Original Article

Sacral Nerve Stimulation Results may be Improved by Electrodiagnostic Techniques

J. T. Benson
Indiana University/Methodist Hospital, Indianapolis, Indiana, USA

Abstract: Sacral nerve electrical stimulation (sacral neuromodulation) therapy for patients with refractory urge incontinence, frequency and urgency, and non-obstructive retention yields an effective 75%–80% success rate. Electrodes are surgically implanted if initial percutaneous stimulation testing has a successful clinical response. Unfortunately, up to 50% of patients are denied surgical implantation because of an unsuccessful response to the test stimulation. In this descriptive study, adding electrodiagnostic monitoring to the currently used biological monitoring techniques was associated with a reduction in the number of tested patients denied implantation to 20%. These findings suggest that the incorporation of electrodiagnostic techniques may improve the clinical efficacy of sacral stimulation therapy. Randomized prospective testing of this hypothesis is suggested.

Keywords: Electrodiagnosis; Implantable pulse generator; Nerve conduction study; Sacral neuromodulation

Introduction

Sacral neuromodulation is a new surgical treatment option for the management of urge incontinence, urgency and frequency, and non-obstructive urinary retention [1,2]. The hypothesis of pathophysiology is that the patient shares a dysfunction in the normal patterns of sacrospinal and sacrosubspinal reflexes governing the coordination of bladder, sphincter and pelvic floor activity. The observation by Schmidt and Tanagho that afferent stimulation of the sacral nerves via an electrical implant can inhibit inappropriate neural reflex behavior [3] has led to the rationale for neuromodulation therapy. The first clinical program for sacral nerve stimulation techniques was developed at the University of California at San Francisco in 1981 [4]. The therapy is reserved for patients failing standard behavioral modification and pharmaceutical treatments. It consists of implantation of a lead containing four electrodes adjacent to a sacral nerve (usually S3). The lead is sewn in place to the sacral periosteum and is connected by a subcutaneous extension to a pulse generator implanted at a subcutaneous site (Fig. 1). The pulse generator transmits electrical pulses into the sacral nerve through electrodes at the end of the lead.

Correspondence and offprint requests to: J. T. Benson, 1633 N. Capitol, Indianapolis, Indiana, 46202, USA.

Fig. 1. The implanted sacral stimulation lead, connection and impulse generator.
Randomized, prospective multicenter clinical trials using the Interstim Sacral Nerve Stimulation System (Medtronic Inc., Minneapolis, MN) for sacral neuromodulation were begun in 1990 for urge incontinence. The encouraging results (Table 1) led to clearance for market release in Europe in 1994 and Food and Drug Administration (FDA) approval for the United States in September 1997. The procedure has now received FDA approval for the indications of voiding difficulty (retention) and urinary frequency.

Before surgically implanting the system, initial testing is performed to determine whether the patient is a suitable candidate for the procedure. This is done by delivering a stimulating electrode to the sacral nerve via a percutaneous lead under local anesthesia in an office procedure. The lead is taped in place and connected to an external test stimulator. Only patients with a successful response (at least 50% improvement in leaking or voiding variables) are candidates for the surgical implant.

Unfortunately, reported series show failure to improve with test stimulations reaching 50%. Thus, half the patients are denied implantation therapy. Both those who improve with the test stimulation and those who fail to improve have similar voiding diaries, and neither gender, patient age, history nor diagnosis were predictors of success or failure in sacral stimulation testing [5].

The failure of many of the patients with the test stimulation was shown to be technical, related to electrode position. Ten patients who had had no improvement in incontinence variables when tested by percutaneous electrode placement were subsequently tested by surgically implanting the electrode and connecting it to an external stimulator: 8 had an improvement and an internal stimulator was then implanted a two-stage implant technique [6]. Thus the failure of satisfactory clinical response to the test stimulation is shown to be due to electrode positioning [7].

The sacral nerve selected for stimulation testing and the location of the stimulating electrode relative to the nerve is currently monitored by biological motor and sensory responses. An electrodagnostic technique may be applied to the test stimulation to provide objective monitoring in addition to the biological monitoring. The technique used is a motor nerve conduction, in which an electrical depolarization of the appropriate sacral nerve creates a response in the urethral skeletal musculature. In this descriptive study the electrodagnostic technique was used in addition to the standard biological monitoring to see whether the selection of the sacral nerve for stimulation and the location of the stimulating electrode could be improved and thereby improve the outcome of the test stimulations.

### Materials and Methods

The first 15 patients deemed appropriate for sacral neuromodulation constituted the study group. All had urge incontinence or frequency/urgency and had failed standard behavioral modification and/or pharmaceutical therapies. A complete medical history and physical examination, upper urinary tract evaluation and urodynamics were performed. Voiding diaries documenting frequency, urgency, incontinent episodes, severity of episodes and pad usage were used as a baseline to compare against test stimulation results.

The test stimulation was performed in an office setting. The patients were placed prone, sacral landmarks outlined, the skin and sacral periosteal areas injected with local anesthetic agent, and an insulated foramen needle introduced into the sacral foramen (Fig. 2). A connection from the EMG stimulator was applied to the foramen needle, the nerve was stimulated and the response observed (Table 2). The motor responses are biological markers depending on contraction of the levator ani muscles and toe flexion. The responses were recorded without objective measurements. The patient was asked to describe the location of sensory responses and these were recorded.

The electrodagnostic response was monitored by ring electrodes located on a Foley catheter which had been inserted into the urethra (Fig. 3). The response obtained is called a compound muscle action potential (CMAP) (Fig. 4). The latency and amplitude of the CMAP and the

![Fig. 2. Foramen needle introduced into a sacral foramen.](image)