Spinal Cord (2000) 38, 262–264

www.nature.com/sc

Short Communication

Bilateral S3 nerve stimulation, a minimally invasive alternative treatment for postoperative stress incontinence after implantation of an anterior root stimulator with posterior rhizotomy: a preliminary observation

K Everaert*,[1], A Derie[1], M Van Laere[2] and T Vandekerckhove[3]

[1]*Department of Urology, Ghent University Hospital, Ghent, Belgium;* [2]*Department of Physical Medicine and Rehabilitation, Ghent University Hospital, Ghent, Belgium;* [3]*Department of Neurosurgery, Ghent University Hospital, Ghent, Belgium*

Study design: A preliminary report.
Objectives: Urinary stress incontinence following implantation of an anterior root stimulator and a posterior rhizotomy is a rare complication which is difficult to treat. It is seen in patients with an open bladder neck (T9-L2 lesion). An artificial urinary sphincter is a possible treatment for this condition but has a higher failure rate in patients with neurogenic bladder disease and could complicate micturition.
Setting: Ghent, Belgium.
Methods: A male paraplegic patient (T9, complete lesion) aged 36 was suffering from severe urinary incontinence due to detrusor hyperreflexia. Preoperatively the bladder neck was closed on cystography. Following implantation (6/95) of an intradural anterior root stimulator with posterior rhizotomy, severe urinary stress incontinence presented. Bilateral S3 foramen leads were implanted and connected to a pulse generator.
Results: The patient has been continent with continuous stimulation of both S3 roots for 4 years, and no fatigue of the levator muscles has been seen. Preoperative urodynamics are compared to results 3 years postoperatively.
Conclusion: Bilateral S3 stimulation is a feasible and minimally invasive treatment of urinary stress incontinence following implantation of an anterior root stimulator.
Spinal Cord (2000) **38,** 262–264

Keywords: incontinence; neurogenic bladder; neurostimulation; rhizotomy

Introduction

Anterior sacral root stimulation with a posterior rhizotomy is a well established treatment for neurogenic bladder disease in complete spinal cord injury patients.[1] Posterior sacral rhizotomy in individuals with spinal cord lesions at T9-L2 level is frequently associated with severe grade 3 stress incontinence due to an open bladder neck.[2]

An artificial sphincter has been suggested as an acceptable treatment for this complication but has several disadvantages.[3–4] These include (1) a higher failure rate in patients with neurogenic bladder disease than in non-neurogenic patients; (2) the recommended placement of cuff around bladder neck in wheelchair-dependent males to avoid bulbar erosion requires more extensive surgery; and (3) possible provocation of obstructive micturition by the artificial sphincter.

A minimally invasive alternative is bilateral S3 stimulation by implantation of two foramen leads connected to a pulse generator (Medtronic Interstim, Lausanne).

Patient and methods

A 36-year-old male patient with complete T9 paraplegia following traumatic injury suffered from severe urinary incontinence requiring two to three large diapers a day. The urinary incontinence, due to detrusor hyperreflexia, was resistant to a high dose of anticholinergic therapy (oxybutinin 5×5 mg/d, oxi-

*Correspondence: K Everaert, Dept of Urology, P6 Ghent University Hospital, De Pintelaan 185, B9000 Ghent, Belgium

phencyclimine HCl 5×10 mg/d, imipramide 3×25 mg/d). Intravesical instillation with capsaicin did not help. Video-urodynamics revealed a closed bladder neck, but it was impossible to fill the bladder with more than 150 ml without the occurrence of detrusor hyperreflexia and a occult open bladder neck was probably present as can be expected in T9-L2 spinal cord lesions.[1]

Following implantation (5/95) of an intradural anterior root stimulator (Finetech-Neurocontrol, Cleveland) with an intradural posterior rhizotomy, grade 3 stress incontinence presented. Anterior root stimulation (S3 and S4 bilaterally) resulted in efficient bladder contraction and the patient emptied his bladder at completion; with S2 stimulation, a good erection was obtained and intercourse was possible with the device.

Video-urodynamics demonstrated low resting pressure of the external urethral sphincter and the bladder neck was slightly open at rest above 200 ml. Conservative treatment (imipramine, alphamimetic drugs) failed. A ring stimulator (Brindley Surgical Implants, London, UK) was offered to the patient and resulted in continence. In order to obtain continence, the ring stimulator had to be fixed to the skin for a prolonged time during the daytime, causing discomfort for the patient. Stimulation parameters (9 Hz, continuous stimulation) as advised by the manufacturer resulted in contraction of S2, S3 and S4 innervated muscles. In the long term, this was complicated with rotational and equinovarus deformity of both feet requiring surgery.

A bilateral percutaneous S3 test stimulation was performed using a Flexon wire (Davis and Geck) and connected to an external test stimulator (Medtronic Interstim, Lausanne). During this test stimulation the patient was continent for 8 days, and only big toe flexion and contraction of the pelvic floor were seen. We noted that unilateral S3 stimulation did not result in continence, and on clinical examination ipsilateral pelvic floor contraction was felt (digital rectal examination). Video-urodynamics showed that the external urethral sphincter contracted equally with unilateral and bilateral stimulation, and cystography revealed that a bilateral stimulation was necessary to lift up the bladder and close the bladder neck.

An IPG3 pulse generator (Medtronic Interstim, Lausanne) was implanted (10/96 and connected via a specially developed Y-shaped connection to two foramen leads (model 3080, Medtronic Interstim, Lausanne). Stimulation parameters were 1.5–5.3 V, 14 Hz and 220 μs with a pulse train of 90 μs and a pause of 55 μs. Using a hand programmer, the patient increased the voltage with increasing activity level and turned the stimulator off during micturition or defecation. At night the pulse generator was switched off to save battery life time. Continence is obtained for 1 year with a ring stimulator and 3 years with the neurostimulator. Some incontinence persists during strenuous activity with a full bladder as is seen in most patients following a posterior rhizotomy.

In October 1999, urodynamics were repeated. A filling cystometry demonstrated complete abolishment of detrusor hyperreflexia and a urethral sphincter resting tone of 84 to 150 cmH_2O when the IPG3 pulse generator was switched 'on' compared to 43 to 72 cmH_2O when the IPG3 pulse generator was switched 'off'. Micturition was impossible with the IPG3 pulse generator 'on' and no detrusor contraction was able to develop. After the IPG3 pulse generator was switched off micturition was easily obtained with detrusor contraction up to 53 cmH_2O. Three urethral pressure profiles with the IPG3 pulse generator 'on' and 'off' revealed respectively a mean maximal urethral pressure of 48.9 cmH_2O compared to 22.9 cmH_2O and a mean urethral closing area of 1543 cmH_2O*mm compared to 721.4 cmH_2O*mm.

Discussion

Stress incontinence is a well known complication following posterior rhizotomy due to an open bladder neck in T9-L2 paraplegic patients even when there is no preoperative bladder neck insufficiency. The diagnosis of an open bladder neck can be difficult due to detrusor hyperreflexia making appropriate filling of the bladder impossible in order to assess the bladder neck. High dose anticholinergic drug therapy (oxiphencyclimine HCl (5×10 mg/day)) failed to diagnose the open bladder neck.

The Brindley ring stimulator was an elegant solution for the urinary stress incontinence and served as a test for risk evaluation of external sphincter muscle fatigue following prolonged stimulation. The ring also stimulated the S2 root as the patient needed this setting for erectile dysfunction and the prolonged stimulation of S2–4 roots resulted in equinovarus deformity. The ring stimulator also causes some discomfort as it has to be fixed on the skin for continence and must be removed for each micturition.

A percutaneous S3 test stimulation had to be performed to evaluate continence with S3 stimulation alone (in contrast to the ring stimulator: S3, S2, S4). Bilateral S3 stimulation was effective to obtain continence, while unilateral S3 stimulation was not. Unilateral and bilateral S3 stimulation provoked a comparable external sphincter contraction on urodynamics but closure of the bladder neck necessitated bilateral stimulation. A longlasting increase in external sphincter pressure and closed bladder neck was demonstrated when the IPG3 pulse generator was switched 'on'.

Muscle fatigue might complicate the treatment but was not a problem in our patient. We suggest that intermittent use (during the day) and training with a ring stimulator for 1 year adapted the pelvic floor, and slow twitch fibers developed.[5]

Battery life with the present stimulation parameters is estimated at between 5–10 years. As the patient does not use the stimulator at night, battery life might exceed 7 years. Bilateral S3 stimulation is probably

competitive in price with an artificial sphincter with which revisions are common between 5 and 10 years after implantation.[3–4] In wheelchair patients the artificial sphincter is implanted around the bladder neck, which is more aggressive surgery, necessitating a longer hospital stay, and has a failure rate of 10% in patients with neurogenic bladder disease. We therefore believe that the ring stimulator and a percutaneous S3 test stimulator is a minimally invasive alternative to an artificial sphincter.

The ring stimulator must be used for a longer period to evaluate the risk of muscle fatigue and the bilateral S3 test stimulation to evaluate whether the effect is reproducible with bilateral S3 stimulation alone.

The more selective the stimulation, the less complications are expected. In the future bilateral S4 stimulation should be evaluated for the purpose of continence as this stimulated the pelvic floor without any toe flexion. No literature was found on this discussion.

Selective stimulation of somatic nerve fibres in sacral ventral roots, using a stimulus current above excitation threshold for larger diameter somatic fibres, but below that for small diameter parasympathetic fibres was described for the treatment of detrusor-sphincter dyssynergia (through muscle fatigue) and might be applicable to control stress incontinence using continuous stimulation by the Neurocontrol-Finetec device.[6] A modification of the Neurocontrol-Finetec controller could therefore simplify the complex situation we created but even then the battery would be extracorporal.

As micturition was impossible with the IPG3 pulse generator switched on we wonder if strong minimal invasive S3 stimulation could replace the more aggressive rhizotomy.[7] This inhibiting effect on the detrusor contraction is not easily explained through afferent neuromodulation, as theoretically a complete sacral posterior rhizotomy was performed. In the future more complex pulse generators with stronger, implantable batteries might be developed for sacral anterior root stimulators and continuous stimulation to abolish detrusor hyperreflexia.

Conclusion

Bilateral S3 root stimulation is a feasible and minimally invasive treatment for urinary stress incontinence following implantation of an anterior root stimulators. This preliminary report needs confirmation in a larger patient population.

Acknowledgements

I would like to thank Professor Brindley and Doctor Woloszko (Medtronic) for their constructive advice in the treatment of this patient.

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