Prevalence, characteristics, and predictors of chronic nonanginal postoperative pain after a cardiac operation: A cross-sectional study

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Objective: This study was designed to assess the prevalence, characteristics, effect, and predictors of chronic postoperative pain 1 to 3 years after cardiac surgery.

Methods: Seven hundred thirty-six patients who underwent coronary artery bypass surgery, valve replacement, or both between 1999 and 2002 were mailed questionnaires (response rate, 79% [n = 579]; 564 questionnaires were analyzed), and their hospital records were reviewed.

Results: Nonanginal chronic postoperative pain affected 23% of patients. Eighty percent of them had pain 1 or more days per week. The worst and usual pain intensities during the week preceding the survey reached moderate to severe levels (≥4/10) in more than half of the patients. Thirty-one percent of the patients with chronic postoperative pain had taken analgesic pain medication during that week. During the same period, pain interfered significantly (≥4/10) with various aspects of patients' daily life (eg, general activity level: 39.1%, sleep: 36.7%). When patients with and without chronic postoperative pain were compared, the former group had significantly higher levels of anxiety and depression, and they perceived their health-related quality of life as more compromised. Multivariate logistic regression analysis revealed that greater analgesic needs in the first few days postoperatively were associated with an increased risk of chronic postoperative pain. The only other significant factor was the time elapsed from surgical intervention to survey: the longer it was, the less likely the patients were to report chronic postoperative pain.

Conclusion: The prevalence, severity, and effect of chronic postoperative pain after cardiac surgery should not be underestimated. Longitudinal prospective studies are needed to further evaluate risk factors, including inadequate postoperative pain relief in the acute period.

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Cardiovascular diseases cause more deaths and disability in industrialized nations than any other groups of diseases.[1,2] Coronary artery bypass grafting (CABG), valve replacement (VR), or both are commonly indicated not only to improve survival but also to ameliorate the patients' quality of life by reducing symptoms such as anginal pain. However, it appears that these operations can also lead to the development of chronic postoperative pain (CPOP), a syndrome that is different from anginal pain felt before surgical intervention.

Many aspects of CPOP in patients undergoing cardiac surgery remain poorly characterized. For example, the prevalence rates vary considerably from one study to the other, ranging from 15% to 56% 1 year or more after surgical intervention.[3-10] Few studies[3,5,7] have assessed the severity of the pain in terms of its effect on patients' well-being. The number of studies that have examined the risk factors of CPOP is limited,[3,6,7] and these do not always use a multivariate statistical approach.

Abbreviations and Acronyms
CABG = coronary artery bypass grafting
CPOP = chronic postoperative pain
ICU = intensive care unit
ITA = internal thoracic artery
SV = saphenous vein
VR = valve replacement

Further research is needed to provide a more comprehensive evaluation of CPOP after cardiac surgery. In addition, factors that might predispose to this type of problem need to be examined more closely. The objectives of the present study were as follows: (1) to assess the prevalence and characteristics (location, intensity, and frequency) of chronic nonanginal pain after cardiac surgery; (2) to measure the effect of this type of pain in terms of interference with daily living, psychologic well-being, and health-related quality of life; and (3) to identify some demographic factors, medical factors, or both that might predict long-term persistent pain after cardiac surgery.

Methods

Patients and Procedure

After study approval by the institutional ethics committee, 800 patients were randomly selected from a computerized list of individuals who survived a first elective CABG surgery, VR, or both through a median sternotomy at the Montreal Heart Institute between 1999 and 2002. Thirty-four patients who already had cardiac surgery before this period or underwent an urgent operation were excluded, as were 8 patients who could not be reached and 22 who died after their hospitalization, leaving a sample of 736 patients. One year or more after the operation, each patient was mailed a survey questionnaire, along with detailed instructions and a stamped return envelope. Patients who returned an incomplete questionnaire or provided ambiguous answers were contacted by telephone to collect missing information. Relevant medical-surgical data were extracted from the patients' hospital records. Postoperative opioid medication (type, dose, and route) administered in the intensive care unit (ICU) and the surgical ward was also recorded. Opioid dosage was converted into parenteral morphine equivalents by using standard dosage tables[11] and was cumulated over time.

Instrument

The first section of the survey questionnaire measured the presence and characteristics of CPOP. Patients were asked whether they had pain in the past 4 weeks that first appeared after their operation and was different in quality from the anginal pain experienced before surgical intervention. If this was the case, patients were defined as having CPOP and were asked to indicate the exact location or locations and severity of their pain. A standard 0- to 10-point numeric rating scale (0 = no pain, 10 = worst pain possible)[12] was used to assess CPOP intensity at the time of the survey (present pain) and in the past 7 days (worst and usual pain). The effect of CPOP on daily living was measured with 6 items of the Brief Pain Inventory,[13] which uses a 0- to 10-point scale (0 = does not interfere, 10 = completely interferes) for pain interference ratings in various areas. Finally, pharmacologic and nonpharmacologic methods used to treat pain were recorded.

The 3 other sections of the questionnaire were completed by all patients, irrespective of whether they had CPOP. Health-related quality of life was assessed with the SF-36 version 1.[14,15] Patients' psychologic well-being was measured with the Hospital Anxiety and Depression Scale.[16] Finally, patients were asked to provide relevant demographic information.

Statistical Analyses

The results are expressed as means ± standard deviation or medians (minimum-maximum) according to the distribution for continuous variables or as number and percentages for categoric variables. For continuous variables, comparison of groups was performed with the parametric (*t* test) or nonparametric (Wilcoxon) test, depending on the distribution. For categoric variables, comparison of groups was performed with the Pearson χ^2 test. Only variables with *P* values of less than .25 in univariate logistic regression analysis were considered as potential predictors for CPOP for multivariate backward logistic regression analysis. Statistical analysis was done with the computer softwares SAS version 8.02 (SAS Institute Inc, Cary, NC) and SPSS 10.0.5 (SPSS Inc, Chicago, Ill).

Results

Participants' Characteristics

Of the 736 patients who were contacted, 128 did not reply, and 29 refused to participate, for a response rate of 79%. Some patients were excluded a posteriori because they had a noncardiac operation to the chest (eg, mastectomy or thoracotomy, n = 7) or were unable to answer the questionnaires because of physical-mental incapacity (n = 6) or insufficient knowledge of French or English (n = 2). The study participants (N = 564) included 418 (74.1%) male subjects and 146 (25.9%) female subjects who were mostly of Canadian origin (92.9%) and who ranged in age from 29.4 to 88.4 years (mean, 63.3 ± 9.9 years) at the time of their operation. The mean number of months elapsed between the operation and the survey was 29.9 ± 10.5 months (range, 13.5-49.4 months). Only 27% (154/563) of the participants were actively working at the time of the survey, and the majority were either retired (359/563 [63.9%]) or not working (50/563 [17.9%]).

Prevalence of CPOP

Twenty-three percent (129/564) of the patients reported experiencing nonanginal CPOP at 1 year or more after their operation. If one assumes that all patients who did not respond or refused to participate in the survey were pain free, the most conservative prevalence rate of CPOP would be 17.5% (129/736). Six percent (37/564) of the participants had persisting anginal pain that was similar to the pain felt before the operation. These were excluded so that analyses

TABLE 1. Characteristics of the patients with and without nonanginal chronic postoperative pain

Characteristics	Patients with CPOP (n = 129)		Patients without CPOP (n = 398)		*P* value
	Mean	SD	Mean	SD	
Age at time of operation (y)	61.5	10.0	63.8	9.6	.024
Body mass index (kg/m^2)	29.1	5.1	28.4	4.2	.089
Time elapsed since operation (mo)	27.8	10.0	30.5	10.7	.012
	% of patients		% of patients		
Sex (% male)	70.5		76.1		.204
CABG with ITA ± VR	79.1		76.6		
CABG without ITA ± VR	3.9		5.3		.765
VR only	17.1		18.1		
Complications necessitating surgical return (yes/no)	6.2		5.8		.859
	Mean	SD	Mean	SD	
Duration of operation (min)	175.6	42.2	171.1	41.1	.284
	Median	Min-max	Median	Min-max	
Total amount of opioids received in the ICU (mg)*	54.3	15.0-514.2	50.5	1.3-568.0	.409
Total amount of opioids received on the surgical ward (mg)*	18.1	0.0-181.7	11.7	0.0-193.0	.018
Duration of ICU stay (h)	44.0	15.8-286.4	44.9	18.0-666.8	.693
Duration of hospitalization (d)	7.0	3.0-31.0	7.0	4.0-36.0	.803

CPOP, chronic postoperative pain; *SD,* standard deviation; *CABG,* coronary artery bypass grafting; *ITA,* internal thoracic artery; *VR,* valve replacement; *ICU,* intensive care unit. *Expressed as milligrams of parenteral morphine equivalents.

focused solely on patients with and without CPOP. As shown in Table 1, the majority of patients underwent CABG alone or in combination with VR, and less than 20% had VR alone. The prevalence rates of CPOP were comparable whether the patients had CABG including the use of the internal thoracic artery (ITA; 25.1% [102/406]), CABG excluding the ITA (ie, use of the saphenous vein [SV], radial artery, or both; 19.2% [5/26]), or a VR alone (23.4% [22/94]; $P = .765$, χ^2 test).

Characteristics of CPOP

CPOP was commonly present in more than one site, but it was most often localized in the thorax area (109/129 [84.5%]). Pain was also reported in other areas of the upper body (arm or arms, shoulder or shoulders, neck, or back: 56/129 [43.4%]) and in the leg or legs (46/129 [35.7%]). Pain was present 1 day or more per week in 80% (104/128) of the patients with CPOP. Mean pain intensity at the time the patients completed the questionnaires was 2.1 ± 2.4 (range, 0-10). Worst and usual pain intensity during the week preceding the survey reached moderate to severe levels (≥4/10) in 61.3% (79/129) and 51.2% (66/129) of the patients, respectively. During the same period, pain interfered substantially (≥4/10) with various aspects of patients' daily living, including general activity (50/128 [39.1%]), sleep (47/128 [36.7%]), walking ability (42/128 [32.8%]), mood (38/128 [29.7%]), enjoyment of life (36/128 [28.1%]), and relations with others (27/128 [21.1%]).

When patients with and without CPOP were compared in terms of perceived physical and mental health status, the former group scored significantly lower on all scales and subscales of the SF-36. On average, patients with CPOP were slightly but significantly more anxious and depressed than patients who were pain free (Table 2).[14]

With respect to analgesic medication, 31% (40/128) of the patients with CPOP reported having used analgesic medication during the week preceding the survey. Most of them had taken over-the-counter mild analgesics (acetaminophen, n = 37; ibuprofen, n = 6). Very few patients were prescribed analgesics (cyclooxygenase 2 inhibitors, n = 5; combination of acetaminophen and codeine, n = 1; morphine, n = 2). In terms of pain-related use of health care resources, 32.6% (42/129) of the patients with CPOP consulted a health professional at least once in the past 3 months. The number of visits varied from 1 to 9, for a total of 102 visits and an average of 2.6 (102/39) visits per patient. About 1 in 5 patients with CPOP (29/128 [22.7%]) saw their family doctor because of their pain, 16 (16/128 [12.5%]) consulted their cardiologist, 1 saw his surgeon, and 1 was referred to a pain clinic. Seven percent (9/129) of

TABLE 2. Perceived health status, anxiety, and depression levels in patients with and without chronic postoperative pain

	Patients with CPOP (n = 129)		Patients without CPOP (n = 394)		
SF-36 subscales*	**Median**	**Min-max**	**Median**	**Min-max**	***P* value**
Physical functioning	65.0	0.0-100.0	80.0	0.0-100.0	.000
Physical roles	50.0	0.0-100.0	100.0	0.0-100.0	.000
Bodily pain	52.0	0.0-100.0	100.0	0.0-100.0	.000
General health	62.0	0.0-100.0	77.0	0.0-100.0	.000
Vitality	55.0	0.0-100.0	70.0	0.0-100.0	.000
Social functioning	75.0	0.0-100.0	87.5	0.0-100.0	.000
Emotional roles	67.0	0.0-100.0	100.0	0.0-100.0	.000
Mental health	68.0	8.0-100.0	80.0	0.0-100.0	.000
Physical summary score	41.0	13.1-57.1	51.5	16.4-64.3	.000
Mental summary score	50.3	19.5-65.6	54.4	14.7-68.1	.000
HADS†	**Mean**	**SD**	**Mean**	**SD**	
Anxiety subscale	7.0	4.4	4.5	3.5	.000
Depression subscale	5.1	4.3	2.9	3.1	.000
Total score	12.1	7.8	7.4	5.9	.000

CPOP, Chronic obstructive pain; *SD*, standard deviation. *Higher scores on the SF-36 subscales mean better health status (min = 0, max = 100). Component summary scores are T scores (mean = 50, SD = 10) based on the US general population.[14] †Higher scores on the Hospital Anxiety and Depression Scale *(HADS)* subscales mean higher levels of anxiety and depression (min = 0, max = 21). Maximum total score is 42.

the patients with CPOP went to an emergency department, were hospitalized, or both in the previous 3 months because of their nonanginal pain.

Risk Factors of CPOP

As shown in Table 3, greater analgesic needs on the surgical ward were a significant predictor of CPOP. The same is true for the length of time since the operation. Although all patients were surveyed at least 1 year or more after surgical intervention, the shorter the interval between the operation and the survey, the more likely they were to report CPOP. In contrast, age, sex, body mass index, type and duration of operation, reintervention during hospitalization, amount of opioids received in the ICU, length of stay in the ICU, and total hospitalization time were not found to be significant risk factors of CPOP.

Discussion

Prevalence and Characteristics of CPOP

The results of this study show that 23% of the participants have CPOP 1 to 3 years after cardiac surgery. Compared with the prevalence rates reported in earlier studies,[3-10] the

TABLE 3. Risk factors of chronic postoperative pain

	Univariate logistic regression			Multivariate logistic regression		
Variables	***P* value**	**Odds ratio**	**95% CI**	***P* value**	**Odds ratio**	**95% CI**
Age at time of operation (<65 y vs ≥65 y)	.159	0.75	0.50-1.12			
Body mass index (kg/m^2)	.091	1.04	0.99-1.09			
Time elapsed between operation and survey (mo)	.013	0.75	0.59-0.94	.007	0.97	0.95-0.99
Sex (female vs male)	.205	1.33	0.86-2.08			
CABG without ITA ± VR (vs CABG with ITA ± VR)	.502	0.71	0.26-1.93			
VR (vs CABG with ITA ± VR)	.728	0.91	0.54-1.54			
Reintervention during hospitalization (yes vs no)	.859	1.08	0.47-2.47			
Duration of operation (min)	.283	1.00	0.99-1.01			
Total amount of opioids received in the ICU*	.735	1.00	0.99-1.00			
Total amount of opioids received on the surgical ward*	.051	1.01	1.00-1.02	.032	1.05†	1.00-1.10
Duration of ICU stay (h)	.558	1.00	0.99-1.01			
Duration of hospitalization (d)	.443	1.02	0.97-1.07			

CPOP, Chronic postoperative pain; *CABG*, coronary artery bypass grafting; *ITA*, internal thoracic artery; *VR*, valve replacement; *ICU*, intensive care unit. *Expressed as milligrams of parenteral morphine equivalents. †For each increase of 5 mg.

rate in this study ranks among the lowest. However, the fact that about 1 in 5 patients have persistent pain after cardiac surgery is far from negligible. In fact, CPOP is much more common than other forms of morbidity associated with cardiac surgery (eg, mediastinitis, renal dysfunction, and neurologic deficits).[17,18] Furthermore, the pain can be severe enough to interfere with daily activities, psychologic well-being, and quality of life in a substantial number of patients, as shown both in this study and some earlier reports.[3,5,7] Cardiac surgery is performed to improve health status, symptoms, functioning, and quality of life,[17] but patients might not be aware of the risk of CPOP and its potential detrimental effects on their well-being. Therefore it is important that information about this type of postoperative morbidity be discussed in preoperative counseling with patients.

Underlying Mechanisms

The presence of CPOP after cardiac surgery is not surprising when one considers the nature of the trauma. CABG, VR, or both types of operations involve many pain-sensitive structures because they require a median sternotomy, rib retraction, and invasion of muscle and visceral tissues. Although the precise pathophysiology of CPOP after cardiac surgery remains unclear, different theories have suggested that CPOP might be due to entrapment neuropathy, musculoskeletal trauma during the operation, sternal nonunion, wound dehiscence, costosternal separation, fractured ribs, painful sternal wires, and/or postoperative infection.[19,20] In CABG the grafting procedure requires harvesting at several sites, including most commonly the ITA. The manipulation and retraction of the sternum, as well as the use of electrocautery to dissect the ITA from the chest wall, might result in nerve damage that leads to intercostal neuralgia.[9,21,22] The SVs are also used to serve as grafts in CABG surgery and require leg incisions that might result in saphenous neuralgia.[3,23,24] In other words, all of these procedures might give rise to chronic nociceptive, neuropathic, or both types of pain, which can persist for variable periods of time after the operation.

In the present study CPOP was most often localized to the thorax, but pain was also present in the legs after SV grafting. A good number of patients also reported persisting pain in the arm or arms, shoulder or shoulders, neck, and back, confirming some earlier reports.[4,7,25] It should be emphasized that patients were repeatedly instructed in the questionnaire to focus only on nonanginal pain related to their cardiac surgery and to exclude any other forms of chronic pain (eg, arthritis). It is possible that persisting pain in these areas resulted from poor positioning during surgical intervention, brachial plexus injury, and/or shoulder girdle pain.[19,21]

CPOP: An Undertreated Problem

The present study suggests that CPOP after cardiac surgery is an undertreated problem. In spite of the fact that a substantial number of patients with CPOP reported moderate to severe pain, only a few were prescribed analgesic medication (eg, nonsteroidal anti-inflammatory drugs, cyclooxygenase 2 inhibitors, and opioids). One third of the patients with CPOP were taking over-the-counter analgesics, and none were receiving medication commonly used to treat neuropathic or other types of chronic pain syndromes (eg, antidepressants and anticonvulsants). Various factors might explain these results, which are consistent with earlier observations made by Eisenberg and colleagues.[5] Patients might perceive persisting pain as "normal" and part of the healing process. When they meet their surgeon or cardiologist at follow-up, they might not consider persistent nonanginal pain worth mentioning because attention is focused on their cardiac condition. Deficient management of CPOP might also be due to the clinicians' lack of familiarity with its symptomatology, persistence, and potential treatment. As a result, patients might turn to other health professionals (eg, family physicians), rely on their own resources for the treatment of CPOP, or both, as revealed by the results in this study.

Risk Factors of CPOP

Our results show that CABG involving ITA grafting is not associated with a higher risk of CPOP compared with VR alone. These results, which are consistent with those of a recent Swedish study,[6] confirm that mechanisms other than trauma occurring during ITA dissection must be involved in the development of CPOP. When comparing the prevalence of CPOP after CABG with ITA versus SV grafting, no significant difference emerged.

Other factors that might contribute or predispose to the development of CPOP after cardiac surgery are relatively unknown. The results of this study revealed no predictable patterns related to duration of surgical intervention, return to the operating room, or length of ICU or hospital stay. The same was true for age, sex, and body mass index. These results contrast with those of Kalso and associates[7] and Bruce and coworkers,[3] who found some significant relationships between the presence of CPOP, younger age, and obesity at the time of the operation. Pre-existing physical-medical and psychosocial characteristics of the patients would need to be evaluated before surgical intervention and followed afterward to get a better understanding of the risk factors of CPOP after cardiac surgery. Our results also suggest that CPOP might fade away in some patients. The longer the time elapsed between the operation and the survey, the less likely the patients were to report CPOP. A prospective design would permit a more careful characterization of the temporal course of the pain.

When examining risk factors of CPOP, special attention should be paid to the intensity of acute pain and analgesic needs during the hospital stay. Our results, as well as those of Kalso and associates,[7] showed that patients who had greater analgesic needs while hospitalized were more at risk of reporting CPOP up to 3 years after the operation. It is interesting to note in our study that the amount of analgesics administered to patients during their ICU stay did not emerge as a significant predictor of CPOP, whereas it did when the patients were on the surgical ward. This might be due to the fact that analgesics were more liberally administered in the ICU, whereas their use was far more restricted in patients on the surgical unit. Several studies[26,27] have shown that patients (including patients undergoing cardiac surgery) who received a larger amount of analgesics tended to be those who reported more intense pain during their hospitalization. Although we did not collect any information on the patients' pain intensity during the early postoperative period, it is tempting to speculate that inadequate pain relief during this period (ie, more intense pain) could be an important factor in the transition from acute to chronic pain. Several studies involving other types of operations (eg, thoracic surgery, breast surgery, and hernia repair) support this hypothesis (see review by Perkins and Khelet[28]). However, it is also possible that the reports of greater pain intensity during the early postoperative period might simply be a marker of those patients who will report CPOP later on, this being true irrespective of the amount of analgesics administered during the acute period. Studies using a prospective design are clearly needed to assess whether the severity of acute postoperative pain, the quality of the analgesic practices during that period, or both are significant predictors of CPOP in cardiac surgery patients.

Study Limitations

The present study did not include patients' physical examination, quantitative sensory testing, or both, thereby precluding clinical differential diagnosis or CPOP classification into subcategories according to pain location, symptoms, and/or underlying mechanisms.[5,29] Other study limitations have to do with the data collection method. Our results are mainly based on patient self-reports. However, adequate assessment from the patients' point of view provides essential information for subjective phenomena such as pain.[30] Patient self-reports were collected by using postal questionnaires. Contrary to face-to-face interviews, this technique limits the control over question misinterpretation. However, all precautions were taken in the present study to ensure proper comprehension of the questions and possible confusion about the origin of pain. Several authors[5,8] report that most patients with persistent chest pain after cardiac surgery can differentiate it from recurrent angina. In our study all patients who were unable to clearly distinguish between the 2 types of pain and all patients who had anginal pain only were excluded from the analysis.

Despite the study limitations, the present findings are believed to have important implications. Acknowledging that a good number of patients undergoing cardiac surgery experience persisting pain that might impair their quality of life is important from a clinical and research point of view. Clinically, cardiologists and surgeons need to recognize the importance of the problem. Further research is needed to obtain a better understanding of the underlying mechanisms of CPOP to provide patients with adequate strategies to prevent the pain, treat the pain, or both, depending on its origin.

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