ORIGINAL RESEARCH—ONCOLOGY

Intraoperative Cavernous Nerve Stimulation and Laser-Doppler Flowmetry during Radical Prostatectomy

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ABSTRACT

Introduction. Erectile dysfunction is a common side effect following radical prostatectomy mainly due to damage of the pelvic autonomic nerve fibers (cavernous nerves). Intraoperative electrical stimulation of the cavernous nerves while measuring changes in penile girth has previously been shown to provide the surgeon with feedback of nerve integrity.
Aim. To test the feasibility of recording changes in glans penis blood flow by Laser Doppler flowmetry from cavernous nerve stimulation.
Methods. Fifteen patients with localized prostate cancer undergoing radical prostatectomy had electrical stimulation of the proximal and distal parts of the neurovascular bundles after prostate removal. The stimulation consisted of 30–40 seconds biphasic constant current (10–30 mA) with 0.5 millisecond pulse duration.
Main Outcome Measures. Stimulus induced changes in penile blood flow was recorded from a Laser Doppler probe attached to the glans penis. Changes in penile girth were simultaneously recorded from a mercury-in rubber strain gauge. Erectile function was evaluated three months after surgery.
Results. Ten patients had stimulus induced increase in Laser Doppler flow unilaterally (N = 7) or bilaterally (N = 3). Out of 10 patients, 6 reported some preserved erectile function postoperatively at 3 months follow-up (indicating 6 true and 4 false positives). Three patients had no Doppler response from stimulation and had no postoperative erectile function postoperatively (indicating three true negatives). Two patients were excluded from the study due to bad signal quality in the Laser Doppler signal. In the majority of patients, stimulation produced increase in penile girth sensed by the strain gauge.
Conclusion. This preliminary report provides evidence that Laser Doppler Flowmetry is able to detect increased penile blood flow from intraoperative electrical stimulation of the neurovascular bundles. However, further improvement in the recording technique is required. Laser Doppler Flowmetry may also be feasible to confirm autonomic nerve sparing in women undergoing pelvic surgery. **Axelson HW, Johansson E, and Bill-Axelson A. Intraoperative cavernous nerve stimulation and Laser-Doppler flowmetry during radical prostatectomy. J Sex Med 2013;10:2842–2848.**

Key Words. Autonomic Nerve Stimulation; Genital Blood Flow; Laser Doppler Flowmetry; Radical Prostatectomy; Localized Prostate Cancer

Introduction

Radical prostatectomy (RP) is a standard curative treatment for localized prostate cancer. The most common side effect after RP is erectile dysfunction with long-term reduced quality of life for affected men up to at least 15 years [1]. The introduction of the first nerve-sparing technique by Walsh and Donker in 1982 was a major step in order to decrease erectile dysfunction in men with favorable tumor characteristics [2]. However, despite a nerve-sparing approach, post-operative erectile dysfunction is still a significant problem [3].

In order to reduce erectile dysfunction, electrical stimulation of the autonomic pelvic nerves has

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been tried in a large number of patients during RP with the aim to provide the surgeon with immediate intraoperative feedback of nerve integrity [4,5]. Stimulus-induced changes in penile blood flow have been recorded, most commonly by measuring changes in penile girth using a strain gauge (SG) around the penis. However, this method has not been widely adopted, presumably due to lack of well defined stimulus-response criteria [5]. Furthermore, pelvic surgery in women requires an alternative technique why an intraoperative method to assess autonomic nerve integrity in both genders would be desirable.

Laser Doppler flowmetry (LDF) has been used in animal- and human-based research to study genital blood flow in different contexts [6–10]. For instance, it is possible to detect changes in rabbit and dog clitoral blood from pelvic nerve stimulation [11,12]. In this study, we explored whether LDF is able to detect changes in glans penis blood flow from electrical stimulation of periprostatic autonomic nerves during RP. An underlying aim of this study was to introduce an intraoperative method that can be used in both men and women undergoing pelvic surgery.

Methods

Subjects

Fifteen patients (mean age 63, range 51–74) with localized prostate cancer and no preoperative erectile dysfunction scheduled for nerve-sparing RP were invited to participate in the study. The study was approved by the local ethics committee at Uppsala university Hospital (Dnr 2006/031) and was carried out in accordance with the Helsinki Declaration of 1975, as revised in 1983. All patients gave oral and written consent to participate. At 3 months postoperative follow-up, all patients were asked about erectile function, which was scored (0–4) according to the Erectile Hardness Scale (EHS) [13]. An EHS of 0 means no tumescence reaction. A score of 1 indicates that the penis is larger than normal, but not hard. A score of 2 means the penis is hard but not hard enough for penetration. A score of 3 means that it is hard enough for penetration but not completely hard. Finally, a score of 4 indicates that the penis is completely hard and fully rigid.

Anesthetic Regimen and Surgical Technique

Total intravenous general anesthesia was induced and maintained by propofol (20 mg/mL) and remifentanil (50 μg/mL) in all but one patient who had sevoflurane (inhalation) in combination with fentanyl (50 μg/mL). Muscle relaxation during intubation and surgery was obtained by rocuronium bromide (10 mg/mL). Intravenous fluids were kept at a minimum and noradrenalin (20 μg/mL) was given to maintain an acceptable mean arterial blood pressure according to the anesthesiological protocol for RP. All patients underwent retropubic open RP with anterior release described by Budaus et al. [14]. In contrast to the somatic nerves that are usually visible in the surgical field, the diffusely distributed autonomic nerve fibers are too small to detect. Hence, a crucial part of the nerve-sparing technique is to release the periprostatic fascia in which the nerve fibers run and collect the tissue into so-called neurovascular bundles (NVB).

Laser Doppler Flowmetry and Strain Gauge Measurements

A sterile (Sterrad®, Johnson &Johnson, Vallentuna, Sweden) LDF probe (part no. 404, Perimed, Stockholm, Sweden) was placed on the ventral part of the glans penis before skin incision. The probe was secured with Steri-strip (3M NexCare, Saint Paul, MN, USA) and the probe was covered and further held in place by preputium (if available). In brief, the technique is based on Laser light that is emitted from the probe and where the light hitting moving blood cells undergo Doppler shift sensed by the receiving part of the probe. The magnitude of the Doppler shift is related to the velocity and the number of moving blood cells. The recording depth is less than 1 mm according to the physical properties of the probe and the emitting light. The recordings do not provide absolute values of blood flow but arbitrary units correlated to the amount of flow. The probe was connected to a main unit (PeriFlux System 5001, Perimed, Järfälla, Sweden). In order to avoid pulse artifacts and record gradual changes in blood flow, a time constant was set to 0.3 seconds. The probe was reapplied if the LDF signal was noisy with random fluctuations. Stimulus-induced changes in the LDF signal was calculated by measuring the mean LDF signal strength during the stimulation period.

In addition to the LDF probe application, a sterile (Sterrad®) mercury-in-silicon SG was placed at the base of the penile shaft in order to sense changes in penile girth. The amplified LDF and SG signals were recorded through the auxiliary inputs of an EEG amplifier (ANT, Enschede, Netherlands) or from a USB digital

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