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REHABILITATION AFTER CORONARY BYPASS SURGERY: COPING STRATEGIES PREDICT METABOLIC IMPROVEMENT AND RETURN TO WORK

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ABSTRACT. Thirty-six consecutive male patients who underwent coronary bypass surgery were investigated before and repeatedly up to 5 years after surgery. We followed the patients' physical capacity, dietary and exercise habits, mood, perception of health and return to work. Discriminant analysis identified four variables from the preoperative interview and the psychological tests which correctly classified 22 out of 24 patients into either metabolic responders – who were characterized by favourable changes in their lipoprotein profile, related to a successful clinical outcome – or non-responders. Responders were found to acknowledge subjective, emotional aspects of their situation whereas non-responders minimised their disease. Six preoperative variables successfully predicted the classification of all but one patient into full-time workers or not, one year after surgery. Full-time workers were more frequent among minimizers. The results suggest that whereas minimising of disease is adaptive in a short-term perspective, acknowledgement may be successful in the long run.

Key words: coronary artery bypass grafting, physical working capacity, plasma lipoproteins, psychosocial factors, long-term follow-up.

Coronary bypass surgery (CAS) is a valuable surgical treatment for patients with severe angina pectoris. However, despite the improvement in physical working capacity (PWC) large randomized studies have failed to show that surgery results in a larger proportion of operated patients returning to work, when compared with medical treatment (5, 40). Recent studies on the psychosocial outcome and quality of life one year after CAS have shown poor adjustment in about 25% of the patients (17, 19). This poor adjustment may influence the long-term outcome. Little research has addressed the possible connections between long-term outcome and psychosocial variables as evaluated before surgery (17).

High levels of cardiac risk factors tend to cluster and act synergistically (16). For example, the results of Luria et al. (16) suggest that total / HDL cholesterol serves as a marker not only for obstructive coronary disease but also for a group of potentially modifiable risk factors. In a recent study, we found that a metabolic response in terms of an early improvement in the lipoprotein profile (HDL cholesterol and triglyceride levels) following CAS preceded a better clinical outcome 5 years after CAS (44). Since the development of a favourable lipoprotein profile may be causally related to a successful clinical result, it seems important to identify predictors of the metabolic response after surgery. A possible explanation for the development of a more favourable lipoprotein profile may be psychological factors which may influence the life-style and adherence to postoperative instructions and advice (e.g. dietary habits, physical activity), thereby indirectly modulating the lipoprotein profile.

In an earlier, preoperative study (29), we identified two broad categories of CAS patients, minimisers and accepters. Minimisers, although equally diseased by objective measures, were less disabled by their disease, had been sick-listed for a shorter time, rated their working capacity as higher and their general mood state as more positive. They viewed their disease and the forthcoming operation in technical, objective non-self terms. Minimising, as defined here, falls into the broad category of denial with mild as well as more rigid forms (3, 9). Accepters, in contrast, acknow-

ledged their disease; in general, they were more disabled by their chest pains and rated their general mood state as more negative than minimisers, although they were not more severely ill by objective measures. The aim of the present study was to evaluate the short- and long-term adjustment of patients who preoperatively had been identified as minimisers and accepters, respectively, and to relate these coping strategies to metabolic variables, especially the lipoprotein profile. The present report describes the psychosocial adaptation after CAS and focuses on variables from the presurgical psychological investigation that might influence the life-style and the lipoprotein profile following surgery. We also studied possible preoperative factors influencing return to work following CAS.

MATERIAL AND METHODS

Patients

We studied 37 consecutive male patients with angina pectoris admitted to the department of thoracic surgery for CAS. The protocol, approved by the local ethics committee, was explained in detail to the subjects, who gave their written consent.

An earlier report included a detailed description of patient selection, preoperative metabolic and physiological data and operative techniques (43). Nineteen of the patients were treated according to standard clinical routines and 18 were randomized to a 12-week training program starting 6 weeks after surgery. A 1-year follow-up of the training program has been published (43).

In this report we exclude one individual because of excessive regular alcohol intake with metabolic derangements including hypertriglyceridemia. One patient had died due to his coronary heart disease (CHD) at the 5-year follow-up. Three of the 36 patients had a second CAS and one a percutaneous transluminal coronary angioplasty (PTCA) during the 5-year follow-up period.

Data from psychological interviews 5 years after CAS were available for 32 individuals. Three individuals did not want to take part in the final follow-up interview. Preoperative data from psychological interviews and tests were not obtained from the first 12 individuals in the series due to a delayed start of the psychological investigation.

Food intake, physiological and biochemical measurements

Dietary habits were assessed by a clinical nutritionist, who obtained a careful diet history before surgery and at 6-week intervals up to 5 months after surgery. The patients were encouraged to keep their diet as constant as possible up to 5 months after surgery. At this point, the nutritionist recommended a weight-reducing diet for overweight patients and a lipid-lowering diet for patients with plasma cholesterol levels > 8 mmol/l.

PWC was assessed in all patients on a bicycle ergometer. PWC, plasma triglycerides (TG) and HDL cholesterol levels were investigated once before and 6, 18, 26, 52 weeks as well as 5 years after surgery.

A detailed description of the physiological and biochemical methods has been published (43).

Clinical outcome

The clinical outcome 5 years after surgery was evaluated with regard to clinical symptoms, need of reoperation and physical capacity. The patients were classified into 3 groups. Group C ($n=9$) included 1 patient who died from CHD, 4 who underwent a second CAS or a PTCA, 2 patients with severe angina pectoris, 1 who suffered a myocardial infarction and 1 whose PWC was lower than before surgery (died 6 years after surgery from CHD). Group B ($n=11$) included all subjects who improved their PWC less than the average of the non-training or training group, respectively, from before to 5 years after surgery; many had reappearing angina, and five were on antianginal drugs. Group A included all individuals in whom the rise in PWC was better than the average ($n=16$); none had symptoms of CHD.

Capacity for everyday physical activities and return to work

A self-report inventory was administered, being presented to the patients by the physician. Assessment of the capacity for different everyday physical activities involved two questions with four response alternatives and one with five. The answers to the inventories were intended to represent the patients subjective opinion. The frequency of angina pectoris was rated according to both the patient's perception and the judgement of the physician.

Frequency of return to work, time of work return and changes in the work situation were recorded by the physician before, half a year, one and 5 years after CAS. Reasons for not working were also evaluated.

Psychological investigation

A semi-structured interview was conducted including the following topics: perceptions of limitations imposed by coronary symptoms, diet, exercise, attitude to and effects of CHD/CAS, and expectations of the future. In an earlier study (29) we have shown that four variables, assessed in the preoperative interview, separate CAS patients into minimisers and accepters. Minimisers, in contrast to accepters, regard CHD/CAS in a parenthetic way, refuse to accept the sick role, do not acknowledge the psychological aspects of their situation and avoid talking about or belittle the operation.

We used two perceptgenetic techniques which investigate perception as process in (micro)time going behind the apparently momentary act of perception. In particular the interpretation of novel or threatening stimuli, during the initial phases of perception have been shown to be influenced by the individual's early experiences of similar situations. Not until the final stages of the percept-genesis are personal aspects replaced by stimulus-proximal, "correct", contents. An individual's percept-genesis is reconstructed by presenting the stimulus repeatedly, first at very short exposure times which are gradually prolonged. The subject's verbal reports after each exposure constitute the experimental data.

The Meta-Contrast Technique (MCT) identifies perceptual defenses, that is strategies which keep threatening stimuli beyond conscious awareness by distorting aspects of reality. In the MCT, a pair of stimuli, A and B, is presented in immediate succession at gradually prolonged exposure times on a screen in front of the subject. According to perceptgenetic theory, the threat is expected to produce defensive responses interfering with correct recognition, responses typical of the subject's habitual defensive system. MCT's reliability and validity have been amply demonstrated (34, 35, 37). MCT has been shown to be a valuable device in investigations of clinical as well as non-clinical samples (10, 36). In the present study, the following scoring dimensions were used: repression, isolation, sensitivity, inadequate identity, and anxiety (indicating faltering defense). Given the threatening nature of CHD we employed MCT to assess the subjects' defenses against emotional threat which we assumed would partly govern their perception of their illness.

The separation theme is also presented in a series of gradually prolonged exposure times. It has been designed to arouse (sub-conscious) primary separation anxiety and to reveal the individual's vulnerability and habitual strategies for controlling it.

In contrast to MCT, which uses an unspecified threat, the separation theme refers to (preoidipal) experiences specific to the separation-individuation period (around 1–3 years). The subject's responses to traumatic and/or protracted threats of separation during this period – which are supposedly reconstructed in the experimental session – presumably develop into more sophisticated measures characteristic for the adult. Further descriptions of the separation themeand its theoretical background have been given by Magnusson et al. (18) and Nilsson (21).

Mood adjective checklist (MACL)

The patients were asked to rate their mood in general on 71 symmetrical, four category scales (32). On the basis of factor analysis, six bipolar mood factors have been identified: hedonic tone (pleasantness/unpleasentness; e.g. happy, sad etc.), activation/deactivation (e.g. active, drowsy, etc.), relaxation/tension (e.g. calm, nervous, etc), extraversion/ introversion (pleasure/displeasure in social interaction: e.g. talkative, silent, etc.), positive/ negative social orientation (inclination/reluctance to participate in task-oriented social activity; e.g. cooperative, unreasonable, etc.) and control/ lack of control (a feeling of competence or incompetence, particularly in social relations; e.g. self-confident, insecure, etc.). It should be noted that the last three mood factors, in particular, have strong behavioral components and thus can be expected to reflect the subject's social as well as his emotional state. In earlier studies reviewed by Sjöberg et al. (32), MACL has proven to be a reliable and sensitive instrument which measures short-term as well as long-term changes in mood. Fifty-eight healthy subjects (age 46–55 years) constituted a reference group (25, 26).

Statistical methods

The X^2-test and its counterpart for small n's, the Fisher exact test was used to calculate differences in distribution within discrete categories, whereas differences in continuous variables were assessed by t-tests or Wilcoxon's rank order test. Changes with time for MACL were evaluated by a one-way ANOVA. Correlations between continuous variables were analysed by Spearman rank correlation test. Mann-Whitney U-test was used for evaluating relationships between clinical outcome and self-assessed level of physical activity as well as favourable changes in diet. Finally step-wise discriminant analysis (SPSS-X) was used to identify factors associated with the development of a favourable lipoprotein profile and return to work.

RESULTS

Clinical outcome and lipoprotein alterations after CAS

Clinical outcome after CAS was not correlated to smoking habits, hypertension, medication, or the degree of myocardial revascularization as judged by the surgeons at the time of surgery (44). The early training program did not significantly influence the distribution of subjects to the "prognostic" groups, A, B and C. The lipoprotein values recorded before surgery did not correlate significantly to the clinical outcome. However, the development of the plasma lipoprotein profile after surgery, especially HDL cholesterol and TG concentrations, was clearly different in the "prognostic" groups. In the group with the poorest clinical outcome (C) there were no significant changes in the mean HDL cholesterol levels during the first 5 years and no significant changes in the mean TG levels during the first year after surgery. In the two groups with better clinical outcome, however, significant favourable changes were registered already 1 year after CAS and remained at the follow-up 5 years after the operation. Patients increasing their HDL cholesterol and decreasing their TG concentrations from before surgery to the 1-year follow-up were classified as responders. By this definition 20 males were classified as responders and 16 as non-responders (Fig. 1). There were no significant differences in mean age and the values of the preoperative mean body weight, energy intake, PWC, plasma TG and HDL cholesterol levels between the responder and non-responder group (Table I).

Coronary arteriography, performed at least one month before surgery, demonstrated that 9 patients in the responder group and 12 in the non-responder group had three-vessel disease.

Myocardial revascularization was assessed by the surgeons (43). Three patients in the responder group and one in the non-responder group were judged to be incompletely revascularized.

During the first year after surgery 6 patients were still smokers, 4 in the responder group and 2 in the non-responder group. Eight patients in the responder

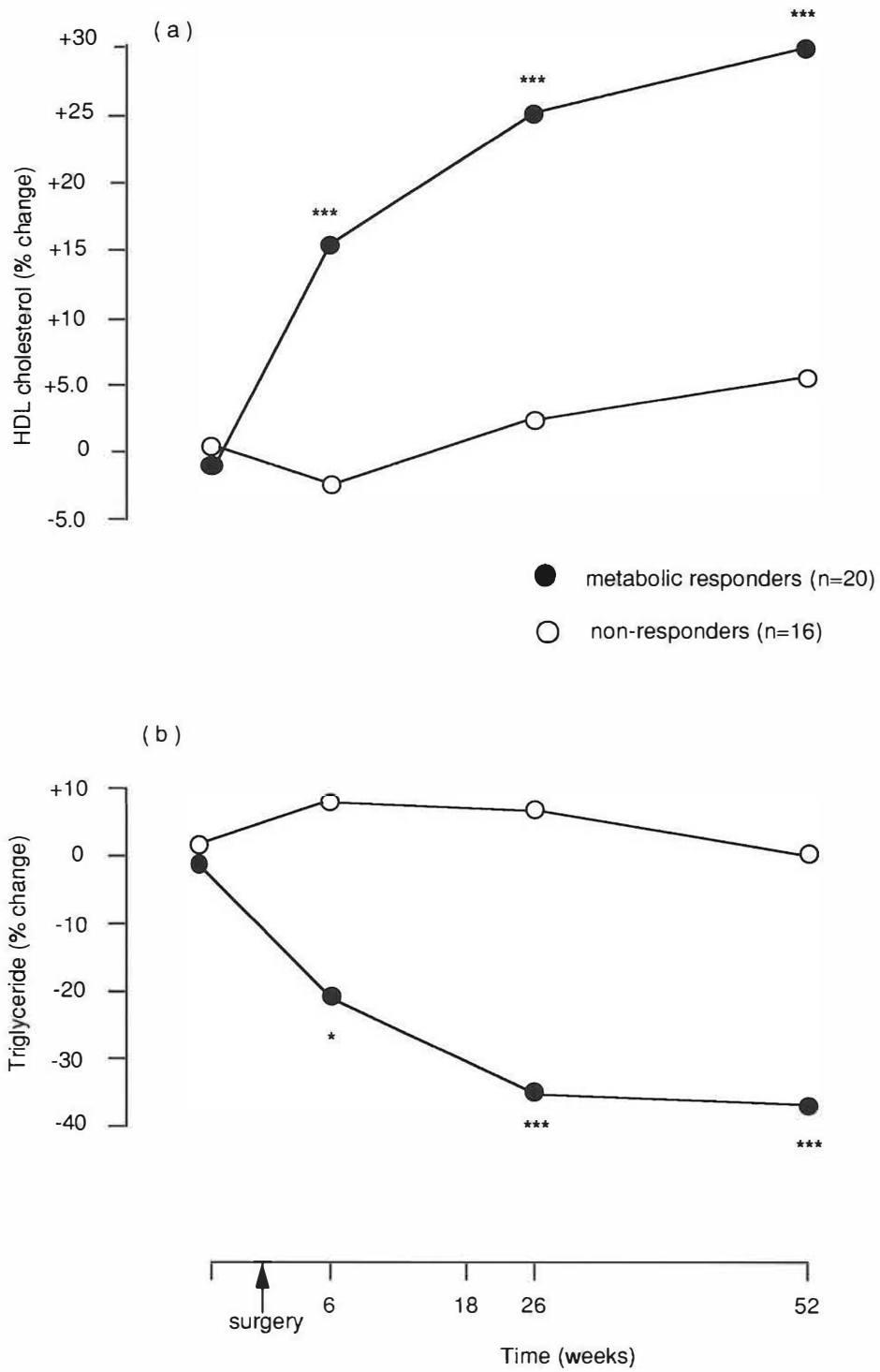

Fig. 1. The time course for the changes in HDL cholesterol (*a*) and triglyceride (*b*) levels from before to one year after coronary bypass surgery in the metabolic responder and non-responder group. * = $p < 0.05$, ** = $p < 0.01$ and *** = $p < 0.001$.

Table I. *Age, body weight, energy intake, physical working capacity, plasma triglyceride and HDL cholesterol level before surgery in the responder and non-responder group*

Data are given before as mean ± SD. Reference ranges for triglycerides, 0.4–1.8 and HDL cholesterol, 0.7–1.6 mmol/l.

	Responder group ($n=20$)	Non-responder group ($n=16$)
Age (years)	54.9 ± 7.7	57.1 ± 7.3
Body weight (kg)	80.5 ± 12.0	81.5 ± 12.0
Energy intake (kcal/day)	2348 ± 870	2190 ± 576
Physical working capacity (watt)	114 ± 27	111 ± 32
Triglycerides (mmol/l)	2.2 ± 1.0	2.2 ± 0.2
HDL cholesterol (mmol/l)	0.8 ± 0.2	0.8 ± 0.2

group and 6 in the non-responder group were on betablockers (beta-selective drugs).

Return to work

One month before surgery, 8 patients worked full- or part-time. One year after surgery 13 patients worked full-time and 9 part-time. In the group not working one year after CAS ($n=14$) more than 2/3 of the patients were retired already before surgery, or prepared for it. Five years after the operation 13 patients were working, 11 retired due to age and 11 retired due to disease.

Putative predictors for return to work were analyzed from data at the 1-year follow-up, since a number of patients had retired due to age at the 5-year follow-up. A number of preoperative differences were found between patients who worked full-time one year after CAS and the remaining patients (Table II). Step-wise discriminant analysis selected a set of variables which successfully predicted the classification of all but one of the patients. Patients who worked full-time were younger, had less severe cardiac symptoms and were less often sick-listed. Full-time workers were also more frequent among those who had been classified as minimizers at the preoperative psychological interview. Step-wise discriminant analysis successfully predicted 84% of the patients who worked 12 months after the operation. Comparison of all patients who worked either full- or part-time with those not-

Table II. *Predictors for classification of patients into those who worked full-time ($n=10$) and those who worked half-time or were sick-listed, retired due to sickness or age ($n=15$) one year after CAS*

Summary of a step-wise discriminant analysis. Canonical correlation coefficient = 0.91, Wilks' Lambda = 0.19, X2 = 33.43, df = 6, $p = < 0.0001$.

Variables	Stand. discriminant function coefficients; direction of differences	Working full-time	Not full-time working	Wilks' Lambda	p
Age (years)	0.88	m = 46.5	m = 58.1	0.55	< 0.0002
Sick-role:					
refuse or		refuse			
accept	0.86		accept	0.23	< 0.0001
Sick-listed before CAS	0.60	40%	93%	0.21	< 0.0001
CAS:					
avoids or belittles or		avoids			
concerned or anxious	0.54		concerned or anxious	0.28	< 0.0001
Psychological aspects of CAS:					
dismiss or		dismiss			
acknowledge	0.44		acknowledge	0.19	< 0.0001
Subjectively limiting coronary symptoms:					
light or		light			
moderate/severe	0.41		moderate/severe	0.32	< 0.0001

working corroborates the finding that patients' coping style is an important predictor for return to work.

Self-assessed levels of physical capacity

The patients estimated their capacity for a few everyday physical activities (Fig. 2). Already half a year after CAS, the group with the poorest clinical outcome 5 years after CAS (group C) estimated their capacity to climb stairs as worse than the groups with better clinical outcome (group A+ B). This difference was more marked 1 and 5 years after the operation. As expected, the distance the patients were able to walk was reported to be lower in the C than in the A+B groups ($p<0.05$); however, this difference was not apparent until 5 years after CAS. All groups demonstrated an improvement in the capacity to manage heavy lifts.

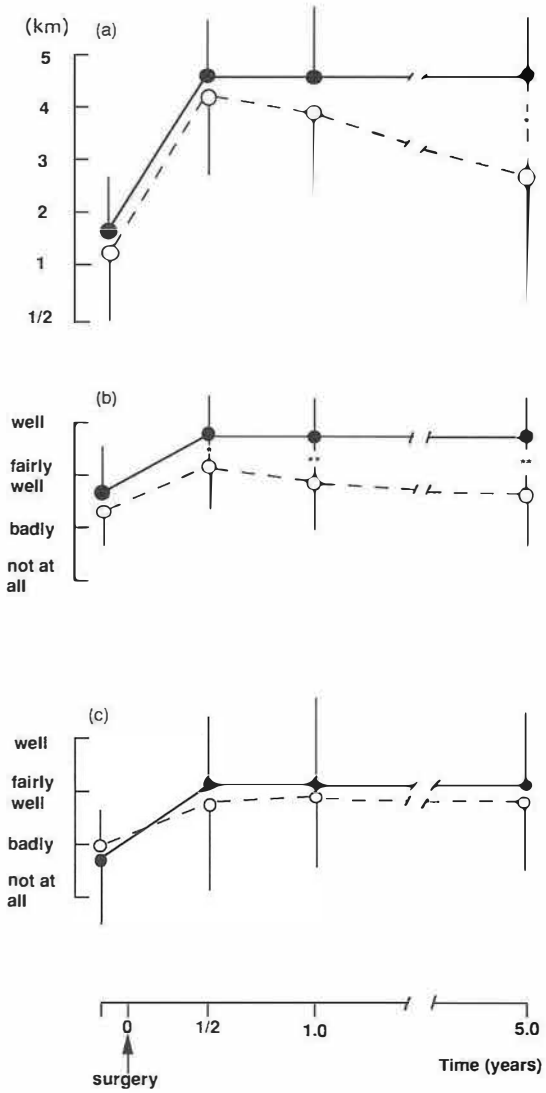

Fig. 2. Self-estimated capacity to walk (*a*), to climb stairs (*b*) and to manage heavy lifts (*c*) before and after surgery for group C with the poorest clinical outcome (- - - -○- - - -, $n=9$) and the groups with the better outcome (—●—, $n=27$). Data are given as mean+SD.

Mood

Twenty patients were asked to rate their mood before and repeatedly after CAS. All six mood dimensions showed a significant increase over the 5-year period after CAS as determined by ANOVA. The Hedonic tone and Control dimensions increased already 6 months after CAS whereas the Social Orientation and Activation dimension did not increase significantly until between 1 and 5 years after CAS (Fig. 3).

The results of our patients obtained after 5 years were well compatible with those recorded in a reference group. Activition and relaxation even reached a higher score than the reference group ($p<0.05$).

Interview 5 years after surgery

When the psychologist asked the patient "Do you consider yourself to have a heart condition or not?" no less than 18 patients (56.3%) answered that nothing was wrong with their heart, another 5 were asymptomatic but admitted to having CHD, and 3 had coronary symptoms but nevertheless felt healthy. Six patients were disabled by their symptoms.

Group C with the poorest clinical outcome 5 years after CAS reported coronary symptoms more frequently ($p<0.001$) than the more successful group A+B.

Twenty-three patients (71.9%) never had limiting coronary symptoms, 5 (15.6%) only occasionally and 4 weekly. As expected, group C reported more limiting coronary symptoms ($p<0.05$) than group A+B.

More than 2/3 of the patients never, or only rarely, thought about their heart surgery. Patients with poor clinical outcome thought about the operation more often ($p<0.01$) than more successful patients.

Asked to summarize possible effects on their attitude to life of their CHD and the CAS, almost half of the group (43.7%) reported such effects, more often beneficial (being calmer, more tolerant or getting more joy out of life) than negative (sadness or irritability) (28.1% vs 15.6%).

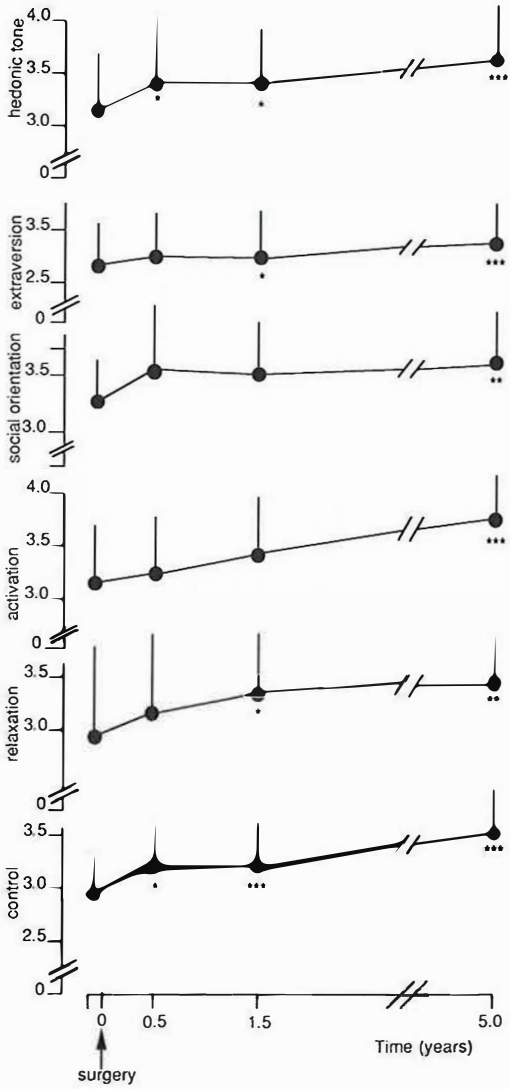

Fig. 3. Mood adjective checklist before and after surgery. Data are given as mean+SD ($n=20$). *$=p<0.05$, **$=p<0.01$ and ***$p<0.001$.

Relationships between physical activity and dietary habits

When the psychologist, not knowing the clinical outcome, asked the patient to estimate the level of physical activity 5 years after CAS, 12 patients (37.5%) reported that they exercised regularly ($\geq$ twice weekly) either strenuously (e.g. tennis) or moderately (e.g. long walks or bike-riding). Only 6 patients (18.5%) were physically inactive.

Five years after CAS, 20 patients (62.5%) reported that they had adapted to the recommended diet by eating less fat and more vegetables. Nine (28.1%) reported similar but only small alterations and only 3 patients had not responded at all to the dietary recommendations they had received.

Group A, with the best PWC 5 years after CAS, were more physically active ($p<0.05$) and had made more extensive dietary changes after CAS ($p<0.05$) than group B+C.

Studying a possible correlation between exercise and dietary habits we found that 10 out of 12 patients who exercised strenuously or moderately had changed their diet radically or according to recommendations ($r_s=0.52$, $p<0.01$). On the other hand, out of 20 patients who made such favourable dietary alterations, 10 exercised only lightly or not at all. This may indicate that a change in exercise habits leads to favourable dietary adjustments more often than vice versa.

Physical working capacity, food intake and body weight

In an earlier report, we identified variables related to, or predicting, a successful clinical outcome (44). As mentioned above, the development of the plasma lipoprotein profile during the first postoperative year was found to be strongly related to the final clinical outcome. A couple of variables, which may directly affect lipoprotein metabolism (i.e. PWC, food intake and body weight), are therefore reported and specified for responders and non-responders.

Before surgery the mean PWC was severely reduced in all subjects (Table I). Both the responder and the non-responder groups rapidly increased their PWC during the first year after surgery. Five years after CAS the increase remained in both groups ($p<0.01$) compared to before surgery. We could not find any significant difference in PWC between the responder and non-responder groups at any time.

In the responder group the mean energy intake decreased ($p<0.01$) from 2348 kcal before to 2149 kcal 6 weeks after surgery. Five months after the operation the mean energy intake was still lower, 2148 kcal. In the non-responder group the change in mean energy intake during the same periods was $<4\%$ (n.s.). No significant changes in the food composition or alcohol intake were registered in either group.

From a preoperative mean weight of 80.5 kg the responder group demonstrated a weight loss of 2.5 kg ($p<0.05$) 6 weeks after surgery, which remained 5 and

Table III. *Predictors for classification of patients into those with a favourable metabolic response (responders, n = 14) and without the favourable metabolic response (non-responders, n = 10) during the first postoperative year*
Summary of data from a step-wise discriminant analysis. Canonical correlation coefficient = 0.73; Wilks' Lambda = 0.47; $Chi^2 = 15.21$, df = 4; $p < 0.004$.

Variables	Stand. discriminant function coefficients; direction of differences	Responders (R)	Non-responders (NR)	Wilks' Lambda	p
Psychological aspects of CAS:					
acknowledge		acknowledge			
dismiss	0.92		dismiss	0.66	0.003
Theme$_{sep}$:					
anxiety	0.62		anxiety	0.54	0.002
MCT:					
anxiety	0.45	anxiety		0.50	0.003
MCT:					
insecure identity	0.37		insecure identity	0.47	0.004

12 months after CAS. In the non-responder group a significant initial decrease of 3.0 kg 6 weeks after CAS remained 5 and 12 months after surgery.

Psychological factors predicting a positive development of the lipoprotein profile

In order to identify possible predictors of a metabolic response one year after surgery, preoperative data were analysed in stepwise discriminant analyses. Four variables (Table III) were selected from the preoperative interview and psychological tests. They correctly classified 22 out of 24 patients, that is 91.7% compared with 50% that would be expected by chance. Responders acknowledged psychological aspects of CAS more often than did non-responders. In the MCT they showed fewer signs of insecure identity and were more often scored for anxiety. When exposed to the separation theme they responded with less anxiety than did the non-responder group. The discriminant function was strongly related to group membership, as shown by the canonical correlation coefficient (0.73). The low value of Wilks' Lambda (0.47) indicates a small variation within the responder/non-responder group compared to between-group variation. The significant Chi-square value (15.21, df = 4, $p < 0.004$) is evidence that these groups' different values on the predictor variables are not the result of chance variation.

Table IV. *Preoperative variables discriminating responders (n = 14) and non-responders (n = 10)*

Variable	Responders (= R)	Non-responders (= NR)	Comparison
Psychological aspects of CAS:			
acknowledge (1)	11	2	R/NR, 1 vs 2,
dismiss (2)	3	8	11/3 vs 2/8, $p < 0.02$
MCT:			
no signs (1)	2	0	R/NR, 1–3 vs 4–5,
repression and/or isolation (2)	3	3	14/0 vs 6/4, $p < 0.04$
(2) with sensitivity ($n = 6$) or anxiety ($n = 4$) or both ($n = 2$) (3)	9	3	
insecure identity (4)	0	3	
anxiety only (5)	0	1	
Theme $_{sep}$:			
no signs (1)	8	1	R/NR, 1–2 vs 3–4,
activity on part of the child (2)	5	1	13/1 vs 2/8, $p < 0.0001$
anxiety only (3)	0	5	
zone of transition only ($n = 3$) or with anxiety (4)	1	3	

Discriminant analysis selects for optimal combinations of discriminating variables. Variables which may be good discriminators by themselves are excluded if they are correlated with the selected combination. The best (maximal) combination may not be identified (13). Hence a more detailed analysis was made of single as well as sets of variables. Table IV displays the additional findings. In the MCT test responders more often used repression and isolation in combination with sensitivity and/or anxiety, or were not scored for any defenses. In contrast, non-responders showed more signs of insecure identity and, in one case, anxiety which was not bolstered by any defenses. Furthermore, many responders were not scored for any defenses in their separation theme protocols, indicating that they were less vulnerable to separation anxiety.

DISCUSSION

The rehabilitation of coronary patients is influenced by many interrelated factors. In the present investigation, we attempted to delineate possible relationships between psychological, physiological and biochemical variables of relevance for the long-term outcome after CAS. Besides yielding descriptive data on the psychological and social characteristics of CAS patients, the study also allowed identification of variables associated with a positive metabolic response after surgery, which in turn, is associated with a successful clinical outcome.

Although the individuals with the poorest clinical outcome after 5 years, group C, demonstrated a similar PWC as group A+B half a year after CAS their poorer self-estimated ability to perform an everyday physical activity – climbing stairs (Fig. 2) – may be an early indication of a lower physical capacity. In contrast, not until 5 years after CAS did group C report restricted walking capacity. Most patients developed a capacity to manage heavy lifts within 6 months despite their surgery. Heavy arm work is more often limited by peripheral muscle function with lactate production than by cardiac function.

Before CAS patients rated their mood as lower than a reference group in the Activation ($p < 0.001$) and Control ($p < 0.01$) dimensions (29), implying that they evaluated themselves as particularly passive and incompetent. This is not surprising in view of their limiting angina pectoris. After CAS different dimensions of mood increased at differing rates, suggesting that psychological recovery is a varying, long-term process. Thus, whereas the patients reported an increased hedonic tone and sense of control within half a year after surgery, it took more than a year until they felt more active and sociable. Our finding that social withdrawal may constitute a long-term side-effect of CHD (Fig. 3) is notable and points to the need of differentiating short- and long-term aspects of rehabilitation after CAS (5, 14). A possible explanation of the high scores obtained 5 years after CAS, surpassing those of a healthy reference group in the Activation and Relaxation dimensions, would be that many of the patients had developed new standards of reference in life as suggested by the responses of more than 1/4 of the patients that they became calmer and more tolerant and that they got more joy out of life. Similar findings have been reported in patients with advanced cancer who have undergone a complete remission (12).

In a recent review of the literature by Russell et al. (28) the rate of return to work after CAS varies between 40 and 90%, but different national levels of employment and wide social and insurance benefits makes it difficult to compare these studies. A report from Finland (6) demonstrated a 60% rate of resumption of work after CAS. Similar results were reported by a Swedish group (24). Seventy-one percent of the men <65 years of age in our study were working one year after CAS compared to 23% 1 month before surgery. This increase is not surprising in view of the registered improvements in mood variables and PWC. Studies on physical training after CAS have shown an increase in PWC (7, 8, 11, 24). Our short-term training program following CAS did not significantly increase the rate of return to work compared to the control group, although patients participating in the training program demonstrated a more marked improvement in PWC (43, 44). Only a few studies (1, 39) have demonstrated improvement in the rate of return to work following an exercise program.

It is notable that a majority (7/9 individuals) who were not working one year after the operation had planned to retire even before surgery due to their CHD. We believe that these patients would have stood a better chance to return to work if they and their families prior to surgery had received better information from their physicians about the postoperative rehabilitation possibilities (cf 2). This could decrease cost and increase cost-efficiency of CAS and of postoperative rehabilitation programs. A report from

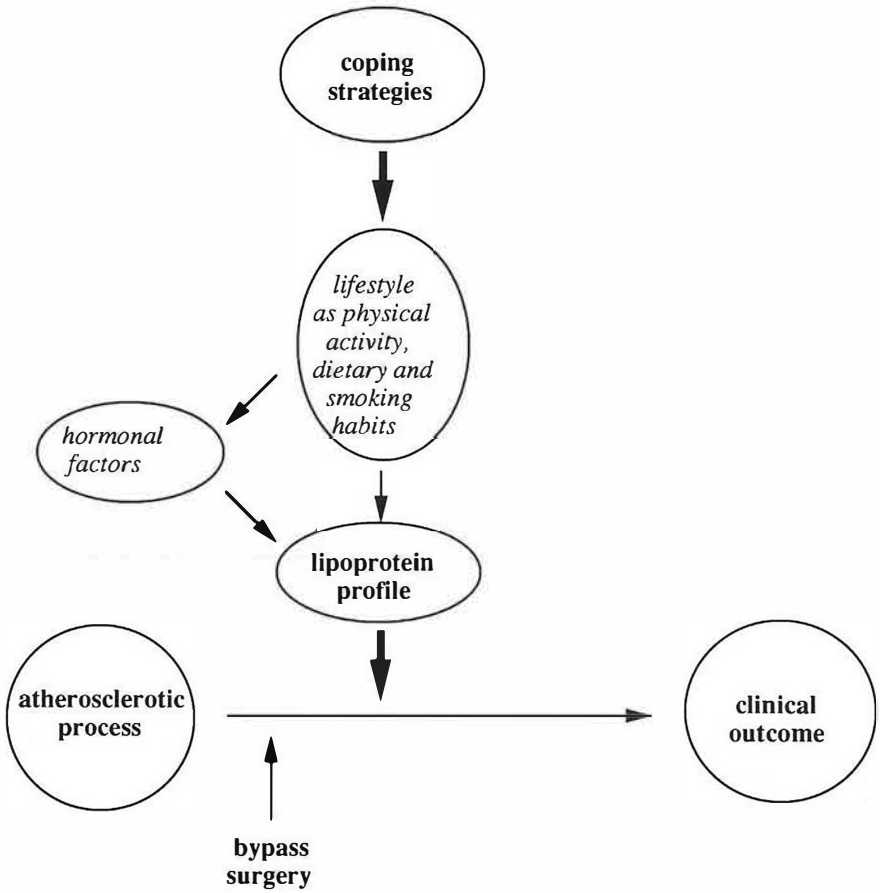

Fig. 4. Suggested causal relationships between coping strategies, lipoprotein profile and clinical outcome.

Belgium described that many of the patients, in fact asymptomatic, who did not resume their work after surgery, had obtained a certificate of permanent disability from their family physician or controlling physician (30).

In the clinical follow-up of these patients we identified two groups of metabolic patterns after surgery, i.e. responders and non-responders. Responders, who rapidly improve their lipoprotein profile after surgery (rising HDL cholesterol levels and decreasing triglyceride concentrations), had a significantly higher probability for a successful clinical outcome than did non-responders (44). In contrast, the plasma lipoprotein pattern before surgery, the angiographic pattern (three vessel disease) and the degree of myocardial revascularization assessed by the surgeons had no prognostic value for clinical status 5 years after surgery. Since a rapid improvement in plasma lipoproteins may be directly linked to the progression or regression of vascular disease and thus not only statistically but also causally related to clinical outcome, we further analyzed variables which may influence lipoprotein metabolism and concentrations.

The level of physical activity and physical capacity is an important determinant of plasma lipoprotein concentrations. A marked increase in PWC was registered for responders as well as non-responders 6 and 12 months after surgery. Although the short-term training program following surgery improved PWC and may have improved the lipoprotein profile in the early period after surgery (43), it is evident that additional factors, environmental as well as genetic, are of importance for the development of the lipoprotein profile. The mechanisms whereby physical training raises HDL levels are not completely understood, but evidence is accumulating that the rise in HDL concentrations is partly mediated via increased activity of the

enzyme lipoprotein lipase in adipose and muscle tissues occurring during training (20, 38). The decrease in initial mean energy intake in the responders may have contributed to the metabolic response. Similar favourable changes in the lipoprotein profile seem to be possible by decreasing energy intake or by increasing energy expenditure by exercising (42), but in our subjects differences in body weight did not seem to explain the differential development of the lipoprotein profile.

A main feature of responders' preoperative psychological profile was their readiness to acknowledge their feelings, hopes and fears with respect to their forthcoming surgery. Provoked in the MCT, they used isolation and repression in combination with anxiety and/or sensitivity. This pattern indicates that they intermittently experience the threats of their situation but also are able to avert the concomitant anxiety. Anxiety and, in particular, sensitivity, can be expected to elicit affiliative behaviour in favourable circumstances, that is when trustworthy support is available. Sensitivity, as measured by MCT, characterizes individuals who are highly aware of other individuals' attitude towards them and who tend to change in accordance with these (23, 33). In a study of patients in chronic hemodialysis, Hagberg (10) found sensitivity and anxiety combined with repression in MCT to be favourable prognostic signs for return to work suggesting that the successful patient admits rather than denies experience of the threat and anxiety which are realistic for the situation.

Responders were less provoked than non-responders by the separation theme (8/14 protocols without any signs), which is evidence of a basic sense of security and affiliative trust in interpersonal relationships. The responders' willingness to adopt a psychological perspective during the interview, as well as their test profile, suggest that they can be expected to be quite responsive to the advice and expectations of surgeons, dieticians, etc.

In contrast, a majority (80%) of non-responders preferred to discuss their forthcoming surgery in technical or pratical terms only, avoiding its psyehological implications and stressing their abilities rather than the limitations caused by their heart condition. Although their MCT-protocols were not very diagnostic, they contained the only signs of insecure identity.

The Separation theme aroused (subconscious) anxiety in 8 out of 10 non-responders as compared with 1 out of 14 responders (Table IV). A heart condition and, in particular, heart surgery, can be expected to evoke fear of death, of which one essential aspect is fear of being abandoned (41). The non-responders' unwillingness to discuss other than superficial aspects of CAS may serve to protect them from a deep-seated vulnerability to separation fear.

In our preoperative analysis of the patients (29), minimisers, that is those patients who viewed their heart condition in objective non-self terms and as a parenthesis in life, were better adjusted than accepters – who adopted the opposite attitude – in terms of mood, capacity for work and everyday activities. Moreover, 6 months after CAS more minimisers than accepters had returned to work. Radley & Green (27) reported that if the patients became symptomatically relieved after CAS deniers soon returned to their premorbid way of life. On the other hand, minimisers do not only belittle symptoms, they are also non-compliant with medical advice (15) and are slow learners in cardiac education classes (31). One year after CAS, we found that minimisers tended to be classified as non-responders, who faced a worse clinical outcome than responders (44). Thus our findings seem to indicate that, in the present category of patients, a minimising strategy has mainly short-term benefits while accepting the disease, as defined here, may be adaptive in the long run.

In summary we found that the patients' psychological profile, characterized in the preoperative interview and psychological tests, was associated with the metabolic response following CAS, which, in turn was strongly related to clinical outcome. We propose that the different coping strategies govern the patients' life-style patterns after surgery, which affect the lipoprotein profile and, thereby, the progression or regression of atherosclerosis (Fig. 4). Consideration of these factors and of their relative contributions to the individual patient's adaptation to disease may make the psychological preparation of the patient and of his family more effective and create a favourable climate for successful postoperative rehabilitation.

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