and the editorial assistance of Teresa Hatch in the preparation of this report.

References


Appendix
Veterans Administration Cooperative Study of Surgery for Coronary Arterial Occlusive Disease


Veterans Administration Medical Center, Buffalo, New York. Co-Investigators: David C. Dean, M.D.; Joginder Bhayana, M.D. Past Co-Investigator: Andrew A. Gage, M.D. Physician: Italo Bessegghi, M.D.

Veterans Administration Medical Center, Cleveland, Ohio. Co-Investigators: Berian Davies, M.D.; Julie Clayman, M.D. Past Co-Investigator: Cathal A. Macleod, M.D. Past Physicians: Robert C. Buhrer, M.D.; Daniel van Heeckener, M.D.


Veterans Administration Medical Center, Little Rock, Arkansas. Co-Investigators: Marvin L. Murphy, M.D.; Ray C. Read, M.D.


Veterans Administration Medical Center, Madison, Wisconsin. Co-Investigators: James Thomsen, M.D.; George Kronke, M.D. Past Co-Investigator: Donald Kahn, M.D.


Veterans Administration Medical Center, West Roxbury, Massachusetts. Co-Investigators: Alfred Parisi, M.D.; Ernest M. Barsamian, M.D. Past Co-Investigators: Robert L. Morse, M.D.; David Littmann, M.D.

Study Co-Chairmen
Herbert N. Hultgren, M.D., Cardiological Co-Chairman; Timothy Takaro, M.D., Surgical Co-Chairman; David Littmann, M.D., Past Cardiological Co-Chairman.

Cooperative Studies Program Coordinating Center
Yick-Kwong Chan, Ph.D., Director; Katherine M. Detre, M.D., Dr. P. H., Veterans Administration Medical Center, West Haven, Connecticut (1973-); Peter Peduzzi, Ph.D., Veterans Administration Medical Center, West Haven, Connecticut (1976-); Elizabeth C. Wright, M.P.H. (1968–1973), Past Statistician.

Executive Committee
Herbert N. Hultgren, M.D., VA Medical Center, Palo Alto, California; Timothy Takaro, M.D., VA Medical Center, Asheville, North Carolina; Marvin Murphy, M.D., VA Medical Center, Little Rock, Arkansas; Yoshio Sako, M.D., VA Medical Center, Minneapolis, Minnesota; Katherine M. Detre, M.D., Dr. P. H., VA Medical Center, West Haven, Connecticut; Peter Peduzzi, Ph.D., VA Medical Center, West Haven, Connecticut. Prof. Jerome Cornfield, Geo. Washington Univ., Bethesda, Maryland, Consultant.

Operations Committee
Noble O. Fowler, M.D., Chairman, Cincinnati, Ohio; Jay L. Ankeney, M.D., Cleveland, Ohio; W. Sterling Edwards, M.D., Albuquerque, New Mexico; William W. Glenn, M.D., New Haven, Connecticut; Ralph F. Frankowski, Ph.D., Houston, Texas; J. David Bristow, M.D., Portland, Oregon; J. O'Neal Humphries,
M.D., Baltimore, Maryland; Lawrence W. Shaw, A.M., Geo. Washington Univ., Bethesda, Maryland, Consultant.

Past Members: Charles K. Friedberg, M.D. (deceased), New York, New York; John W. Kirklin, M.D., Birmingham, Alabama; J. Willis Hurst, M.D., Atlanta, Georgia; William R. Best, M.D., Hines, Illinois; James J. Morris, Jr., M.D., Durham, North Carolina.

Past Surgical Consultant: David C. Sabiston, Jr., M.D., Durham, North Carolina.

Veterans Administration Central Office Coordinator
James A. Hagans, M.D., Ph.D., Past Coordinator: Lawrence A. Shaw, A.M., Past Surgical Coordinators: Mark W. Wolcott, M.D.; Francis C. Jackson, M.D.

Cooperative Lipid Studies Laboratory
Steven H. Quarfordt, M.D., Chief, VA Medical Center, Durham, North Carolina.

Radiologic Consultant
Martin J. Lipton, M.D., University of California, San Francisco, California.

Pathology Consultant
William C. Roberts, M.D., NIH, Bethesda, Maryland.

Consultant in Arteriographic Interpretation

ECG Reading Center
Ronald Prineas, M.D., University of Minnesota, Minneapolis, Minnesota.

LV Angiogram Analysis Lab
Karl Hammermeister, M.D., Cardiology Service, VA Medical Center, Seattle, Washington.
Effect of medical vs surgical treatment on symptoms in stable angina pectoris. The Veterans Administration Cooperative Study of surgery for coronary arterial occlusive disease.

P Peduzzi and H N Hultgren

Circulation. 1979;60:888-900
doi: 10.1161/01.CIR.60.4.888

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1979 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/60/4/888.citation

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/