

# Epidural spinal cord stimulation in therapy-resistant angina pectoris – influence on myocardial perfusion or improvement of the quality of life? Pilot study

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## Abstract

**Introduction:** Epidural spinal cord stimulation (SCS) seems to be an alternative treatment for therapy-resistant angina pectoris. This report assesses the efficacy of SCS in improving quality of life (QoL) and influence on myocardial perfusion.

**Material and methods:** In the year 2004 seven patients with therapy-resistant angina pectoris were enrolled in a prospective study. The patients had a spinal cord stimulator implanted. Myocardial perfusion was evaluated in SPECT-MIBI prior to implantation and in the 3<sup>rd</sup>, 6<sup>th</sup> and 12<sup>th</sup> month after. Coronary reserve was assessed in an exercise test and QoL in a questionnaire.

**Results:** QoL improved in all patients within 3 months of the implantation. Coronary capacity increased in 2 patients and in 5 patients it stayed at the same level. Myocardial perfusion improved in 2 patients, deteriorated in 3 patients and in 2 it did not change.

**Conclusions:** SCS improves QoL. It seems not to influence myocardial perfusion.

**Key words:** spinal cord stimulation, angina pectoris, exercise test.

## Introduction

Angina pectoris which does not respond to optimal pharmacological treatment is one of the basic indications for percutaneous and/or surgical coronary revascularization. However, some patients – according to some authors' estimations up to 10% – are disqualified from revascularization due to expected lack of effectiveness of such therapy. Patients with so-called therapy-resistant angina can be qualified for transmyocardial laser revascularization. It seems that epidural spinal cord stimulation can be an alternative or additional form of treating anginal symptoms [1].

Spinal cord neurostimulation has routinely been used for treatment of neurogenic pain syndromes since the beginning of the 1970s. Further works confirmed its usefulness in advanced obliterative atherosclerosis of the lower limbs, where it relieved pain and increased capillary blood flow [2, 3]. In 1986 the first attempts were made to apply this method for

relieving therapy-resistant anginal symptoms [4, 5]. The aim of this study is to present preliminary experience of Polish authors regarding the first group of 7 patients with severe anginal symptoms who had an epidural spinal cord stimulator implanted.

### Material and methods

The study has been conducted since 2004 with follow-up until now. From April to December 2004 seven patients were enrolled in a prospective study (IRB approval). The entry criterion is therapy-resistant angina pectoris, defined (according to the Polish Cardiac Society) as a condition that manifests in pain episodes due to coronary insufficiency in the presence of coronary artery disease unresponsive to pharmacotherapy and percutaneous or surgical revascularization procedures. It must be clinically documented that the underlying cause of anginal symptoms is reversible myocardial ischaemia. Chronic state is defined as recurrent angina lasting longer than 3 months despite optimal drug therapy. Therefore, therapy-resistant angina concerns patients in whom conventional forms of treatment have proved ineffective [1].

From April to December 2004 spinal cord stimulators were implanted in seven patients with therapy-resistant angina pectoris unsuitable for revascularization. Prior to the procedure they had been receiving optimal anti-anginal medication (beta-adrenolitics and/or calcium channel blockers, ACE-inhibitors, antiplatelet agents, statins) in maximal tolerated doses. 5 patients had previously undergone percutaneous and/or surgical revascularization and 2 of them had also received transmyocardial laser revascularization. The demographic data of the group of patients are presented in Table I.

The procedure of epidural stimulator implantation (Figure 1) was performed in the Department of Neurosurgery in the Central Hospital

of the Ministry of Interior and Administration in Warsaw under local anaesthesia, which allowed the patient to stay awake and respond during the operation. In the first stage, under fluoroscopy the epidural space was punctured at the level of Th6 using a Thony needle inserted through a small incision. Subsequently, an electrode was introduced, passed in the rostral direction and placed at the level of Th1-Th2. Having connected the electrode to pulse generation, the electrode was finally positioned so that the field of paraesthetic sensations covered the area of anginal pain perception. Finally, the end of the electrode was connected to the permanent pulse generator (Medtronic Irel II or III) implanted subcutaneously in the left subcostal region. Afterwards, the generator was programmed telemetrically.

All patients included in the study underwent measurement of quality of life (using a questionnaire created for the purpose of the study), electrocardiographic exercise test and exercise scintigraphy to evaluate reserve of myocardial perfusion. The tests were performed prior to and in the 3<sup>rd</sup>, 6<sup>th</sup> and 12<sup>th</sup> month after stimulation implantation. Exercise test was carried out on a running track in accordance with widely accepted standards. Stress myocardial perfusion scintigraphy was qualitatively assessed using 500 MBq 99Tc MIBI and after several hours resting study with 1000 MBq 99Tc MIBI was performed. The end points of this study were improvement of coronary capacity, myocardial perfusion and quality of life.

All patients were trained in regulation of stimulation impulse intensity so that in the case of stenocardial pain they could interrupt it, increasing amplitude of stimulation.

### Results

All patients included in the study demonstrated improvement in quality of life parameters (reduction

Table I. Baseline characteristics

Data	Number of patients
Sex (male)	4
Hypertension	6
Diabetes mellitus	4
Myocardial infarction (past)	6
Arteriosclerosis obliterans	2
Coronary artery bypass surgery	2
Percutaneous coronary intervention	3
3-vessel disease	4
Laser revascularization (past)	2
Age (middle, standard deviation)	63.7±7.5 years

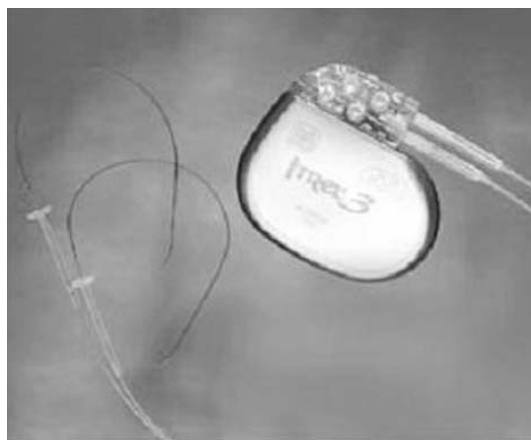


Figure 1. Stimulator used in research

**Table II.** Results

	Myocardial perfusion (SPECT – MIBI)	Coronary capacity (ExT)	Quality of life
Improvement	2 pts	2 pts	7 pts
Deterioration	3 pts	–	–
Not change	2 pts	5 pts	–

of number of anginal episodes, subjective improvement in exercise capacity and mental status). This was associated with reduction in daily nitrate consumption and a decrease in the number of additional medical consultations as well as hospitalizations due to aggravation of anginal symptoms. Improvement in quality of life occurred within the first 3 months after implantation and only slightly increased during the subsequent 6-12-month follow-up period.

Two patients exhibited increased working capacity evaluated in exercise testing performed in the 6<sup>th</sup> month of follow-up. Maximal workload achieved during the test increased from 2 to 7 Mets and from 5 to 8 Mets. The effect lasted over the whole observation period. In the remaining 5 individuals no significant change in working capacity was noted in consecutive tests.

Also SPECT revealed improvement of myocardial perfusion in 2 patients after 6 months from stimulator implantation. This parameter remained at the same level over the observation period. In another 2 patients myocardial perfusion remained unchanged and in 3 it deteriorated after 6 months and did not improve in further observation. Results: improvement of quality of life, myocardial perfusion and coronary capacity did not depend on age, sex, number of occluded vessels, prior revascularization or diabetes mellitus. All results are presented in Table II.

## Discussion

According to the definition of the Polish Cardiac Society, therapy-resistant angina pectoris is a condition that manifests in pain episodes due to coronary insufficiency in the presence of coronary artery disease unresponsive to pharmacotherapy and percutaneous or surgical revascularization procedures. The underlying cause of anginal symptoms must be clinically documented, reversible myocardial ischaemia. Chronic state is defined as recurrent angina lasting longer than 3 months despite optimal drug therapy. Therefore, therapy-resistant angina relates to patients in whom conventional forms of treatment have proved ineffective [1, 3]. It seems that epidural spinal cord stimulation and transmural laser revascularization can be an alternative or additional form of treating anginal symptoms. But there are a few experimental methods of treatment of therapy-resistant angina pectoris such as application growth factors, gene therapy, angiogenic proteins, and stem

and progenitor cells, which are still being investigated. During the last twenty years about one thousand epidural spinal cord stimulators have been implanted in medical centres worldwide [6]. In Poland only eight spinal cord stimulators have been used for treatment of therapy-resistant angina since 2004.

The present study included patients unsuitable for revascularization (frequently after previous revascularization procedures) who did not respond to optimal medication. Two of them had previously undergone laser revascularization. All of them had an epidural spinal cord stimulator implanted. In this study quality of life improved in all the patients, coronary capacity in 2 and myocardial perfusion in the other 2 patients. There was no relationship between results and demographic characters and number of occluded vessels. A general limitation of this study is the too small population that does not allow the use of statistical methods of analysis. Besides, it is difficult to conduct placebo-controlled trials, because there is no alternative for the paraesthesia induced by the neurostimulators; therefore our study has – like others – no placebo group.

The applied method proved fully effective in relieving anginal symptoms, improving quality of life, and reducing frequency of hospitalizations and number of consultations, which is consistent with previous observations by Murray et al. [7]. This group of researchers also worked out a preliminary analysis of costs, which revealed long-term economic benefits despite the relatively high cost of the implantation procedure.

We did not observe improvement in objective clinical parameters in the study group. Only 2 patients demonstrated an increase in coronary reserve evaluated in exercise testing and improvement of myocardial perfusion assessed by means of SPECT.

However, other researchers obtained quite opposite results. Dietrichs et al. [8] reported an improvement in functional capacity during 6-minute walk test (from 142 to 20 m) as well as increased exercise capacity during electrocardiographic treadmill testing (from 67 to 98 Watts). Maximal beneficial effect was observed after 3 months from stimulator implantation. SPECT performed 3 months after implantation did not show any increase in myocardial perfusion; however, after 6 months a significant improvement was noted in as many as 50% of investigated patients and this effect persisted

in long-term observation. It was suggested that neurostimulation has a positive effect on the development of myocardial collateral circulation.

Mobilia et al. evaluated myocardial perfusion in patients after stimulator implantation using positron emission tomography (PET). Apart from a general improvement in mean myocardial perfusion, they observed a redistribution of radioactive tracer between regions with lower and higher perfusion. Thus, a hypothesis was made that neurostimulation leads to homogenization of myocardial perfusion, which was described as the 'Robin Hood effect' [9].

Norrsell et al. investigated coronary blood flow in arteries supplying regions of decreased perfusion using endovascular Doppler. They did not observe an increase of blood flow in those vessels. Thus, the previous presumption that the anti-anginal effect of neurostimulation is related to coronary blood flow improvement was not confirmed [10].

In conclusion epidural spinal cord stimulation significantly improves quality of life (in social and psychosomatic areas) in patients disqualified from revascularization procedures with otherwise intractable angina pectoris. However, this study did not show that spinal cord stimulation influences myocardial perfusion or exercise capacity in this group of patients.

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