



# Neuromodulation Therapies for Intractable Angina: A Review

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## Abstract

**Background:** Transcutaneous Electrical Nerve Stimulation (TENS) and Spinal Cord Stimulation (SCS) are neuromodulation therapies that have shown to be effective as treatments for the care of Intractable Angina. In addition, Stellate Ganglion Block (SGB), although not considered a neuromodulation therapy, has proven to be a successful interventional therapy.

**Objective:** With the minimal research studying the use of neuromodulation therapies to treat intractable angina, this review looks to summarize the pre-existing data published and see which neuromodulation therapies have proven to be successful in treating patients with Intractable Angina.

**Methods:** A literature search was done on PubMed, Google Scholars, and ResearchGate to discover 3 different neuromodulation therapies that have shown to be effective in the treatment of intractable angina. Factors that were searched for include safety, complications, and the application of the neuromodulation therapy.

**Results:** 12 articles were analyzed with 3 three different neuromodulation therapies. For Spinal Cord Stimulation (SCS), 19 patients were implanted for SCS and the results found that both admission rate and hospital stay time were lower after SCS (0.97 vs. 0.27) and (8.3 days vs. 2.5 days). For Transcutaneous Electrical Nerve Stimulation (TENS), results have shown reduced frequency of anginal attacks, and increased work capacity. For Stellate Ganglion Block (SGB), the mean pain relief duration was 3.5 weeks. SGB has proven to be an alternative neuromodulation invasive strategy for the treatment of intractable angina.

**Conclusion:** Through the various articles analyzed, it's clear that TENS, SCS, and SGB have proven to be both safe and effective in treatment of intractable angina. Although the patient populations tested are low, the patients who did undergo treatment have proven to be effective. Through more trials and larger patient population sizes, the usage of TENS, SCS, and SGB can be better supported for their effectiveness and safety.

**Keywords:** Neuromodulation; Angina; Transcutaneous electrical nerve stimulation; Spinal Cord Stimulation; Stellate Ganglion Block

## Introduction

Intractable angina, or often referred to as refractory angina, refers to a chronic condition in which patients constantly suffer from recurrent restricting angina [1]. With roughly 600,000 to 1.8 million individuals suffering from refractory angina, it's clear that this condition is fairly common [1]. Furthermore, intractable angina is often documented as a chronic condition that tends to react poorly to various treatments. In specific, intractable angina has proven to react poorly to conventional pharmacological therapies such as oral nitrates,  $\beta$ -blockers, and calcium channel blockers [2]. However, early research has proven that neuromodulation therapies have shown to be successful in the treatment of intractable angina [3-5]. Neuromodulation therapy refers to the act of performing directly upon the nerves. By altering the nerve activity through electrical agents, neuromodulation allows modification upon an individual's life [6]. Neuromodulation has played an important role in the treatment of diseases such as Parkinson's disease and Alzheimer's, however, through early successful research, it's clear that neuromodulation can play a role in the treatment of intractable angina [2-5]. In specific, Transcutaneous Electrical Nerve Stimulation (TENS) and Spinal Cord Stimulation (SCS) have proven to be successful neuromodulation therapies in the treatment of Intractable Angina [2-4,7]. Spinal Cord Stimulation (SCS) refers to the implanting

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of a neuromodulating device that helps to send electrical signals [4]. In comparison, Transcutaneous Electrical Nerve Stimulation (TENS) refers to the delivery of electrical impulses through the use of electrodes that are placed within the surface of the skin [2,8,9]. In addition to these two successful neuromodulation therapies, Stellate Ganglion Block (SGB), although not considered a neuromodulation therapy, has shown to be a successful interventional therapy [2,7,8]. Overall, this review aims to discover the pre-existing research on the use of neuromodulation therapies for the treatment of intractable angina and relate their safety and complications upon completion of treatment. By investigating the pre-existing studies already conducted, we look to further study the effects neuromodulation therapies can have within the treatment of patients suffering from intractable angina.

## Methods

A literature search was done on PubMed, Google Scholars, and ResearchGate to discover 3 different neuromodulation therapies that have shown to be effective in the treatment of intractable angina. Factors that were searched for include safety, complications, and the application of the neuromodulation therapy.

## Review

With the growing number of therapeutic treatments to treat various medical conditions, refractory angina still remains one of the most growing problems in many patients [10]. With the most common treatment methods for refractory angina being oral nitrates, beta-blockers, calcium channel blockers, antiplatelet agents, and lipid-lowering agents, these conventional therapies, although extremely helpful in the patient's care, still may not be enough in treating refractory angina. Thus, in our particular review, we aim to display the way neuromodulation therapies can play an important role in improving care for patients who suffer from refractory angina. In specific, TENS and SCS have proven to be successful neuromodulation techniques to support patients suffering from refractory angina. In addition to both TENS and SCS, another successful interventional therapy that has shown success is SGB.

## Transcutaneous electrical nerve stimulation

Transcutaneous electrical nerve stimulation, or TENS, refers to the use of electric current in order to treat pain. In specific, usually a small device is used to deliver the current near a nerve. The way in which TENS is said to work is that through the electrical current delivered, the nerve cells are stimulated that help to block the transmission of pain signals that occur. Through this, the way in which pain is said to be perceived, is altered, resulting in improvement in patient care. TENS has proven to be an effective tool to treat chronic back pain, labor pain, and for treating muscle problems [11]. However, TENS has shown promising results for treating refractory angina as well. A particular study detailed that through an assessment of 80 patients whose age was 55 ( $\pm 7$  years), patients' conditions were said to have improved through the use of TENS [12]. In specific, refractory angina episodes reduced (baseline  $20 \pm 3$ , TENS  $3 \pm 1$ ;  $P=0.012$ ) and coronary vascular resistance reduced (baseline  $0.96 \pm 0.04$ , TENS  $0.85 \pm 0.06$  mmHg) [12]. A major conclusion reached for why TENS has shown to be an effective method is because neurostimulation, as mentioned before, can help to block the transmission of pain signals that occur within the patient, and thus, improve the patient suffering from refractory angina.

In addition, TENS has shown to be an effective method after

surgical interventions have occurred within a patient. In specific, a particular case report details the way in which TENS was said to be used to treat a young man for his refractory angina after both coronary angioplasty as well as coronary bypass surgery had occurred [13]. After both of these interventions, the patient's refractory angina was said to have not been better controlled, however, after the use of TENS in this particular patient after intervention had occurred, helped improve the patient's refractory angina, but also, helped to reduce the rate of hospitalization. This particular case report clearly displays that TENS can be an effective first source treatment, however, after surgical intervention has occurred and has not been effective, TENS can then also be used for treating refractory angina as well. Thus, the use of TENS is a successful neuromodulation therapy for the patient's care at multiple stages in their condition.

## Spinal cord stimulation

In addition to the success TENS has shown for treating refractory angina, Spinal Cord Stimulation (SCS) has also shown to be effective as well. In specific, clinical trial results have shown to be effective in decreasing pain in patients, but also, helped to improve overall quality of life [14]. In particular, through a total of 12 trials involving the use of 476 patients suffering from refractory angina, an overall decrease of angina frequency was found (MD= -9.03, 95% CI, -15.70 to -2.36) [14]. Also, in regards to improving overall patient quality of life, through the set of total patients used in the trials, increased exercise time was found in the patients as well (MD=0.49, 95% CI, 0.13 to 0.85) [14]. Thus, in addition to SCS being an effective method in treating patients with refractory angina, it's also important to consider that SCS can also be used to improve the quality of life of patients as shown through the increased exercise time found by using SCS.

Furthermore, as mentioned before in regards to the increased duration of exercise found through the use of SCS for patients suffering from refractory angina, another particular study found through 518 patients whose mean age was 66.8 years with 68.5% of the participants being male, that both exercise duration and exercise capacity increased [15]. Increased exercise duration (1.90 min, 95% CI 1.71, 2.06) as well as less angina episodes daily (95% CI -1.75, -1.33) were found through the use of SCS as well [15]. Therefore, it's clear that SCS can be used as an adjunct therapy to the use of medical management, but also, it's important to understand that SCS not only helps to decrease the rate of angina episodes daily, but also, helps to overall increase the quality of life for patients [15,16].

## Conclusion

With the growing number of patients suffering from refractory angina, patient care and practice needs to be better studied to improve overall outcomes for these individuals. In this particular review, we were able to outline how neuromodulation therapies have shown promising early results to help patients suffering from refractory angina. In specific, Transcutaneous Electrical Nerve Stimulation (TENS) and Spinal Cord Stimulation (SCS) have shown to improve patient care, but also, overall quality of life. In addition to these two neuromodulation therapies, Stellate Ganglion Block (SGB), although not directly considered a neuromodulation therapy, has shown promising results as well. Overall, it's important to note that although early results of these neuromodulation therapies were promising, the overall patient populations who have underwent neuromodulation therapies to treat their refractory angina is small. Therefore, through more trials and larger patient population sizes,

these neuromodulation therapies can be further supported through data about their usefulness and success.

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