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A review of sacral nerve stimulation parameters used in the treatment of faecal incontinence

Liam A. Devane [a], Judith Evers [a], James F.X. Jones [a], P. Ronan O'Connell [a,b,*]

[a] School of Medicine and Medical Sciences, University College Dublin, Belfield, Dublin 4, Ireland
[b] Centre for Colorectal Disease, St. Vincent's University Hospital, Elm Park, Dublin 4, Ireland

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ABSTRACT

Sacral nerve stimulation (SNS) was originally developed in the field of urinary incontinence. Without adaptation, it was subsequently applied to treat faecal incontinence. SNS has now become a first line therapy for this socially disabling condition, however the mechanism of action is unknown. This review examines the evidence for stimulation parameters currently used for SNS in humans and considers the potential electrophysiological effects of changing these parameters. However, without a proper understanding of the physiology of SNS, changing stimulation parameters remains empirical.

Introduction

Sacral nerve stimulation (SNS) originates from studies by Brindley[1] and Tanagho[2] in the 1970s. In spinalized animals, they elicited bladder voiding via sacral ventral root stimulation. A similar approach was then used in humans with spinal cord injuries to assist bladder emptying[3,4] and later defaecation.[5] The high voltages used in these patients would be painful in sensate, spinally-intact individuals. Treatment was adapted for patients with non-neurogenic bladder dysfunction using lower voltage stimulation[4] and subsequently a percutaneous technique of electrode insertion was developed.[6,7]

While studying the physiological changes occasioned by SNS, Matzel noticed an increase in anal canal pressures in patients undergoing treatment of urinary dysfunction.[8] He subsequently reported use of SNS in treatment of faecal incontinence (FI) in three patients, all of whom improved.[9] SNS has since become a first line treatment in patients with socially disabling FI.[10] The mechanism by which SNS modulates anorectal physiology to improve function is unknown. The long term success rate of SNS in treatment of FI is only 54% on an intention-to-treat basis.[11] This lack of understanding of the underlying modulatory mechanisms makes it difficult to objectively identify patients most likely to achieve a satisfactory clinical response to what is an invasive and expensive intervention.

* *Corresponding author*. Surgical Professorial Unit, St Vincent's University Hospital, Elm Park, Dublin 4, Ireland. Tel.: +353 1 2215124.
E-mail addresses: liam.devane@ucd.ie (L.A. Devane), judith.evers@ucdconnect.ie (J. Evers), james.jones@ucd.ie (J.F.X. Jones), ronan.oconnell@ucd.ie (P. Ronan O'Connell).
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Early treatments in cases of spinal cord injury focused on coordinating sphincter activity with bladder and bowel contractions to gain continence.[3–5] Targeting sphincteric motor response with SNS was also used in patients without spinal cord injury to treat FI. The stimulation parameters were originally optimised to directly increase anal closure pressure by chronic, stimulation-induced transformation of fatigable fast-twitch muscle fibres to fatigue resistant slow-twitch fibres.[12] The voltage used has changed over time and SNS is now administered below the motor threshold.[13] The current hypothesis is that SNS has a more complex mechanism of action than simply increasing neuromuscular function. Some groups think that efficacy involves modulation of afferent fibres rather than increasing motor discharge to the sphincteric muscles.[14–16] Notwithstanding this view, implantation and stimulation parameters continue to be directed towards optimal stimulation of sphincteric muscle to increase tone but without causing fatigue. If however, afferent nerve fibres are the more important target of SNS, parameters tailored to optimally stimulate these fibres may improve clinical success rates.

The aim of this review is to examine the evidence supporting currently used SNS parameters for the treatment of FI. These may be divided into 3 components: electrode position, electrical parameters and stimulation duration. The potential electrophysiological effect of changing each parameter is discussed and the literature reviewed for studies concerning these changes.

Search strategy

A review of the literature was performed for articles on the development of SNS parameters and studies concerning changes to these parameters. Searches of Medline and Embase were performed using combinations of the following terms: 'faecal, fecal, anal, incontinence', 'sacral nerve stimulation', 'sacral neuromodulation'. Further articles were identified by searching reference lists of relevant papers and reviews. Clinical studies included in this review are presented in Table 1.

Electrode position

Sacral nerve root selection

The third sacral nerve root (S3) was chosen in early treatment of spinally injured patients as stimulation showed the greatest muscular response in the perineum and sphincters.[7] S3 is still the most commonly used root.[13,17,18] During peripheral nerve evaluation (PNE), electrodes are placed unilaterally into the S2, S3 and S4 sacral foramina. The most effective nerve root in eliciting a motor response (a bellows-like contraction of the anus and plantar flexion of the hallux) at the lowest stimulation voltage is chosen. Lead insertion under local anaesthesia has become more popular with reports of

Table 1 – Details of clinical studies in review.

	First author	Year	Study type	No. of patients	Parameter studied
Electrode insertion	Mitchell	2011	RCS	111	LA vs GA lead insertion
	Talwar	2011	PCS	57	LA vs GA lead insertion
	Huang	1997	PCS	114	Pudendal afferent fibre anatomy
	Dudding	2008	RCS	81	Predictive factors for SNS success
	Hamdy	1999	PCS	8	Pudendal efferent fibre anatomy
	Matzel	2002	CR	1	Bilateral SNS
	Melenhorst	2007	CS	100	SNS outcomes
	Pham	2008	RCS	124	Uni- vs bilateral SNS (Urology)
	Scheepens	2002	Rz, Cr	33	Uni- vs bilateral SNS (Urology)
	Duelund-Jakobsen	2013	Rz, Cr	30	Uni- vs bilateral SNS (FI)
Electrical parameters	Tanagho	1989	CS	22	SNS in neurogenic bladder
	Matzel	1990	CR	1	SNS frequency
	Dudding	2009	PCS	12	SNS frequency
	Duelund-Jakobsen	2012	DB, Rz, Cr	15	SNS frequency
	Blok	2006	PCS	19	SNS effect on cortical activation
	Malaguti	2003	PCS	24	SNS effect on somatosensory EPs
	Finazzi-Agro	2009	PCS	24	SNS effect on somatosensory EPs
	Matzel	1995	CS	3	Effectiveness of SNS for FI
	Vaizey	1999	CS	12	Effectiveness of SNS for FI
	Koch	2005	PCS	8	SNS stimulation threshold
	Duelund-Jakobsen	2013	DB, Rz, Cr	19	SNS voltage
	Vaizey	2000	DB, Cr	2	Sub-sensory SNS
	Gallas	2011	PCS	200	Predictive factors for SNS success
Stimulation duration	Norderval	2013	RCS	42	Intermittent SNS
	Michelsen	2008	Rz, Cr	19	Turning off SNS at night
	de la Portilla	2014	PCS	30	PTNS outcomes
	Altomare	2013	PCS	19	Turning off SNS after 1 year
	Giannini	2013	PCS	20	Turning off SNS after 1 year

RCS, retrospective cohort study; PCS, prospective cohort study; CR, case report; CS, case series; DB, double-blind; Rz, randomized; Cr, crossover; LA, local anaesthesia; GA, general anaesthesia; SNS, Sacral Nerve Stimulation; EP, evoked potential; FI, faecal incontinence, PTNS, posterior tibial nerve stimulation.