Does pain relief with spinal cord stimulation for angina conceal myocardial infarction?

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Abstract

Objective—To investigate the possibility that spinal cord stimulation (SCS) used for pain relief can conceal acute myocardial infarction (AMI).
Design—Prospective evaluation of patients treated with SCS.
Setting—University hospital.
Patients—50 patients with coronary artery disease and severe, otherwise intractable angina treated with SCS for 1–57 months.
Main outcome measures—Necropsy findings, symptoms, serum enzyme concentrations, electrocardiographic changes.
Results—Ten patients were considered to have had AMI. In nine of these SCS did not conceal precordial pain and in one patient no information about precordial pain could be obtained.
Conclusion—There was no evidence that SCS concealed acute myocardial infarction.

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The perception of cardiac pain during myocardial ischaemia is mediated via sympathetic afferent nerve fibres.[1] High thoracic epidural anaesthesia can block cardiac afferent sympathetic fibres; this technique therefore reduces cardiac pain during myocardial ischaemia.[2] The same effect is achieved by spinal cord stimulation (SCS),[3] which has become a well established treatment for chronic pain. SCS was first reported as a successful treatment of otherwise intractable angina pectoris in 1987.[4]

Precordial pain is the cardinal symptom of acute myocardial infarction (AMI) and it is possible that effective pain relief by SCS may conceal acute myocardial infarction.[5] Currently several centres use SCS to treat angina: other centres are reluctant to use SCS because they fear that the stimulation could conceal an acute myocardial infarction.

We sought evidence of acute myocardial infarction in patients treated with SCS for angina.

Patients and methods

The study was approved by the local ethics committee and the patients gave their informed consent before enrolment. We studied 50 patients (40 men and 10 women) treated with SCS for otherwise intractable anginal pain (table 1). Eighteen of the patients had had one myocardial infarction and 15 had had two or more. Forty two of the patients had previously been treated with percutaneous transluminal coronary angioplasty (PTCA) or coronary artery bypass graft surgery (CABG) or both. In all the patients SCS treatment was started because further medical treatment or revascularisation was regarded as impossible.

The patients were reviewed after an average of 29 (range 1–57) months of SCS treatment. The minimum observation time for patients who did not die or stop SCS treatment (6 patients) was 12 months. During the observation period electrocardiographic changes and cardiac enzymes, if available, were reviewed for every hospital admission and visit to the casualty ward. All admissions to hospital in the 3 years before SCS treatment were also reviewed.

The patients were seen by one of us every 1 to 4 months. At these visits they were questioned about symptoms and visits to other medical institutions. If the patient had consulted a general practitioner, information about the visit was obtained. Because of severe chest pain 44 of the patients were treated with opioids before SCS treatment. A reduction in dose during SCS was used to assess symptomatic relief.

When possible the diagnosis of acute myocardial infarction was established according to WHO criteria that is, pain, ECG changes, increase in myocardial enzymes (creatine kinase B > 20 U/l and lactate dehydrogenase 1 > 170 U/l).[6,7] If this information was unavailable, acute myocardial infarction was diagnosed if the patient died suddenly or acute heart failure developed.

A 12 lead ECG was recorded at follow up and compared with the ECG recorded immediately before SCS treatment was started. Any alterations in Q wave, QRS configuration, ST/T segment, and T wave were evaluated.

Table 1   Data on Patients

Variable	AMI (n = 10)	Non-AMI (n = 40)
Age (y)	57 (47–71)	61·5 (43–78)
F/M	9/1	9/31
CABG (%)	8 (80)	31 (78)
PTCA (%)	1 (10)	9 (23)
AMI (%)	9 (90)	24 (60)
Hospital admissions before/with SCS*	3·0/1·6	3·0/1·9
Opiate consumption before/with SCS†	47·5/0·2	30·4/0·4
Digoxin (No of patients (%))	4 (40)	10 (25)

*Mean number of hospital admissions per patient per year.
†Median opiate consumption equivalent to mg morphine per patient per 24 h.

Table 2 Data on the 10 patients with acute myocardial infarction

Case No	Age	Sex	Previous AMI	CABG	PTCA	SCS (mnth)	Survival/ cause of death	CK-B	LD-1
1	49	M	2	1	–	21	Alive	34	219
2	54	M	1	2	–	13	Alive	56	294
3	55	M	1	1	1	25	Alive	51	495
4	59	M	1	2	–	27	Alive	131	901
5	49	F	–	2	–	37	Heart failure	–	–
6	53	M	3	–	–	1	VF	–	–
7	57	M	1	–	–	6	AM*†	–	–
8	61	M	1	1	–	9	Heart failure	–	–
9	66	M	2	1	–	11	AMI*	81	160
10	71	M	1	2	–	12	VF	–	–

*Confirmed at necropsy. †Sudden death.
CK-B, creatine kinase isoenzyme B; LD-1, lactate dehydrogenase; VF, Ventricular fibrillation.

STATISTICAL ANALYSIS

The groups with and without acute myocardial infarction were compared by rank sum test (Mann-Witney) and observations before and with SCS were evaluated by the Wilcoxon/Pratt test. Differences were regarded as significant if $P < 0.05$.

Results

We evaluated 108·6 patient-years of SCS treatment. During the observation period 10 patients were diagnosed as having an acute myocardial infarction while they were being treated with SCS: six of them died (table 2). Two patients died of other causes: one of pneumonia and one of progressive heart failure.

In the four survivors and one of the patients who died acute myocardial infarction was verified by serum enzyme concentrations; the other patients died before a blood sample was taken. In an additional patient acute myocardial infarction was verified at necropsy: the diagnosis was based on clinical observations in the remaining four patients. Two of these died in intractable ventricular fibrillation, and two patients in heart failure died suddenly. Nine of the ten patients with acute myocardial infarction recognised that the precordial pain during their acute myocardial infarction was being clearly different and definitely more severe than their usual angina and that it was not alleviated by SCS. Furthermore, the pain at acute myocardial infarction was accompanied by unusual symptoms such as dyspnoea, general weakness, etc. Patients with previous myocardial infarction reported that some symptoms were the same as at the last myocardial infarction.

One patient (case 7) died suddenly; it is not known whether he experienced any chest pain. He was admitted to hospital for a transurethal resection of the prostate and was well when he was given premedication. About

one hour later he was found dead in the ward. Acute myocardial infarction was verified at necropsy (table 2). One patient refused hospital admission; she was treated at home by her general practitioner and died suddenly in heart failure. This death was attributed to AMI (case 5, table 2).

During the observation period 37 of the 50 patients were admitted to hospital. During the observation period there were 153 admissions. The mean number of admissions for chest pain or angina or observation for acute myocardial infarction during the 3 year period before SCS treatment and during the period with SCS treatment were not significantly different ($P = 0.6$) in the 10 patients with acute myocardial infarction and the patients without (table 1).

During SCS treatment about 90% of the visits to the casualty ward or the general practitioner were for prescriptions or socioeconomic problems or both. The median number of contacts with a physician was one per month. There were, however, large variations between individual patients (0–30 per month).

During the follow up period five patients had their antianginal medication adjusted. One patient had CABG because coronary angiography showed occlusion of a previously inserted bypass graft.

The symptomatic relief achieved by SCS treatment (assessed from the reduction in opiate consumption) was significant; there was, however, no difference between the 10 patients with acute myocardial infarction and the others (table 1). Forty three of the 50 patients reported that SCS treatment reduced angina. All 10 patients who had an acute myocardial infarction during SCS treatment claimed to have a considerable reduction in angina.

There were no differences in the number of previous acute myocardial infarctions or in the number of bypass operations between the ten patients in the acute myocardial infarction-group and the other 40 patients (table 1).

The electrocardiograms recorded before SCS were abnormal in most of the patients, with a high incidence of Q wave and ST-T abnormalities (table 3). In the patients without acute myocardial infarction a comparison of the follow up electrocardiograms with those recorded before SCS showed no significant changes in Q wave, T wave inversion, or new bundle branch block (table 3). In the group with acute myocardial infarction follow up electrocardiograms could be recorded only in the four patients who survived: one patient developed bundle branch block, two had T wave changes, and in one no changes were seen in the electrocardiogram. The four patients who survived their acute myocardial infarction have not been admitted to hospital since.

Table 3 Electrocardiographic abnormalities in the AMI and non-AMI groups before SCS and at follow up

Abnormality	AMI before (n = 10) (%)	AMI after AMI (n = 4)	Non-AMI before (n = 40) (%)	Non-AMI follow up (n = 40)
Q wave	5 (50)	—	9 (23)	9
Bundle branch block	1 (10)	1	2 (5)	2
LV hypertrophy	1 (10)	–	4 (10)	4
Cohn effect	4 (40)	–	10 (25)	10
T wave	3	2*	21 (53)	21

*Changes at acute myocardial infarction (AMI). LV, left ventricular.

Discussion

Recognition of sympathetic afferent fibres as the pathway for cardiac pain led to efforts to

treat angina with sympathectomy. This treatment relieved angina in about 75%.[8] In 1977 Melzack and Wall published their gate control theory of pain transmission,[9] which led to attempts at relieving pain by electric stimulation of the spinal cord. Low-amplitude electric impulses transmitted through implanted epidural electrodes attached to a subcutaneous neurostimulator stimulate the spinal dorsal columns and alleviate pain. Pain relief alone, however, does not account for the improvement in exercise tolerance reported in patients treated with SCS.[10] Mannheimer *et al* used transcutaneous electrical nerve stimulation for pain relief in angina and they believe that reduction of sympathetic overactivity may contribute to its effectiveness.[11]

Angina may be regarded a warning sign, signalling that the patient's myocardium is at risk because oxygen supply is insufficient and that it should be protected by reducing effort. When this warning is abolished it may prevent the patient from recognising acute myocardial infarction. We investigated whether SCS can conceal acute myocardial infarction. Ten of the 50 patients treated with SCS were believed to have had an acute myocardial infarction during the observation period. The diagnosis was confirmed by enzyme concentrations or necropsy or both in six of the patients. In the remaining four patients the clinical picture suggested acute myocardial infarction and these patients were included in the group with acute myocardial infarction.

Some of the 40 patients without acute myocardial infarction during SCS were admitted to hospital with severe precordial pain. In all these instances acute myocardial infarction was ruled out by serum enzyme analysis and electrocardiograpy. We therefore feel confident that symptomatic acute myocardial infarction did not occur in this group. This does not, however, rule out the possibility that some patients in this group may have had silent AMI, with the pain being overruled by SCS.

In the Framingham study 23% of the acute myocardial infarctions documented by electrocardiography were not accompanied by symptoms severe enough to require medical attention.[12] However, unrecognised myocardial infarction was rare in patients with prior angina. All our patients had prior angina.

No changes attributable to acute myocardial infarction were seen when the electrocardiogram taken at follow up was compared with the one taken immediately before SCS. Absence of electrocardiographic changes does not rule out acute myocardial infarction, however, particularly in patients with previous acute myocardial infarction as in our patients.[6 7 13] The nine patients in the AMI group who reported on their symptoms also had additional symptoms at the same time as the pain caused by acute myocardial infarction. During follow up none of the 40 patients without acute myocardial infarction reported additional symptoms.

A major problem in investigations is the uncertainty with which acute myocardial infarction can be diagnosed or excluded in patients such as ours. In four of our patients the diagnosis of acute myocardial infarction was based on circumstantial evidence. We considered it prudent to include these patients in the group with acute myocardial infarction. It would not alter our conclusion, however, if they were not included.

The most critical factor in our investigation is the possible occurrence of unrecognised acute myocardial infarction in the group without acute myocardial infarction. This may probably never be fully resolved because silent acute myocardial infarction could remain completely unrecognised. None the less close surveillance in hospital of patients whenever chest pain was not alleviated by SCS seems to indicate that clinically significant acute myocardial infarction did not occur in the group without acute myocardial infarction.

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