Chronic Angina Pectoris:

Managing Pain with Spinal Cord Stimulation in Cases that Resist Conventional Strategies

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The coronary arteries supply the heart muscle (myocardium) with oxygen and nutrients. According to current scientific views, low-grade inflammation causes lipid deposits in the artery wall, which may create plaques. This condition, atherosclerosis, occurs predominantly in larger arteries, including coronary arteries. The subsequent narrowing of the artery restricts blood flow to the myocardium, especially during exercise. As a consequence, the heart muscle does not receive enough oxygen (reduced supply) when the demand increases (mainly during exercise).

This imbalance in the demand and supply of oxygen to cells of the heart is known as cardiac ischemia. Insufficient oxygen supply usually causes chest discomfort (angina pectoris), which may become severely debilitating. The term "chronic refractory angina pectoris" describes a form of angina pectoris that cannot be adequately treated by a combination of medication, often aimed to reduce demand of the myocardium, along with procedures to increase blood flow to the myocardium, such as angioplasty (percutaneous coronary intervention, or PCI) and coronary artery bypass surgery (CABS).

Survival rates from cardiac disease have improved through preventive measures, such as smoking cessation, advances in medications, and the development of sophisticated revascularization procedures. As a consequence of better treatments leading to prolonged lives, more and more people are living with refractory angina, since patients who survive coronary artery disease longer may become "refractory" over time to conventional treatments to relieve their angina.

People with refractory angina have an annual rate of myocardial infarction (heart attack), re-hospitalization, and mortality comparable to that of

Patient-controlled and reversible, SCS lowers pain and appears not to mask life-threatening cardiac events.

patients who are amenable for revascularization procedures. At least 100,000 patients in the United States and 100,000 in Europe are considered unsuitable for treatment with conventional revascularizations.

There are complex cardiac and nervous mechanisms involved in the perception of angina. Angina is most often felt as a sense of strangling and anxious discomfort on the chest, resulting from myocardial ischemia. Obvious myocardial ischemia can occur without symptoms of angina (silent ischemia). In contrast, a specific group of patients with apparently normal coronary arteries are suffering from typical exercise angina pectoris, in the presence of ECG changes (Syndrome X or small vessel disease).

Is there hope for relief of angina in patients who can't have angioplasty or coronary artery bypass surgery?

For these patients for whom pharmacological treatments are exhausted and who are unsuitable for revascularizations, alternative procedures are available that can improve their quality

of life without endangering their lives – examples include the application of laser technology, angiogenesis, enhanced external counter pulsation (EECP) and electrical neurostimulation. While the first two methods have been more or less abandoned, one of the best adjunct therapies to consider is electrical neurostimulation. Electrical examples include the application of laser technology, angiogenesis, enhanced external counter pulsation (EECP) and electrical neurostimulation. While the first two methods have been more or less abandoned, one of the best adjunct therapies to consider is electrical neurostimulation. Electrical neurostimulation can be done through the skin (transcutaneous electrical nerve stimulation, or TENS), via the spinal cord (spinal cord stimulation, or SCS) – or underneath the skin (subcutaneous electrical nerve stimulation, or SENS) all of which are considered "neuromodulation".

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Specifically, the SCS and TENS methods of the electrical nerve stimulation technique have been used for many years in the treatment of chronic pain and, for more than 25 years, predominantly in Europe, for the management of angina pectoris. SCS is performed by surgically implanting an epidural lead with multiple electrodes. These electrodes enable the device to deliver an electrical, low-output, impulse near the dorsal surface of the spinal cord. SCS *modulates* pain stimuli and leaves the patient with pleasant tingling sensations instead of pain. Because SCS defers the propagation of pain signals from the heart, instead of blocking these signals, the patients feel their angina during an acute myocardial infarction, even in the presence of active SCS. In brief, many observational studies have confirmed that during a myocardial infarction SCS treatment does not exclude the heart from receiving its "warning" angina signal. In addition to its anti-angina effect, SCS does make the myocardial cells more resistant to ischemic challenges, probably even in the setting of an acute myocardial infarction.

How do we know neurostimulation works?

In several randomized studies and meta-analysis the clinical efficacy of SCS in patients with chronic stable angina is compared to 'sham' neurostimulation (inactive SCS) and to CABS, laser therapy and EECP as active comparators. SCS provided similar benefits in terms of angina control and quality of life improvement. In a group of patients with a high operative CABS risk, SCS even showed lower rates of mortality, cerebrovascular morbidity and re-hospitalization. In addition, SCS was shown to be comparable to the other active comparators. Compared to the sham SCS, active SCS resulted in significant improvement in quality of life, exercise capacity and reduction in cardiac ischemia. Much investigational research has been carried out using experimental models to understand the effects of SCS more precisely. From this work we know that the extent of the ischemic border zone of an induced myocardial infarct is far less when SCS is in use. In addition, SCS has been found to reduce the number of ventricular arrhythmias and also may improve the pump function of the heart as well.

How does neuromodulation work?

The exact way in which electrical neurostimulation or neuromodulation improves ischemia of the heart is not fully known but is attributed, at least in part, to reduced oxygen demand, alterations in coronary microcirculation, preconditioning (increasing resistance heart muscle cells), and redistribution of coronary blood flow. SCS is also associated with normalizing the heart's own nervous system activity.

Is it possible that SCS might work by enhancing a placebo effect?

Indeed all treatments for angina by their very nature will induce a placebo effect. The placebo effect has been observed to decrease over time and is assumed to be negligible after a few months. In contrast, the beneficial effect of SCS lasts for years, suggesting that other mechanisms are involved. Also supporting the theory that the decrease in symptoms is not a placebo response is that once a neurostimulator's battery fails, patients may report a recurrence of angina attacks and impaired physical activity. Blinding a patient to an active SCS treatment is difficult because it is performed with stimulation intensity that causes a tingling sensation in the chest region. Stimulation below the sensory threshold has been tested in patients suffering from refractory angina. In a randomized placebo-controlled trial improvement in functional status and in quality of life was reported, as well as reduction in angina frequency in the group with sub-threshold stimulation, when compared to the "off-stimulation" group.

What are the risks of neuromodulation?

The complications related to SCS include, among others, infection, electrode migration or rupture, and device failure. These occur in about 1% of the patients and usually do not lead to permanent consequences since SCS is a reversible

therapy. Furthermore, specific attention has to be paid to the SCS device when other devices are also have been implanted, such as an artificial cardiac pacemaker.

What is the long-term cost and effect of neuromodulation?

From an economic point of view, SCS results in a 30% annual saving in medical costs, mainly due to reduced invasive tests. Moreover, the cost of implanting an SCS system can be recovered within three years. Overall, this translates into a yearly saving per patient of more than $8,000 USD. This compares favorably to the high cumulative costs of either CABS or PCI with stenting, which are greater than $50,000 USD over five years. When compared to a standard surgical approach, SCS is obviously less expensive.

In conclusion, SCS is a safe and effective therapeutic option and allows patients with refractory angina to have significantly improved quality of life and less chest discomfort. Moreover, it is patient-controlled and reversible, has a low complication rate and does not seem to conceal life-threatening cardiac events, graft material, or other concurrent chronic illness.

Please note: *This information should not be used as a substitute for medical treatment and advice. Always consult a medical professional about any health-related questions or concerns.*

Further reading

Buiten, M. S., DeJongste, M. J., Beese, U., Kliphuis, C., Durenkamp, A. and Staal, M. J. Subcutaneous Electrical Nerve Stimulation: A Feasible and New Method for the Treatment of Patients With Refractory Angina. *Neuromodulation: Technology at the Neural Interface.* 2011 May;14(3):258–265.

de Vries J, Dejongste MJ, Zijlstra F, Staal M. Long-term effects of electrical neurostimulation in patients with unstable angina: refractory to conventional therapies. 2007 Oct;10(4):345-8.

Resources

American Heart Association
www.heart.org

British Heart Foundation
http://www.bhf.org.uk/