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## Key Concepts

- Implantation after a successful trial, like SCS, can be performed in either a percutaneous or surgical fashion.
- There are advantages to each approach, which should be considered carefully in light of the specific clinical scenario and should be reviewed with the candidate.

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## Introduction

If the trial is successful, the second stage involves insertion of a permanent electrode. This electrode is anchored in place, usually to the underlying fascia. Subsequently, the electrode lead or an appropriate extension cable is connected to an implantable pulse generator (IPG)/battery via a tunneling procedure.

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## Percutaneous

Historically, PNS electrode leads were implanted surgically via an open technique to better visualize deeper anatomical structures, such as nerves and blood vessels, proximate to the more superficial nerves being treated. However risks, such as perineural scarring, made the open approach problematic historically. More recently, introduction of ultrasound guidance has gained favor, allowing minimally invasive access for accurate percutaneous electrode insertion. Because of the variable course and depth of the nerves to be stimulated, as well as the proximity of nerves to blood

vessels, ultrasound guidance has become very helpful to differentiate pertinent structures and to allow for safe placement of electrodes.

Currently, percutaneous electrode leads are usually selected for several reasons: (1) when the nerve of interest is to be found in a predictable anatomical area, whereby stimulation is deliverable without direct contact with the nerve, and (2) when the painful area may require coverage with multiple leads, whereby stimulating paresthesias are concordant with the pain distribution. Generally, percutaneous placement dominates the field of PNS.

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## Surgical

Some neuromodulators still use surgically placed paddle leads for PNS because of several important benefits:

1. Paddle electrodes have several rows of electrode contacts separated by a preset distance, which allows for multiple stimulation paradigms in the longitudinal, transverse, and oblique directions. Thus, electrode contact configuration parallels the course of sensory fibers inside the nerve trunk and allows for more precise targeting and programming.
2. Paddle electrodes are flat and offer unidirectional stimulation, directing electrical energy toward the nerve while shielding the surrounding tissue via insulation of the paddle's backing, leading to more efficient use of energy, which maintains battery life of the IPG.
3. Paddle electrodes are more stable over time and are associated with lower migration rates.

The most important requirement in selecting the surgical approach over percutaneous approach is the need for highly refined surgical skills, which allows better exposure of peripheral nerves, since multiple reports of perineural fibrosis following long-term PNS therapy with paddle leads have raised concerns about their safety and appropriateness of this approach in future applications.

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## Suggested Reading

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