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Laser Fibre Deterioration and Loss of Power Output During Photo-Selective 80-W Potassium-Titanyl-Phosphate Laser Vaporisation of the Prostate

Thomas Hermanns [a], *Tullio Sulser* [a], *Markus Fatzer* [a], *Martin K. Baumgartner* [a], *Julien M. Rey* [b], *Markus W. Sigrist* [b], *Hans-Helge Seifert* [a,*]

[a] *Department of Urology, University of Zürich, University Hospital, Zürich, Switzerland*
[b] *ETH Zürich, Institute of Quantum Electronics, Laser Spectroscopy and Sensing Lab, Zürich, Switzerland*

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Abstract

Background: The potassium-titanyl-phosphate (KTP) laser technique for photo-selective vaporisation of the prostate (PVP) has been regularly improved over the last decade. Nonetheless, decreasing efficiency of tissue vaporisation during the course of the operation and macroscopic alterations of the laser fibre's tip are regularly observed and seem to affect the outcome of this procedure.
Objective: To investigate the course of power output and to determine the type and extent of fibre deterioration during PVP.
Design, Setting, and Participants: Forty laser fibres were investigated during PVP in 35 consecutive patients with prostatic bladder outflow obstruction between January 2007 and August 2007 in a university hospital.
Intervention: All patients underwent PVP performed by three different surgeons using the 80-W KTP laser.
Measurements: Power output was measured at the beginning and regularly throughout PVP and throughout in vitro vaporisation without fibre–tissue contact. Microscopic documentation of the fibre tip was performed after the procedure.
Results and Limitations: Carbonisation and melting of the fibre tip was regularly visible and appeared to be more pronounced as more energy was applied. Additionally, 90% of the fibres showed a significant decrease of power output during PVP, resulting in an end-of-lifespan (ie, 275-kilojoule) median power output of 20% of the initial value. Final median power output after in vitro vaporisation was 83% of the starting value. The extent of the structural and functional changes might only be valid for the operative technique performed in this investigation.
Conclusions: Fibre deterioration caused significant reduction of power output during PVP. This finding is an explanation for the often observed decreasing efficiency of tissue ablation and may also be responsible for some of the typical drawbacks and complications of PVP. Hence, improvements in fibre quality are necessary to advance the efficiency of this technique.

* Corresponding author. Urologische Klinik und Poliklinik, Universität Zürich, Universitäts-Spital, Frauenklinikstr. 10, 8091 Zürich, Switzerland. Tel. +41 44 2555405; Fax: +41 44 2554566.
E-mail address: Hans-Helge.Seifert@usz.ch (H.-H. Seifert).

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1. Introduction

Photo-selective vaporisation of the prostate (PVP) using the potassium-titanyl-phosphate (KTP) laser was introduced in the mid-1990s to treat patients suffering from obstructive symptoms caused by benign prostatic hyperplasia (BPH) [1]. Since then, substantial modifications have been made to improve this technology ([2] for recent review).

Several studies have shown that PVP is feasible and safe [3–5], but long-term results are still lacking [6]. The combination of tissue ablation and simultaneous coagulation results in a virtually bloodless operation without absorption of irrigation fluid [7]. These characteristics of the KTP laser allow for the operation of patients with high prostate volume [8], of high-risk patients [9,10], and of patients under ongoing anticoagulation treatment [11,12].

Despite these promising results, some disadvantages of PVP have also been described, including a longer operation time compared to the conventional transurethral resection (TURP) [13,14]. Furthermore, the high costs of the disposable fibres are continually under discussion [15,16]. Typical complications commonly reported for PVP are prolonged dysuria, delayed haematuria, bladder neck strictures, urinary retention, and urinary infections [3,17].

One reason for some of the disadvantages of PVP might be the quality of the laser fibre. Unlike the power generator, there have been no reports on any substantial improvements to this component. The vulnerability of the laser fibre often becomes apparent as visible alterations to its tip. Structural deterioration of the fibre might lead to scattering and impaired laser energy deposition, resulting in reduced tissue vaporisation and increased coagulation [18]. These effects, in turn, might be responsible for the often observed decreasing efficiency of tissue ablation, especially during the last third of the fibre's lifespan [19]. These alterations could result in a longer operation time and in some of the typical complications after PVP.

To the best of our knowledge, investigations concerning the loss of power output during PVP have, so far, not been performed. Therefore, we investigated a series of PVP with regard to the course of power output during treatment and associated structural changes of the laser fibre.

2. Methods

Between January 2007 and August 2007, 40 IQ™ Greenlight PV® BPH fibres (Laserscope®, San Jose, CA) were investigated during a consecutive series of PVP in 35 patients suffering from prostatic bladder outflow obstruction. Patient characteristics are summarised in Table 1a. PVP using the 80-W Greenlight PV® Laser System (Laserscope®) is the standard operative BPH treatment in our department. It was performed by two laser-experienced urologists (surgeons 1 and 2) with 300 and 150 previous operations, respectively, and one novice (surgeon 3) without PVP experience.

Table 1 – Pre- and intraoperative parameters of 35 patients

a) Preoperative	
Number of patients	35
Age (yr)	71 (47–85)
Prostate volume (ml)	50 (25–155)
BPH	32 (91.4%)
Prostate cancer	3 (8.6%)
PSA (ng/ml)	4.93 (0.48–178.4)
Residual volume (ml)	80 (0–1400)
Indwelling catheter	7 (20%)
Anticoagulation (CD/PAI)	14 (40%) (7/7)
b) Intraoperative	
Number of fibres	40
Operation time (min)	90 (60–205)
Energy applied per fibre (kJ)	237 (125–275)
Energy applied per patient (kJ)	250 (125–550)
Irrigation volume (l)	18 (9–27)

Data are presented as median (range) or number (percent); BPH = benign prostatic hyperplasia, PSA = prostate-specific antigen, CD = coumarin derivates, PAI = platelet aggregation inhibitors.

The power of the laser beam was measured after its emission from the fibre using the PS-V3104 power detector coupled to a TMP-300CE power monitor (both from Gentec-EO, Quebec, Canada; Fig. 1). Power measurements were performed at the start of the operation and regularly after the application of every 25 kilojoules (kJ) throughout the operation, resulting in 12 measurements if the maximum energy of 275 kJ was applied. The operative procedure was performed according to the technique described by Bachmann and colleagues [19]. The laser fibre was introduced into the prostatic urethra via a 25 French laser cystoscope. An automated irrigation–suction pump system (Endo Fluid Management System® Urology, Future Medical System SA, USA) and sterile saline were used for continuous irrigation. The end point of the procedure was a wide open, TURP-like cavity surrounded by capsular fibres.

After the application of every 25 kJ the fibre was withdrawn from the cystoscope. Following manual cleaning of the fibre tip with a damp gauze pad, the fibre was positioned for further measurements (Fig. 1). At the end of the operation, microscopic photo documentation of the fibre tip was performed.

A standardised set-up was designed to create consistent conditions for each measurement: (1) the measuring head was placed in a special, sterile covered box to guarantee a steady distance between the fibre and the measuring field; (2) a 2-ml syringe without its plunger was placed in a fixed position on the box to act as guiding channel for the fibres (Fig. 1); (3) a pneumatic on/off switch was constructed to standardise the laser release time for each series of measurements (Fig. 1 Insert) and was attached via an infusion tube to the footswitch adapter of the laser console; the laser was released for a