Laser therapy in dogs and humans—is there a difference?

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Objective To compare quantitatively the reduction of volume of benign prostatic hyperplasia (BPH) achieved by laser therapy in dogs and men.

Patients, materials and methods Twelve mongrels, with a mean prostatic volume of 33.4 mL, underwent transurethral laser treatment using an Nd:YAG laser with an Ultraline® fibre at 60 W power setting. The reduction in prostatic volume was assessed quantitatively 3 months after treatment using stereological methods. Forty patients (mean age 70.2 years, range 51–84) with symptomatic BPH (pre-operative mean prostate volume 46.3 mL) were treated under similar operative conditions with the same laser, power and fibre system. Their urinary performance was assessed before and 6 months after treatment using urinary flow rates, residual volume and a symptom score, and their prostatic volume and necrosis assessed using transrectal ultrasonography.

Results After laser treatment, the mean reduction in the dog prostate volume was 50% and in the patients was only 21%. The different impact was probably caused by anatomical differences between the human and dog prostate; the human prostate consists mainly of stromal tissue and the canine prostate of glandular epithelium.

Conclusions The canine model gives only an approximate guide to the extent of tissue destruction that laser treatment can achieve in men with BPH. Furthermore, tissue differences between men may also affect the response to laser treatment.

Keywords Benign prostatic hyperplasia, volume reduction, laser therapy, dog, human
The prostatic urethra was irradiated continuously with the laser beam, beginning at the bladder neck and extending to the colliculus seminalis, by gradually withdrawing the fibre. Standard cystoscopes (19.5 F) were used, with normal saline (0.9%) for intra-operative irrigation. Throughout the application of energy and for up to 5 min after completing the treatment, the temperature in the outer zones of the prostate, including the pararectal area, was measured by the temperature sensors.

Of the 12 dogs, four were killed within the first week from treatment, a further four at 4 weeks and the remaining four at 12 weeks. In those dogs killed at 12 weeks, TRUS was performed immediately after death to detect any laser-induced intra-prostatic cavities and the prostates from all the dogs were examined histologically. The extent of the necrotic zones in the prostate was quantified using stereological methods. After the prostates were fixed whole in formalin, they were cut into slices 5 mm thick with a precision slicing machine (Fig. 1). After embedding in paraffin wax, large sections were cut from each slice. The outlines of the prostate slices were drawn under direct vision using a light microscope and the zones of necrosis outlined with a fine pen. Each of the large sections thus marked was projected on to a point grid, and the total number of points counted in the necrotic zones, divided by the total number of points in the prostate, provided an undistorted estimate of the proportion by volume of necrotic tissue in the prostate.

Patients

As part of a prospective multicentre study, 40 patients (mean age 70.2 years, range 51–84) were investigated in our hospital. In all patients, the indication for laser therapy was symptomatic BPH with a significant residual urine volume. All patients underwent a thorough physical examination, including a DRE, before laser therapy. A sextant biopsy of the prostate was taken preoperatively in all patients to exclude those with prostatic carcinoma. The size of the prostate was measured preoperatively using TRUS with a biplanar 7.5 MHz head and a Kombison 530 ultrasound instrument (Kretz). The volume of the prostate was calculated from the formula: transverse dimension × anterior/posterior dimension × craniocaudal dimension × 0.52 [8]. To assess changes in urinary performance, the maximum urinary flow rate (Q_{max}) and post-void residual urine volume (PVR) were determined pre-operatively and the patients’ symptoms were assessed using the AUA-7 symptom score.

Operative technique

Laser therapy was applied as transurethral laser ablation of the prostate (TULAP), using continuous irrigation with 0.9% saline and a special 24 F laser resectoscope (Wolff, Germany) with a straight working channel. The laser beam was applied at 60 W output in continuous-wave mode. In all patients, the prostatic urethra was irradiated continuously, starting at the bladder neck at the 2, 4, 8 and 10 o’clock positions and withdrawing the fibre slowly down to the apex of the prostate (Fig. 2).
At the end of the operation, a 20 F catheter was left in place for 48 h.

All 40 patients were assessed 6 months after laser therapy and the Qmax, PVR and AUA-7 symptom score re-assessed. The total volume of the prostate was measured by TRUS and any cavities induced by laser therapy noted.

Student’s t-test was used to assess differences between pairs of means, with significance indicated at $P<0.05$.

Results

The dog model

The mean (sd) pre-operative prostatic volume in the dogs was 33.4 (±24.5) mL and the mean (sd) laser energy applied was 37.5 kJ (±17.8). The highest temperature measured in the outer zones of the prostate or between the prostate and rectum was 42.2°C. As determined stereologically, the mean (sd) proportion (by volume) occupied by areas of necrosis 3 months after treatment was 50 (±23)% (Figs. 1 and 3a).

Patients

The changes in the variables assessed in the men with BPH are shown in Table 1. In 19 patients (48%), TRUS showed a detectable intraprostatic cavity 6 months after laser therapy (Fig. 3b). The mean (sd) laser energy applied to the patients was 111.1 kJ (±54.4).

In none of the 40 patients was laser treatment followed by any serious complications such as the TUR syndrome or haemorrhage requiring blood transfusion. A urinary tract infection needing treatment occurred in 14 of the 40 patients (30%), epididymitis occurred in three (7.5%) within the first 8 weeks after laser therapy and erectile dysfunction, occurring for the first time post-operatively, was reported in one (2.5%). Four of the 40 patients (10%) subsequently underwent conventional TURP because of persistent obstruction.

Discussion

BPH in dogs is generally accepted as a model for testing methods of treating BPH in men. Previous experiments in dogs have shown that laser treatment can achieve dramatic reductions in the volume of BPH [9,10]. In the present animal experiments there was an equally impressive and substantial destruction of BPH tissue using the laser. The extent of laser-induced tissue necrosis has not been investigated quantitatively before; estimated stereologically, the prostatic tissue in the dog was shown to be reduced by half and the effect was also visible on TRUS as large intraprostatic necrotic areas.

When these results are compared with those obtained in man, there is a clear difference; although about half the present patients had a laser-induced necrotic zone detectable by TRUS 6 months after laser therapy, the necrosis was much less pronounced than it was in the dog (Fig. 3). The reduction in prostatic volume in the patients was only 21%, much less than that achievable in dogs.

This is surprising, given that the conditions of treatment were similar in both, using the same fibre system, laser and wavelength and with comparable operative techniques. The only difference was the mean laser energy applied, which was 35.5 kJ in dogs, considerably lower than the 111 kJ applied to the men. However, other studies [11,12] using the same laser system show that better functional indices can be attained in men by increasing the applied energy.

We propose that the differences between dog and man
Table 1 The changes in the variables assessed before and after TULAP

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before (mean [sd])</th>
<th>6 months after (mean [sd])</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prostatic volume (mL)</td>
<td>46.3 (± 14.3)</td>
<td>36.3 (± 12.7)</td>
<td>&lt;0.0015</td>
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</tbody>
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