Stimulation of the Neurovascular Bundle Results in Rhabdosphincter Contraction in a Proportion of Men Undergoing Radical Prostatectomy

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OBJECTIVE To use nerve conduction studies to clarify the functional innervation of the male urethral rhabdosphincter (RS). In particular, to test the hypothesis that in some men, fibers of the neurovascular bundle supply the RS. These fibers may be at risk during radical prostatectomy.

MATERIALS AND METHODS Men undergoing robot-assisted radical prostatectomy for clinically localized prostate cancer were included. Men with a history of pelvic surgery and/or radiation and/or trauma, obesity, or neurological diseases were excluded.

Nerve conduction studies were performed before and after prostate removal. The St. Mark's pudendal electrode was used for pudendal (control) stimulation. The ProPep Nerve-Monitoring System (ProPep Surgical, Austin, TX) was used to stimulate the neurovascular bundle at the level of the prostate base, mid, and apex. ProPep needle electrodes inserted into the RS were used to measure evoked compound motor action potential response. Results were only included if a valid pudendal control was elicited.

RESULTS Seventeen men in total underwent investigation. Valid measurements were obtained after initial quality control in seven. In two cases, evidence of sphincteric activation was observed, providing evidence to support neurovascular bundle innervation of the RS. In the other five patients, no intrapelvic nerve supply was demonstrated.

CONCLUSION Somatic nerve supply to the RS is variable. Direct intrapelvic supply to the RS may exist in some men. This may be one explanation as to why some patients unexpectedly develop severe urinary incontinence postoperatively despite technically satisfactory surgery. Further research is required to validate our findings. UROLOGY 87: 133–139, 2016. © 2015 Elsevier Inc.

Postprostatectomy urinary incontinence (PPI) is a devastating side effect for a significant number of men following radical prostatectomy. A meta-analysis of robotic-assisted radical prostatectomy outcomes demonstrated 12-month continence (no pad definition) rate of 84%.[1] PPI is associated with reduced quality of life[2,3] and significant economic costs.

The pathophysiology of PPI is likely multifactorial, but remains uncertain. There is some evidence that preservation of the neurovascular bundles (NVB) improves postprostatectomy continence,[4] raising the possibility that direct innervation of the rhabdosphincter (RS) by nerve fibers traveling in the NVBs has a functional role in the maintenance of urinary continence. However, this is highly contentious.[5] Although some small dissection series have described the presence of intrapelvic somatic nerves to the RS,[6-8] these are not consistently reported and the precise course and frequency of such nerves are unclear. Clarification of the neuroanatomy of urinary continence is required to inform surgical technique for the optimization of urinary continence outcomes. Given the challenging nature of gross dissection in this area,[9] and the limitations of histological methods, functional studies may provide more valuable, clinically relevant, anatomical information in this setting.

The primary aim of this study was to utilize intraoperative nerve conduction studies (NCS) to investigate the func-

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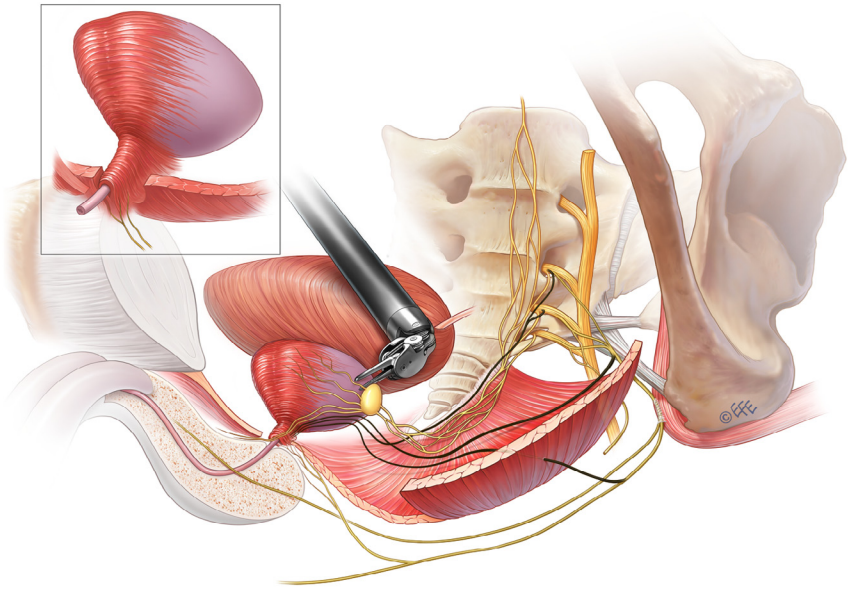

Figure 1. Innervation of the male urethral rhabdosphincter by the perineal branch of the pudendal nerve. Potential origin and course of intrapelvic somatic fibers to the rhabdosphincter illustrated in black: (1) branches directly from the sacral nerve roots, (2) early intrapelvic branch from the pudendal nerve, (3) infralevator branch of the pudendal nerve, which becomes intrapelvic by piercing the levator ani muscle. (Color version available online.)

tional innervation of the male urethral RS. In particular, we sought to investigate the hypothesis that in some men, somatic fibers take an intrapelvic course (with the NVB) to supply the RS. Based on evidence from dissection studies, we expect that intrapelvic somatic nerves to the RS may have three possible origins (Fig. 1): branches directly from the sacral nerve roots,[10] early intrapelvic branch from the pudendal nerve,[7] or infralevator branch of the pudendal nerve, which becomes intrapelvic by piercing the levator ani muscle.[11] NCS of the pudendal nerve were utilized as a control to ensure correct recording electrode placement. This was based on the assumption that the pudendal nerve provides functional innervation to the RS in all men. NCS of the NVB were performed with the aim of establishing at which level (if at all) somatic innervation to the RS travels with the NVB.

The secondary objective was to establish whether operative damage to the NVB or pudendal nerve was relevant to the development of postprostatectomy incontinence.

MATERIALS AND METHODS

This study was conducted at Epworth Hospital Richmond and Peter MacCallum Cancer Centre with institutional ethics approval. Written consent was obtained from all included patients.

Adult males who underwent robot-assisted radical prostatectomy for clinically localized prostate cancer between May and November 2014 were considered for inclusion in the study. Exclusion criteria included conditions that could potentially alter normal pelvic neurological anatomy or function. These included known neurological disorders, previous major pelvic surgery or trauma, previous or current hormonal, chemotherapy, or local radiation treatment. Men with body mass index (BMI) > 32 were excluded due to technical limitations of the St. Mark's pudendal electrode in obesity.

For the purpose of the study, sphincter innervation was defined as an appropriate RS EMG signal (evoked compound motor action potential [eCMAP]), with visual contraction of the sphincter in response to nerve stimulation. The relationship between stimulation of each nerve and sphincter response ("sphincter innervation") was classified as "influence or no influence" (binary event).

Nerve Conduction Studies

Robotic prostatectomy was performed in a standardized fashion as previously described.[12] NCS of the pudendal nerve and NVB were performed with the St. Mark's pudendal electrode and ProPep Nerve Monitoring System (specialized modified electrophysiology machine (Sierra Wave) designed for intraoperative neuromonitoring during surgery with the da Vinci Surgical System), respectively. A Cadwell adapter connected the St. Mark's pudendal electrode to the Sierra Wave (ProPep Nerve-Monitoring System, ProPep Surgical, Austin, TX). This enabled integrated testing of both nerves with one electrophysiology machine. The stimulation settings used were 10-20 mA, pulse width 200-300 μs, 3-5 Hz for pudendal stimulation, and 5-10 mA, pulse width 200-300 μs, 3-5 Hz for NVB stimulation.

NCS were performed twice during each operation—first prior to the removal of the prostate, and then again after the prostate was excised. The first study was performed immediately after suture ligation of the dorsal vascular complex. This ensured that minimum dissection had been performed to allow identification of anatomical landmarks while minimizing the potential risk of neurological trauma from further dissection. By performing the NCS again after the prostate had been excised (immediately prior to anastomosis), we aimed to assess any measurable effect of surgery on the function of these nerves. In patients undergoing a