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Laser prostatectomy for benign prostatic obstruction (Review)

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TABLE OF CONTENTS

[Intervention Review]

Laser prostatectomy for benign prostatic obstruction

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ABSTRACT

Background

Symptomatic benign prostatic obstruction is a common problem for older men. The gold standard treatment, transurethral resection of the prostate (TURP), significantly improves urinary symptoms and urinary flow. However, TURP has up to a 20% morbidity. Currently, there are a number of minimally invasive procedures that may be safe, effective alternatives to TURP. One promising surgical technique is laser prostatectomy.

Objectives

To assess the therapeutic efficacy and safety of laser prostatectomy techniques for treating men with symptomatic benign prostatic obstruction.

Search methods

Randomized controlled trials were identified from the Cochrane Collaboration Library, MEDLINE, EMBASE, bibliographies of retrieved articles and reviews, and contacting expert relevant trialists and laser manufacturers.

Selection criteria

All randomized controlled trials evaluating laser prostatectomy treatment for men with symptomatic BPH. Trials were eligible if they (1) were randomized comparisons of a laser technique with TURP, (2) included at least 10 men with BPO in each treatment arm, (3) provided at least 6-months follow-up, and (4) included clinical outcomes such as urologic symptom scales or urodynamic measurements.

Data collection and analysis

Data extraction and assessment of methodologic quality was performed independently by two reviewers. Information on study design, subject and treatment characteristics, adverse events, urinary symptoms, and urinary flow were extracted using a standard form.

Main results

Twenty studies involving 1898 subjects were evaluated, including 4 studies with multiple comparisons. We found eight comparisons of TURP with contact lasers, eight with non-contact lasers, four with hybrid techniques, and one with interstitial laser coagulation (ILC). Two studies compared transurethral electrovaporization (TUVP) with contact lasers, one study compared interstitial laser coagulation with transurethral microwave thermotherapy (TUMT), and one study compared holmium contact lasers (HoLRP) with open prostatectomy. Among the studies comparing laser prostatectomy with TURP, follow-up duration ranged from 6 to 36 months. Mean age (67.2 yrs), mean baseline symptom score (20.2), and mean baseline peak urinary flow (9.2 mL/s) did not differ by treatment group. The pooled percentage improvements for mean urinary symptoms ranged from 59% to 68% with lasers and 63% to 77% with TURP. The improvements for mean peak urinary flow ranged from 56% to 119% with lasers and 96% to 127% with TURP. Overall, laser subjects were less likely to receive

transfusions or develop strictures and their hospitalizations were shorter. Non-contact laser subjects were more likely to have dysuria, urinary tract infection, and retention. Re-operation occurred more often following laser procedures.

Authors' conclusions

Laser techniques are a useful alternative to TURP for treating BPO. Small sample sizes and differences in study design limit any definitive conclusions regarding the preferred type of laser technique. Data were insufficient to compare laser techniques with other minimally invasive procedures.

PLAIN LANGUAGE SUMMARY

Laser prostatectomy for benign prostatic obstruction

Bothersome lower urinary tract symptoms (LUTS) associated with benign prostatic obstruction (BPO) is a common problem for older men. LUTS can be both irritative (urgency, frequency, frequent nighttime urinations) and obstructive (weak stream, hesitancy, intermittency, and feeling the bladder is not emptied). Transurethral resection of the prostate (TURP) is considered the gold standard treatment for symptomatic BPO. TURP improves urinary symptoms and urinary flow by surgically removing prostatic tissue through the urethra. However, side effects occurring in approximately 20% of all TURPs include blood loss requiring transfusion, infections, strictures, sexual dysfunction, urinary incontinence, and urinary retention. Laser prostatectomy, which uses a laser to destroy the enlarged prostate tissue that leads to LUTS, is a minimally invasive procedure currently used as an alternative to TURP. This review of 20 studies involving 1898 subjects found laser techniques to be useful and relatively safe alternatives to TURP. The small number of enrolled subjects and differences in study design limit any definitive conclusions regarding which type of laser technique is the most effective. Improvements in LUTS and urine flow slightly favored TURP, though laser procedures had fewer side effects and shorter hospitalization times. The follow-up durations of these studies ranged from 6 to 36 months and men with extremely large prostates were generally excluded from the trials. The risk of needing a reoperation for recurrent LUTS was higher following laser procedures. Study results were insufficient to adequately compare laser techniques with other minimally invasive procedures. More studies, using randomized treatment assignment, enrolling larger numbers of subjects, and comprehensive measures of treatment effectiveness and side events, are needed to better define the long-term safety and durability of laser techniques for treating LUTS associated BPO.

BACKGROUND

Lower urinary tract symptoms (LUTS) consistent with benign prostatic obstruction (BPO) become increasingly prevalent with age. LUTS can be both irritative (urgency, frequency, nocturia) and obstructive (weak stream, hesitancy, intermittency, and incomplete emptying). By age 80, an estimated one in four men will have undergone treatment to relieve LUTS related to BPH (Barry 1990). For many years, the transurethral resection of the prostate (TURP) has been the definitive treatment for BPO. Approximately 400,000 procedures are performed annually at a total cost of $5 billion (Oesterling 1995). Although TURP has been proven to reduce symptoms of BPO and increase urinary flow compared with watchful waiting (Wasson 1995), the procedure has some limitations. The morbidity of TURP is nearly 20%, including blood loss requiring transfusion, infections, strictures, sexual dysfunction, urinary incontinence, urinary retention, and the development of the transurethral resection syndrome (Oesterling 1995; McConnell 1994; AUA 2003). Furthermore, up to 25% of patients undergoing TURP do not have satisfactory results (Lepor, 1990), and the reoperation rates is about 1% to 2% annually (Wasson 1995; Roos 1998).

In recent years a number of minimally invasive surgical techniques have been developed for treating BPH, including transurethral incision of the prostate, prostatic stents, microwave therapy, and laser prostatectomy (Lepor 1996; Jepsen 1998; Tewari 1999; Oesterling 1995). The laser techniques include visual laser ablation of the prostate, contact laser ablation, interstitial laser, transurethral evaporation of the prostate, and transurethral ultrasonic laser incision. There has been considerable interest in laser prostatectomies because preliminary data suggest that they are effective and safe treatments for BPO. Compared to TURP, laser procedures have been reported to have fewer complications, require shorter hospitalizations, and can be performed on outpatients (Oesterling 1995). However, the different laser techniques may not be comparable in efficacy, comparisons with other minimally invasive procedures are limited, and few long-term follow-up data are available. Finally, no systematic reviews and quantitative meta-analyses of these techniques have been published to evaluate safety and efficacy. Primary care physicians are increasingly becoming responsible for managing symptomatic BPO patients with behavioral and drug therapies. However, when patients are considering surgical interventions, primary care physicians should also be able to inform them of the risks and benefits of the various procedures.

OBJECTIVES

Our objective was to conduct a systematic review and, where possible, quantitative meta-analysis, of randomized controlled trials to evaluate the efficacy and safety of laser prostatectomy techniques compared to TURP in treating men with symptomatic BPO.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled trials of at least 6 months duration with or without blinding.

Types of participants

Men with symptomatic BPO as determined by urinary symptoms or scale scores with or without documented decreased urinary flow rates.

Types of interventions

Laser prostatectomy techniques reviewed included visual laser ablation of the prostate (VLAP), contact laser ablation, interstitial laser, and transurethral ultrasonic laser incision (TULIP), and transurethral evaporation of the prostate. Control interventions could include transurethral resection of the prostate (TURP), open prostatectomy, transurethral incision of the prostate (TUIP), transurethral electrovaporization of the prostate (TUVP), pharmacologic therapy, watchful waiting, electrovaporization of the prostate, prostate stents, radiofrequency transurethral needle ablation, microwave therapies, or high-intensity focused ultrasound.

Types of outcome measures

The primary clinical outcome was the efficacy of laser prostatectomy in improving urinary tract symptoms based on changes in urologic symptom scale scores (American Urologic Association (AUA) Symptom Index, International Prostate Symptom Score (IPSS), Madsen-Iversen, Boyarsky). Secondary outcomes included changes in peak and mean urinary flow. Data were recorded for 6- and/or 12-month follow-up periods. We also extracted data on operative time, hospital length of stay, catheter duration, the need for re-hospitalization or re-operation, adverse events, and perioperative mortality.

Search methods for identification of studies

We searched MEDLINE from 1966 through June 2002 using an optimally sensitive search strategy from the Cochrane Collaboration with the MeSH headings: prostatic hypertrophy, prostatectomy, prostatic hyperplasia/surgery, laser surgery, TULIP, and ELAP (Dickersin 1994). We also searched the Cochrane Library, the Prostatic Diseases and Urologic Cancers Group registry, Science Citation Index, and reference lists of all identified trials and previous reviews. The *Journal of Urology* and *Urology* were hand-searched from 1998 through June 2002. There were no language restrictions.

Data collection and analysis

Titles and abstracts of the electronic search results were evaluated by two independent reviewers. From the results of the electronic searches, bibliography searches, hand searches, and contacts with experts and manufacturers, two reviewers independently selected trials meeting previously defined inclusion criteria. Trials selected by at least one reviewer were retrieved. Two reviewers independently abstracted study characteristics and outcomes, including information on study design, subject characteristics, interventions, follow up, treatment outcomes, and adverse events. Differences were resolved by discussion among the reviewers or using an independent arbitrator. Reasons for study exclusion were documented.

Methodologic quality was assessed based on selection bias (randomization strategies), performance bias (whether those receiving care were blinded), detection bias (whether outcomes assessors were blinded to assigned therapy), attrition bias

(systematic differences between groups in losses to follow-up), clinical description of study subjects, baseline comparison of study groups, duration of follow-up, discussion of co-interventions, completeness of efficacy and morbidity data. As a measure of overall methodologic study quality we will assess the quality of concealment of treatment allocation according to a scale developed by Schulz (Schulz 1995) assigning 1 to poorest quality and 3 to best quality: 1= trials in which concealment was inadequate (e.g. such as alternation or reference to case record numbers or to dates of birth); 2 = trials in which the authors either did not report an allocation concealment approach at all or reported an approach that did not fall into one of the other categories; and 3 = trials deemed to have taken adequate measures to conceal allocation (e.g. central randomization; numbered or coded bottles or containers; drugs prepared by the pharmacy; serially numbered, opaque, sealed envelopes etc. that contained elements convincing of concealment).

Statistical methods:
We analyzed available efficacy outcomes data on intention-to-treat basis using the Cochrane Collaboration Review Manager (RevMan 4.1) software. We calculated weighted mean differences (WMD), the between-treatment difference in pooled means for outcome variables at follow-up or the pooled mean change in outcome variables between baseline and follow-up, and the 95% confidence intervals for continuous variables. A random effects model was used to allow for heterogeneity between the trials (DerSimonian 1986). Continuous variables were also evaluated by comparing differences in pooled mean scores (weighted for sample size) between baseline and follow-up measurements. We evaluated categorical events by calculating weighted relative risks and their 95% confidence intervals. The Fisher's exact test was used when cell sizes were less than 5.

RESULTS

Description of studies

The combined search strategies identified 46 reports of trials and 20? met our inclusion criteria.

LASER versus TURP (n = 18 trials)
Overall, we analyzed 19 comparisons between laser techniques and TURP because two trials each evaluated multiple laser techniques (Suvakovic 1996; Zorn 1999). We found eight comparisons of TURP with non-contact laser (Anson 1995; Costello 1995; Cowles 1995; Donovan 2000; Gujral 2000; Kabalin 1995; Sengor 1996; Suvakovic 1996), eight comparisons with contact laser (Gilling 1999; Keoghane 2000a; Mottet 1999; Shingleton 1999; Suvakovic 1996; Tuhkanen 1999a; van Melick 2003; Zorn 1999) and four comparisons with hybrid techniques (Carter 1999a; Suvakovic 1996; Tuhkanen 1999b; Zorn 1999). Two studies used holmium laser resection of the prostate (HoLRP) (Gilling 1999; Mottet 1999), the rest used neodymium yttrium-argon-garnet (Nd:YAG) lasers.

LASER versus Transurethral Electrovaporization (TUVP) (n = 2 trials)
We evaluated two comparisons of contact laser with transurethral electrovaporization (Shingleton 1999; van Melick 2002; van Melick 2003).

LASER versus Open Prostatectomy (n = 1 trial)
We evaluated one comparison between HoLRP and open prostatectomy for treatment of prostates > 100 gm (Kuntz 2002).

LASER versus Transurethral Microwave Thermotherapy (TUMT) (n = 1 trial)
We evaluated one comparison between interstitial laser coagulation and TUMT prostates > 100 gm (Norby 2002).

We excluded studies that did not present outcomes at 6 or 12 months following treatment or that reported only economic or quality-of-life outcomes data (Carter 1999b; Fraundorfer 2001; Gilling 2000; Keoghane 1996; Keoghane 2000b; McAllister 2000; Shingleton 2002; Tuhakanen 2001). We also excluded studies with less than 6 months follow up (Langley 1997), those comparing different laser regimens (high vs. low power) or techniques (coagulation or evaporation) without a sham or active control (TURP) treatment arm (Albert 1997; Beerlage 1998; Boon 1995; Breteau 1997; Bryan 1999; de la Rosette 1995; Narayan 1995; Orihuela 1995), and those providing no indication of randomization or non-randomized controlled clinical trials (Ichiyanagi 1997; Jung 1996; Kaplan 1995; Kollmorgen 1996; Matsuoka 2000; Schatzl 1997; Wada 2000).

Risk of bias in included studies

Treatment allocation concealment was adequate in seven studies (Anson 1995; Carter 1999a; Cowles 1995; Donovan 2000; Gujral 2000; Keoghane 2000a; van Melick 2003) and outcomes assessors were blinded to treatment allocation in one study (Keoghane 2000a). Nine studies reported excluding subjects in urinary retention (variably defined by a post-void residual ranging from 250 mL to 300 mL or history of being unable to void) (Carter 1999a; Costello 1995; Cowles 1995; Donovan 2000; Gilling 1999; Mottet 1999; Sengor 1996; Tuhkanen 1999a; Tuhkanen 1999b). Ten studies provided 12 or more months of follow up. The overall proportion of subjects available for follow-up ranged from 53% to 97% in studies with at 12 months of follow up and 89% to 99% in studies with less than 12 months of follow up.

Effects of interventions

LASER vs. Transurethral Resection of the Prostate (TURP)
A total of 1488 participants were randomized in the 16 trials, including 733 to TURP, 374 to non-contact laser techniques, 244 to contact laser techniques, and 137 to hybrid laser techniques. The mean age, (67.4 years, range 61 to 70.6 years), mean baseline symptom score (20.2, range 15.7 to 24.7), and the mean baseline peak urinary flow (9.5 mL/s, range 6.2 to 12.2 mL/s) did not differ by treatment group.

Operative time, hospital length-of-stay, catheter duration, and treatment failure data are shown in Table 1, Table 2, Table 3, and Table 4. Non-contact laser procedures consistently took less time than TURP, ranging from 13 to 43 minutes compared to 20 to 58 minutes (Cowles 1995; Kabalin 1995; Sengor 1996). Contact and hybrid procedures took similar or longer amounts of time than TURP, ranging from 19 to 88 minutes compared to 20 to 106 minutes for TURP. Hospital length of stay, reported by 10 studies, was significantly less following laser treatment, with differences ranging from 1 to 2 days. No study reported a shorter hospital length of stay with TURP. Duration of urinary catheter placement was significantly shorter following TURP in three non-contact studies [Anson 1995; Donovan 2000; Gujral 2000], one contact study [Tuhkanen 1999a], and one hybrid study (Tuhkanen 1999b), with differences ranging from 10 hours to 22.5 days. The duration of urinary catheter placement was significantly shorter following laser

techniques in one non-contact study (Suvakovic 1996), four contact studies (Gilling 1999; Keoghane 2000a; Suvakovic 1996; Zorn 1999), and one hybrid study (Zorn 1999). Treatment failure leading to re-operation was more likely following laser techniques (28/528) than TURP (5/537), relative risk (RR) = 5.7, 95% CI, 2.2 to 14.6.

Outcomes:
All studies found significant decreases in urinary symptoms and significant increases in peak urinary flow between baseline and follow-up for both TURP and laser techniques (Table 5; Table 6).

Non-contact lasers versus TURP
Non-contact lasers provided similar improvement in LUTS in comparison to TURP. The pooled mean symptom score for men undergoing non-contact laser techniques decreased 59% by 12 months (19 to 7.7) versus 63% (19.3 to 7.1) in the men undergoing TURP. Weighted mean differences between treatments varied depending upon whether studies reported mean changes or mean values at follow up. The WMD for 3 studies reporting mean changes in urinary symptom scores was - 2.47 points (95% CI, -4.24 to -0.70) significantly favoring TURP (Cowles 1995; Donovan 2000; Gujral 2000) (figure 01.01). For the 4 studies reporting only the mean urinary symptom scores at follow-up, and the WMD was 0.21 (95% CI, -2.28, 2.70) favoring laser [Anson 1995; Kabalin 1995; Sengor 1996; Suvakovic 1996] (Analysis 1.2).

TURP led to greater improvement in urinary flow in three comparisons with non-contact laser, ranging from 1.6 mL to 6.4 mL/s higher at follow up (Anson 1995; Donovan 2000; Sengor 1996). The pooled mean peak urinary flow for men undergoing non-contact laser techniques increased 56% (10.1 to 15.8 mL/s) versus 96% (9.8 mL to 19.2 mL/s) in men undergoing TURP. Three studies reported mean changes in peak urinary flow, the WMD was 3.18 mL/s (95% CI, 1.47 to 4.89) significantly favoring TURP (Cowles 1995; Donovan 2000; Gujral 2000) (Analysis 1.3). Four other studies reported mean peak urinary flow data at follow-up, the WMD was 2.64 (95% CI, 0.53 to 4.75) favoring TURP (Anson 1995; Kabalin 1995; Sengor 1996; Suvakovic 1996) (Analysis 1.4).

Contact lasers versus TURP
We evaluated Nd:YAG and HoLRP separately because of their different tissue effects; NdYAG lasers vaporize tissue while HoLRP lasers vaporize and excise tissue. In three comparisons with Nd:YAG lasers, TURP led to greater improvement in symptoms, ranging from 2.9 to 4.0 points lower at follow up (Keoghane 2000a; Shingleton 1999; Suvakovic 1996; Tuhkanen 1999b; van Melick 2003; Zorn 1999). The pooled mean symptom score for men undergoing Nd:YAG contact laser treatments decreased 66% by 12 months (22.4 to 7.7) versus 78% (20.5 to 4.5) for men undergoing TURP (Keoghane 2000a; Shingleton 1999; Suvakovic 1996; Tuhkanen 1999b; van Melick 2003; Zorn 1999). Three Nd:YAG studies reported mean urinary symptom scores at follow-up, the weighted mean difference for Nd:YAG contact lasers versus TURP was -2.08 points (95% CI, -4.51 to 0.36) favoring TURP (Keoghane 2000a; Suvakovic 1996; van Melick 2003) (Analysis 2.1). There were no differences in symptom scores between men treated with HoLRP versus TURP. The pooled mean symptom score for men undergoing HoLRP laser treatments decreased by 79% (21.4 to 4.5) versus 81% (23.1 to 4.4) for men undergoing TURP (Gilling 1999; Mottet 1999). The weighted mean difference for HoLRP versus TURP was 0.10 points (95% CI, -1.88 to 2.08), favoring laser (Gilling 1999) (Analysis 2.1).

None of the Nd:YAG laser studies found statistically significant differences between treatments in improving peak urinary flow. The pooled mean peak urinary flow for men undergoing Nd:YAG laser treatments increased by 85% (10.0 mL/s to 18.5 mL/s) versus 125% (9.6 mL/s to 21.6 mL/s) in men undergoing TURP (Keoghane 2000a; Shingleton 1999; Suvakovic 1996; Tuhkanen 1999b; van Melick 2003; Zorn 1999). Five Nd:YAG studies reported peak urinary flow at follow up, the weighted mean difference for lasers versus TURP was 1.72 mL/s (95% CI, -0.32 to 3.76) favoring TURP (Keoghane 2000a; Shingleton 1999; Suvakovic 1996; Tuhkanen 1999b; van Melick 2003) (Analysis 2.2). For men undergoing Ho:YAG treatment, peak urinary flow increased by 175% (8.8 mL/s to 24.2 mL/s) versus 128% (8.8 mL/s to 20.1 mL/s) in men undergoing TURP (Gilling 1999; Mottet 1999). One HoLRP study reported peak urinary flow at follow up and the weighted mean difference favored HoLRP (-4.80 mL/s, 95% CI -8.79 to -0.81) (Gilling 1999) (Analysis 2.2).

Hybrid lasers versus TURP
The pooled mean symptom score for men undergoing hybrid laser techniques decreased 67% by 12 months (20.5 to 6.8) versus 71% (20.3 to 5.8) in men undergoing TURP. TURP led to significantly better improvement in symptoms than hybrid laser techniques in one study (Zorn 1999). No studies provided data on mean urinary symptom scores at follow up.

The pooled mean peak urinary flow for men undergoing hybrid laser techniques increased 109% by 12 months (9.3 mL/s to 19.1 mL/s) versus 107% (9.9 mL/s to 20.5 mL/s) in men undergoing TURP. Three studies reported mean peak urinary flow at follow up, the weighted mean difference for hybrid lasers versus TURP was 1.53 (95% CI, -1.13 to 4.19) favoring TURP (Analysis 3.1) (Carter 1999a; Suvakovic 1996; Tuhkanen 1999b).

Adverse events (Analysis 4.1; Analysis 4.2; Analysis 4.3; Analysis 4.4; Analysis 4.5):
Most trials did not comprehensively report adverse events. The frequencies of adverse events associated with TURP and laser techniques are shown in Table 4. Overall, subjects undergoing laser techniques had less morbidity and fewer complications. More men undergoing TURP required transfusions (6.7%, 49/735 subjects vs. < 1% 2/720; RR = 24, 95% CI 5.9 to 98) and developed strictures (8.2%, 43/527 vs. 3.8%, 20/520; RR = 2.1, 95% CI 1.3 to 3.6) than men receiving any laser procedure.

We found no differences between TURP and laser groups in erectile dysfunction, retrograde ejaculation, TURP syndrome, epididymitis/orchitis, clot retention, or urinary incontinence. However, urinary retention was more common following laser techniques (RR = 2.4, 95% CI 1.5 to 3.9) and non-contact laser techniques caused more dysuria than TURP (RR = 3.6, 95% CI, 1.0 to 13.1). No treatment-related deaths were reported, though one patient died of a myocardial infarction eight days after uncomplicated HoLRP (Gilling 1999).

CONTACT LASER versus Transurethral Electrovaporization (TUVP) (n = 2 trials)
A total of 122 subjects were randomized in two trials of Nd:Yag contact lasers (n = 56) versus transurethral electrovaporization (TUVP) (n = 66) (Shingleton 1998; van Melick 2003). Van Melick and colleagues reported similar operative times for the two procedures, 58 minutes for contact laser compared with 50 minutes for electrovaporization, and similar hospital length of stay, 3.8 versus 3.4 days, respectively (van Melick 2003). Neither study reported on

catheter duration; Van Melick and colleagues reported one (2%) reoperation during six months follow up after contact laser and 2 (4%) reoperations following electrovaporization.

Both treatments were equally effective for relieving BPO symptoms and improving urinary flow. The contact lasers reduced pooled mean symptom scores by 67% (18.9 to 6.3) at 6-month follow up while the TUEV reduced symptom scores by 68% (20.8 to 6.6). Pooled mean peak urinary flow increased 106% (10.9 mL/s to 22.5 mL/s) following contact laser and 104% (10.0 to 20.4 mL/s) following TUVP.

Urinary retention developed following 8 (14.3%) contact laser procedures and 1 (1.5%) TUVP procedure. Shingleton and colleagues reported 1 stricture following contact laser and one following TUVP; new erectile dysfunction was reported in 9% and 10% of laser and TUVP subjects, respectively, who had normal function at baseline (Shingleton 1998). Van Melick and colleagues reported 2 (4.3%) cases of clot retention following TUVP; no clot retention developed following contact laser and neither group required transfusions (van Melick 2003). A similar proportion (8% vs. 10%) of subjects developed urinary tract infections following contact laser and TUVP, respectively (van Melick 2003).

INTERSTITIAL LASER COAGULATION versus Transurethral Microwave Thermotherapy (TUMT) (n = 1 trial)
Norby and colleagues (Norby 2002) compared interstitial laser coagulation (n = 48) with transurethral thermotherapy (n = 46). TUMT was performed as an outpatient procedure, the median length of stay for ILC was three days. Median catheter duration was 3 days following ILC, and 7 to 14 days following TUMT, with longer catheterization required after higher energy procedures. During six months of follow up, one TUMT patient underwent reoperation for BPO compared to none in the ILC group.

Both treatments were equally effective for relieving BPO symptoms and improving urinary flow. The ILC reduced mean symptom scores by 56% (21.4 to 9.5) at 6-month follow-up while the TUMT reduced mean symptom scores by 54% (20.5 to 9.5). Mean peak urinary flow increased 59% (10.2 mL/s to 16.2 mL/s) following ILC and 45% (9.1 mL/s to 13.2 mL/s) following TURP.

Subjects undergoing ILC were twice as likely (61% vs. 30%) to develop a urinary tract infection. Urinary retention occurred in 4 (9%) subjects following ILC and 3 (7%) subjects following TUMT. One ILC subject developed a stricture, none had clot retention or urinary incontinence. One TUMT subject had clot retention, none developed a stricture or urinary incontinence. Among men with normal sexual function, 29% developed erectile dysfunction and 35% developed retrograde ejaculation following ILC. The corresponding proportions were 9% and 22%, respectively, following TUMT.

CONTACT LASER versus Open Prostatectomy (n = 1 trial)
One study (Kuntz 2002) compared HoLRP (n = 60) with open prostatectomy (n = 60) to treat men with large prostates (> 100 gm) with PVR > 50 mL. Operative time was significantly longer with HoLRP (136 vs. 91 minutes, P < 0.0001), while hospital length of stay was significantly longer with open prostatectomy (251 vs. 70 hours, P < 0.0001) as was catheter duration (194 vs. 31 hours, P < 0.0001). During follow up, six laser subjects underwent reoperation, two for BPO, three for bleeding, and one for stricture. Following open prostatectomy, reoperation was required by three subjects for bleeding and by two subjects for strictures.

Both treatments were equally effective for BPO resulting from large prostates. The HoLRP reduced mean symptom scores by 89% (22.1 to 2.4) at 6-month follow up while the open prostatectomy reduced mean symptom scores by 87% (21.1 to 2.8). Mean peak urinary flow increased from 3.8 mL/s to 29.9 mL/s following HoLRP and 3.6 mL/s to 27.0 mL/s following open prostatectomy. The baseline PUF values for this study were markedly low.

Eight (13%) subjects required transfusion following open prostatectomy compared to none of the HoLRP subjects. Six (10%) subjects developed urinary incontinence following open prostatectomy compared to five (8%) of the HoLRP subjects. Erectile dysfunction developed in 10% of open prostatectomy and 9% of HoLRP subjects with normal baseline erectile function; 79% of open prostatectomy subjects developed retrograde ejaculation compared to 70% of HoLRP subjects. Neither difference was statistically significant.

DISCUSSION

Our systematic review found that laser techniques were effective in reducing lower urinary tract symptoms attributable to BPO and in improving peak urinary flow for up to one year following surgery. Symptom scores were reduced by about 70% and urinary flow usually doubled. Urinary symptom and flow outcomes following laser surgery were generally similar to TURP, though a number of studies found significantly better results following TURP (Anson 1995; Cowles 1995; Donovan 2000; Keoghane 2000a; Shingleton 1999; Zorn 1999). Only one study found a laser technique (non-contact) more effective than TURP in improving urinary symptoms [Sengor 1996] and only one study found a laser technique (HoLRP) more effective in improving peak urinary flow (Gilling 1999). Hospital lengths of stay were shorter with laser techniques compared to TURP. The operating time for TURP was about the same or shorter than for contact procedures, but TURP took longer than non-contact procedures. Contact laser procedures had the shortest duration of urinary catheter placement followed by TURP and then non-contact laser procedures. Adverse events generally occurred less frequently with laser techniques, particularly transfusion, clot retention, strictures, and TUR syndrome. The occurrence of urinary tract infections was similar between laser techniques and TURP, but non-contact procedures led to a substantially higher occurrence of dysuria than either TURP or contact laser procedures. The re-operation rate was higher during the 12 months following laser techniques than with TURP.

Baseline characteristics, including age, symptoms, and flow measures, were similar to subjects enrolled in other surgical studies of BPO treatment suggesting that our results are generalizable. The average age of study subjects was 67 years and baseline symptom and urinary flow measures were consistent with moderately severe obstruction. However, men with extremely large prostates or acute retention were generally excluded.

Although we limited our analysis to randomized controlled trials, the majority of the studies had potential methodologic flaws. Just seven studies clearly had adequate concealment of randomization and only one study blinded study personnel. Studies did not consistently report comprehensive information on

efficacy outcomes and adverse events, particularly dysuria and erectile dysfunction, and our estimates for these events may be unreliable. Only three studies, which used non-contact techniques, reported data on the mean changes in urinary symptom scores and peak urinary flow; just 11 studies reported mean values for these outcomes at follow up. Consequently, we were often unable to pool data, limiting our ability to statistically assess the relative efficacy of laser techniques versus TURP, open prostatectomy, and other kinds of minimally invasive techniques. Several studies provided follow up beyond one year, but outcome data were unreliable because sample sizes were small and the rates of attrition were high (Keoghane 1996; Gilling 2000; McAllister 2000; Shingleton 2002; Tuhakanen 2001). There were too few studies to determine whether variations in laser energy source, power setting, laser wavelength, or treatment duration and location affected outcomes. Similarly, there were too few studies to adequately compare laser techniques with other minimally invasive procedures such as TUMT or TUVP.

AUTHORS' CONCLUSIONS

Implications for practice

Patients and providers can use the information provided by this systematic review to weigh the relative risks and benefits of TURP and laser procedures. Improvements in urinary symptoms and flow slightly favored TURP, though laser procedures had fewer adverse events and shorter hospitalizations. The risk of re-operation was higher following laser procedures. Data were insufficient to adequately compare laser techniques with other minimally invasive procedures.

Implications for research

Despite the widespread use of laser procedures, relatively few subjects have been studied in controlled clinical trials. Further studies, using randomized treatment allocation, larger sample sizes, and comprehensive measures of outcomes and adverse events, are still needed to better define the role of laser techniques for treating BPO.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Anson 1995

Methods	NON- CONTACT LASER. Tissue effect: coagulation. Subjects blinded: No
Participants	N=151 men, >50 yrs old. Country/Region: UK Mean age: 68 yrs (range 52-84) Race: not stated Not available to follow-up: 29 (17%).

Anson 1995 *(Continued)*

Interventions	1. VLAP (n=76): Urolase fiber - Nd-YAG laser - settings; 60 watts, 60 spd x 4, 4 to 9 minutes per session (mps). 2. TURP (n=75). Catheter protocol: at MD discretion. Routine antibiotics (preop): at MD discretion. Mean average of follow-up: 12 months
Outcomes	American Urological Association (AUA) symptom score; peak urine flow (PUF); residual volume (RV); total voided volume (TVV); hospital length of stay; rehospitalization/re-operation; adverse events.
Notes	Inclusion criteria: candidates for surgical treatment of Bladder outflow obstruction (BOO) secondary to Benign prostatic hyperplasia (BPH).

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Carter 1999a

Methods	HYBRID LASER. Tissue effect: coagulation and vaporization. Subjects blinded: Unclear.
Participants	N=204 men. Country: UK Mean age: 67.4 years Race: not stated Not available to follow-up: 35 (17%)
Interventions	1. Hybrid laser group (n=101): KTP/Nd:YAG - a. KTP settings; 30 watts. b. Nd:YAG settings; 60 watts. 2. TURP (n=103): Catheter protocol: no Routine antibiotics (preop): yes Mean average of follow-up: 12 months
Outcomes	IPSS; PUF; prostate size; BPH-11 (symptom improvement); QoL (SF 36); tissue resected; hospital length of stay; rehospitalization/re-operation; adverse events.
Notes	Inclusion criteria: "BLUES PROTOCOL" IPSS >12 points; PUF <15 ml/s with a VV >200 ml or PUF <13 (VV 150-200) or PUF <10 (VV 100-150); RV <300 ml; BPH "severe enough to warrant an operative intervention."

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Costello 1995

Methods	NON-CONTACT LASER.

Costello 1995 *(Continued)*

	Tissue effect: coagulation. Subjects blinded: No
Participants	N=71 "evaluable" men, >50 yrs old. Country/Region: Australia Mean age: 68 yrs (range 50-88) Race: not stated Not available to follow-up: "50 patients have completed 6 months of follow-up."
Interventions	1. VLAP (n=34): Urolase fiber Nd-YAG laser - settings; 60 watts, 21.7 kJ, 60 spd x 4 for each lobe, 6.5 mps. 2. TURP (n=37). Catheter protocol: yes Routine antibiotics (preop): yes Mean average of follow-up: 6 months.
Outcomes	AUA; PUF; Mean urine flow (MUF); RV; PV; hospital length of stay; rehospitalization/re-operation; adverse events.
Notes	Inclusion criteria: "symptomatic bladder neck obstruction."

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Cowles 1995

Methods	NON-CONTACT LASER. Tissue effect: coagulation Subjects blinded: No.
Participants	N=115 men, >50 yrs old. Country/Region: USA Mean age: 66 yrs (range 50-84) Race: not stated Not available to follow-up: 3 (3%)
Interventions	1. VLAP (n=56): Urolase fiber Nd-YAG laser settings; 40 watts, 10.2 kJ, 30 spd x 2 for each lobe, 4.2 mps. 2. TURP (n=59). Catheter protocol: unclear Routine antibiotics (preop): unclear Mean average of follow-up: 12 months
Outcomes	AUA; PUF; RV; PV; QoL; global assessment; hospital length of stay; rehospitalization/re-operation; adverse events.
Notes	Inclusion criteria: "candidates for surgical treatment."

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Donovan 2000

Methods	NON-CONTACT LASER. Tissue effect: coagulation Subjects blinded: No
Participants	N=340 men. Country: UK (multicenter) Mean age: 67.0 years Race: white Not available to follow-up: 8 (2%)
Interventions	1. Laser group (n=117): Nd-YAG laser settings; 60 watts. 2. TURP (n=117): 3. CM group (n=106) Catheter protocol: no Routine antibiotics (preop): yes Median follow-up: 7.5 months
Outcomes	IPSS; PUF; RV; hospital length of stay.
Notes	Inclusion criteria: IPSS >8 points; PUF <15 ml/s

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Gilling 1998a

Methods	HoLRP STUDY. Subjects blinded: unclear Tissue effect: coagulation vs. resection/ vaporization. IRB/Human subjects approval: not reported
Participants	N=44 men, <85 yrs old. Country/Region: USA, New Zealand Mean age: 66 yrs (range 44-81). Race: not stated Not available to follow-up: ?
Interventions	1. HoLRP (n=23): settings; 60 watts, 67 kJ. 2. VLAP (Coagulation group) (n=21): Nd-YAG laser settings; 60 watts, 53 kJ, 60 spd x 4. Catheter protocol: VLAP 5 days, HoLRP 1 day. Routine antibiotics (preop): unclear Mean average of follow-up: 12 months
Outcomes	AUA; PUF; RV; PV; tissue resected; rehospitalization/re-operation; adverse events.
Notes	Inclusion criteria: AUA >8; PUF<15 ml/s; prostate sizes <100 cm."urodynamically proven BOO."

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Gilling 1999

Methods	CONTACT LASER. Tissue effect: resection/ vaporization. Subjects blinded: unclear
Participants	N=120 men, <80 yrs old. Country/Region: USA, New Zealand Mean age: 67 yrs (range 36-80). Race: not stated Not available to follow-up: 18 (15%)
Interventions	1. HoLRP (n=61): Nd-YAG laser settings; 80 watts. 2. TURP (n=59). Catheter protocol: yes Routine antibiotics (preop): unclear Mean average of follow-up: 12 months
Outcomes	AUA; PUF; RV; PV; QoL; tissue resected; hospital length of stay; rehospitalization/re-operation; adverse events.
Notes	Inclusion criteria: AUA >/=8**; PUF</=15 ml/s; RV <400 mls; with prostate sizes <100 cm.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Gujral 2000

Methods	NON-CONTACT LASER. Tissue effect: coagulation. Subjects blinded: no
Participants	N=82 men. Country: UK (multicenter) Mean age: 70.2 years Race: white Not available to follow-up: 2 (2%)
Interventions	1. VLAP (n=38): Nd-YAG laser, 2. TURP (n=44) Catheter protocol: no Routine antibiotics (preop): yes Median follow-up: 7 months
Outcomes	IPSS; PUF; RV; QoL; Hospital length of stay.
Notes	Inclusion criteria: IPSS > 8, PUF <10-15 ml/s depending on voided volume). Required acute retention or PVR > 300 ml. Prostate size < 120 ml.

Risk of bias

Gujral 2000 *(Continued)*

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Kabalin 1995

Methods	NON-CONTACT LASER. Tissue effect: coagulation. Subjects blinded: unclear
Participants	N=25 men, >50 yrs old. Country/Region: USA Mean age: 67 yrs Race: not stated Not available to follow-up: 3 (12%)
Interventions	1. VLAP (n=13): Urolase Nd-YAG laser settings; 40 watts, 11.5 kJ, 30-60 spd >/= 4, >/= 3 mps. 2. TURP (n=12). Catheter protocol: yes Routine antibiotics (preop): yes Mean follow-up: 6 months
Outcomes	AUA; PUF; RV; PV; global assessment; tissue resected; rehospitalization/re-operation; adverse events.
Notes	Inclusion criteria: AUA >6, PUF<15 ml/s; "significant voiding symptoms."

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Keoghane 2000a

Methods	CONTACT LASER. Tissue effect: coagulation and vaporization Subjects blinded: Yes
Participants	N=152 men. Country: UK Mean age: 70 years Race: not stated Not available to follow-up: 30 (20%)
Interventions	1. Contact laser "prototype" (n=76): Nd-YAG laser settings; 31 kJ. 2. TURP (n=76). Catheter protocol: no Routine antibiotics (preop): yes Mean average of follow-up: 12 months

Keoghane 2000a *(Continued)*

Outcomes	AUA-7; PUF; PV; Short Form-36 (SF-36) includes BPH Bother Score and global assessment;rehospitalization/ re-operation; adverse events.
Notes	Inclusion criteria: "all patients referred for surgical treatment of BPH."

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Kuntz 2002

Methods	CONTACT LASER. Tissue effect: vaporization/resection. Subjects blinded: No.
Participants	N=120 men. Country: Germany. Mean age: 70.2 years. Race: not stated. Not available to follow-up: 16 (13.3%)
Interventions	1. HoLRP (n=60) 80-100W. 2. Open prostatectomy (n=60). Catheter protocol: unclear Pre-op antibiotics: yes Mean follow-up: 6 months
Outcomes	AUA, PUF, RV, tissue resected, adverse events, hospital length of stay, reoperations
Notes	Prostate > 100 gm, AUA = 8, PUF = 12 mL/s, RV > 50 ml

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Mottet 1999

Methods	CONTACT LASER. Tissue effect: resection/ vaporization. Subjects blinded: Unclear
Participants	N=36 nondiabetic men, > 45 yrs old. Country/Region: France Mean age: 66 yrs (range 50-77) Race: not stated Not available to follow-up: 16 (44%) at 52 weeks.
Interventions	1. HoLRP (n=23): Nd-YAG laser settings; 60 watts, 2.4 kJ, 25 spd or 80 watts, 2.6 kJ, 30 spd. Mean energy delivered = 103.6 kJ. 2. TURP (n=13) Catheter protocol: yes Routine antibiotics (preop): not stated.

Mottet 1999 *(Continued)*

	Mean average of follow-up:
Outcomes	AUA; Madsen score; PUF; PV; catheter time; operation time; adverse events.
Notes	Inclusion criteria: AUA >13; PUF <12 ml/s; RV <250 mls; PV <60 grams.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Norby 2002

Methods	INTERSTITIAL LASER COAGULATION. Tissue effect: coagulation Subject blinded: No
Participants	N=118 men. Country: Denmark (multicenter). Mean age: 66 years Race: Not stated. Not available to follow-up: 8 (6.7%)
Interventions	1. ILC group (n=48); NdYag: 7-20W 2. TUMT (n=46): Prostatron 2.0, 2.5. 3. TURP/TUIP (n=24). Catheter protocol: yes Routine antibiotics (pre-op): yes Mean follow-up: 6 months
Outcomes	IPSS, PUF, RV, QOL, hospital length-of-stay, rehospitalization/reoperation, adverse events.
Notes	Inclusion criteria: PUF < 12 ml/s, IPSS = 7

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Sengor 1996

Methods	NON-CONTACT LASER. Tissue effect: coagulation Subjects blinded: no
Participants	N=60 men, >50 yrs old. Country/Region: Turkey Mean age: 64 yrs (range 50-85) Race: not stated Not available to follow-up: none
Interventions	1. VLAP (n=30): Ultraline fiber - Nd-YAG laser settings; 60 watts, 12.5-110 kJ (mean 46.6 kJ), x 4 positions (1 additional if median lobe enlarged) 2. TURP (n=30)

Sengor 1996 *(Continued)*

	Catheter protocol: yes Routine antibiotics (preop): not stated Mean average of follow-up: 6 months
Outcomes	AUA; PUF; MUF; PV; Hospital length of stay; Catheter time; Operation time; Adverse events.
Notes	Inclusion criteria: PUF</=15 ml/s; MUF </=10 ml/s; "significant voiding symptoms causing the patient to request therapy."

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Shingleton 1998

Methods	CONTACT LASER. Subjects blinded: Tissue effect: vaporization
Participants	N=31 men. N=31 men. Country: USA Mean age: 67 years (range 48-82) Race: not stated Not available to follow-up: unclear
Interventions	1. VLAP + KTP (n=11) Nd-YAG laser settings; 60 watts, 60 spd. KTP; 40 watts. 2. TVP (n=20): Catheter protocol: yes Routine antibiotics (preop): unclear Mean average of follow-up: 6 months
Outcomes	AUA; PUF; Adverse events.
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Shingleton 1999

Methods	CONTACT STUDY. Subjects blinded: Unclear Tissue effect:

Shingleton 1999 *(Continued)*

	vaporization IRB/Human subjects approval: unclear
Participants	N=100 > 45 yrs old. Country/Region: USA Mean age: 68 yrs Race: White 68-76%, Black 24-32% Not available to follow-up:
Interventions	1. VLAP + KTP BNI (n=50): Nd-YAG laser settings; 60 watts, 60 spd. KTP; 40 watts. 2. TURP (n=50): Catheter protocol: Routine antibiotics (preop): Mean average of follow-up: 6 months
Outcomes	AUA; PUF; MUF; Prostate size; Adverse events.
Notes	Inclusion criteria: > 45 yrs of age; PUF</=15 ml/s; failed therapy with alpha-blockers.

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Suvakovic 1996

Methods	HYBRID, CONTACT and NON-CONTACT LASERS Tissue effect: Coagulation and vaporization Subjects blinded: Unclear
Participants	N=40, > 50 yrs old. Country/Region: UK Mean age: 65 yrs Race: White
Interventions	1. VLAP (non-contact) side-fire laser (n=10): Urolase Nd-YAG laser settings; 60 watts, 60 spd x 4. 2. Contact laser group (n=10): Urolase Nd-YAG laser settings; 40 watts. 3. VLAP (non-contact) side-fire laser + debridement (n=10). 4. TURP (n=10). Catheter protocol: yes Routine antibiotics (preop): yes Mean average of follow-up: 12 months
Outcomes	AUA; PUF; Prostate size; Adverse events.
Notes	Inclusion criteria: Prostate volume < 40 cc; AUA > 15; PUF</=15 ml/s; PSA < 2.5 ng/ml.

Risk of bias

Suvakovic 1996 *(Continued)*

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Tuhkanen 1999b

Methods	CONTACT LASER. Tissue effect: coagulation and vaporization. Subjects blinded: Unclear
Participants	N=50 Country/Region: Finland Mean age: 67 (range 56-77) Race: unknown Not available to follow-up: 2 (4%)
Interventions	1. Laser group (contact and vaporization) (n=25) Nd-YAG laser settings; 40 watts. 2. TURP (n=25): Catheter protocol: no Routine antibiotics (preop): yes Mean average of follow-up: 6 months
Outcomes	Danish PSS-1; PUF; RV; Prostate size; Hospital length of stay; Rehospitalization/re-operation; Adverse events.
Notes	Inclusion criteria: Prostate volume 40-100 cc. Urodynamic evidence of obstruction; voiding detrusor pressure >40 cm H2O or slope detrusor pressure/urine flow >2 cm H20 mL/s.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Tuhkanen 1999a

Methods	HYBRID LASER. Tissue effect: coagulation and vaporization. Subjects blinded: Unclear
Participants	N=45 Country/Region: Finland Mean age: 67 (range 46-78) Race: unknown Not available to follow-up: 2 (4%)
Interventions	1. VLAP Hybrid laser group (n= 21): Nd-YAG laser settings; 40 watts, 56 kj, 90 spd for 75 minutes. 2. TURP (n=24): Catheter protocol: yes Routine antibiotics (preop): yes

Tuhkanen 1999a *(Continued)*

	Mean average of follow-up: 6 months
Outcomes	Danish PSS-1; PUF; MUF; RV; Prostate size; Rehospitalization/re-operation; Adverse events.
Notes	Inclusion criteria: Prostate volume < 40 cc. Urodynamic evidence of obstruction; voiding detrusor pressure >40 cm H2O or slope detrusor pressure/urine flow >2 cm H20 mL/s.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

van Melick 2002

Methods	CONTACT LASER. Tissue effect: vaporization. Subjects blinded: No.
Participants	N=141. Country: Netherlands. Mean age: 65.6 years Race: not stated. Not available to follow-up: 6 (4.3%)
Interventions	1. Contact laser (n=45); NdYag. 2. Electro-vaporization (n=46) 3. TURP (n=50). Catheter protocol: no Pre-op antibiotics: unclear Mean follow-up: 6 months
Outcomes	IPSS, QOL, PUF, length of stay, re-operations, adverse events
Notes	LUTS c/w BPH, Schafer obstruction score = 2.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

van Melick 2003

Methods	See van Melick 2002
Participants	
Interventions	
Outcomes	
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement

van Melick 2003 *(Continued)*

Allocation concealment?	Low risk	A - Adequate

Zorn 1999

Methods	CONTACT LASER. Tissue effect: vaporization Subjects blinded:
Participants	N=37 men, >50 years old. Country: USA Mean age: 70 years Race: not stated Not available to follow-up: 10 (27%)
Interventions	1. Contact laser ablation of the prostate [CLAP] (n=26): Nd-YAG laser, 2. TURP (n=12): Catheter protocol: no Routine antibiotics (preop): no Mean follow-up: 12 months
Outcomes	AUA; PUF; RV; hospital length of stay; catheter time; hematocrit changes; adverse events.
Notes	Inclusion criteria: AUA > 12; PUF< 15 mL/s; RV >125 mL/s

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

VLAP=Visual Laser Ablation of the Prostate
TURP=Transurethral resection of the prostate
Nd-YAG=neodymium:yttrium-aluminium-garnet-laser
HoLRP=Holmium laser resection of the prostate
spd=second pulse duration

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Albert 1997	Comparison of 2 laser techniques (coagulation vs, Vaporization) with no active control (i.e. TURP) or sham arm.
Beerlage 1998	Comparison of 2 laser coagulation techniques with no active control (i.e. TURP) or sham arm. Follow-up of de la Rosette 1995.
Boon 1995	Comparison of 2 laser coagulation techniques with no active control (i.e. TURP) or sham arm.
Breteau 1997	Comparison of 2 laser techniques (coagulation vs, Vaporization) with no active control (i.e. TURP) or sham arm.

Study	Reason for exclusion
Bryan 1999	Pilot study focusing on treatment options for BPH; no outcomes data.
Carter 1999b	Quality of life data. Follow-up of Carter 1999.
de la Rosette 1995	Comparison of 2 laser coagulation techniques with no active control (i.e. TURP) or sham arm.
Fraundorfer 2001	Economic study, follow-up to Gilling 1999.
Gilling 1998b	Comparison of 2 laser techniques (coagulation vs, Vaporization) with no active control (i.e. TURP) or sham arm.
Gilling 2000	Small sample size and/or high rate of attrition.
Ichiyanagi 1997	Non-randomized study.
Jung 1996	Non-randomized, controlled clinical trial.
Kaplan 1995	No indication of randomization.
Keoghane 1996	Small sample size and/or high rate of attrition.
Keoghane 2000b	Economic study, follow-up to Keoghane 2000a
Kollmorgen 1996	Non-randomized, controlled clinical trial.
Langley 1997	Follow-up < 6 months.
Matsuoka 2000	No indication of randomization, no control group.
McAllister 2000	Small sample size and/or high rate of attrition, follow-up to Anson.
Muschter 1995	No control group.
Narayan 1995	Comparison of 2 laser techniques (coagulation vs. evaporation) with no active control (i.e TURP) or sham arm.
Orihuela 1995	Comparison of 2 laser coagulation regimens with no active control (i.e TURP) or sham arm.
Schatzl 1997	No indication of randomization
Shingleton 2002	Small sample size and/or high rate of attrition.
Tuhakanen 2001	Small sample size and/or high rate of attrition.
Wada 2000	No indication of randomization.

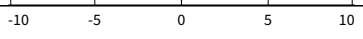
DATA AND ANALYSES

Comparison 1. Non-contact Laser versus TURP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Mean Change - AUA Symptom Score: > 6 months follow-up	3	359	Mean Difference (IV, Random, 95% CI)	-2.47 [-4.24, -0.70]
2 AUA Symptom Score:	4	236	Mean Difference (IV, Random, 95% CI)	0.21 [-2.28, 2.70]
2.1 12 months follow-up	2	157	Mean Difference (IV, Random, 95% CI)	-0.51 [-5.00, 3.97]
2.2 6 months follow-up	2	79	Mean Difference (IV, Random, 95% CI)	1.35 [-0.28, 2.97]
3 Mean Change - Peak Urine Flow (mL/s): > 6 months follow-up	3	385	Mean Difference (IV, Random, 95% CI)	3.18 [1.47, 4.89]
4 Peak Urine Flow (mL/s)	4	236	Mean Difference (IV, Random, 95% CI)	2.64 [0.53, 4.75]
4.1 12 months follow-up	2	157	Mean Difference (IV, Random, 95% CI)	3.47 [-2.78, 9.72]
4.2 6 months follow-up	2	79	Mean Difference (IV, Random, 95% CI)	1.78 [0.70, 2.86]

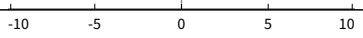
Analysis 1.1. Comparison 1 Non-contact Laser versus TURP, Outcome 1 Mean Change - AUA Symptom Score: > 6 months follow-up.

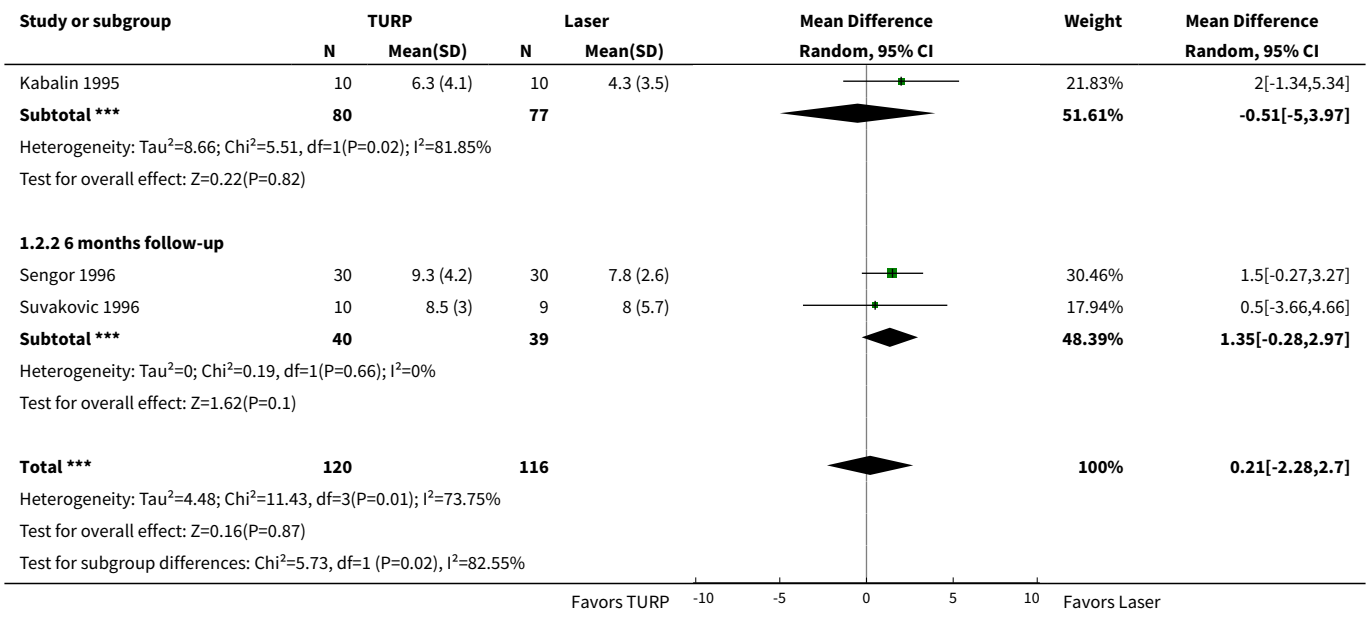
Study or subgroup	TURP N	TURP Mean(SD)	Laser N	Laser Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Cowles 1995	57	-13.3 (7.5)	55	-9 (8.9)		32.2%	-4.3[-7.35,-1.25]
Donovan 2000	89	-12.3 (7.5)	96	-10.8 (8.8)		53.34%	-1.5[-3.84,0.84]
Gujral 2000	33	-14.2 (8.8)	29	-12.2 (9.6)		14.47%	-2[-6.61,2.61]
Total ***	**179**		**180**			**100%**	**-2.47[-4.24,-0.7]**
Heterogeneity: Tau²=0.11; Chi²=2.08, df=2(P=0.35); I²=3.89%							
Test for overall effect: Z=2.74(P=0.01)							



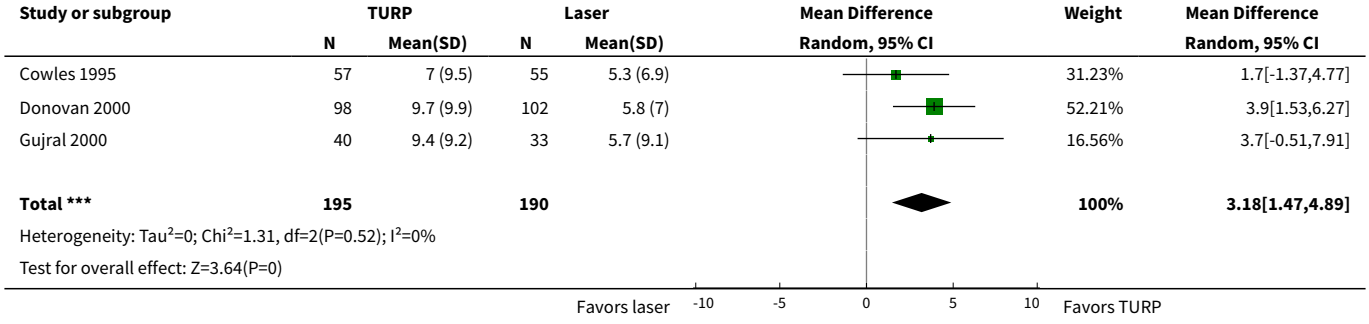
Analysis 1.2. Comparison 1 Non-contact Laser versus TURP, Outcome 2 AUA Symptom Score:.

Study or subgroup	TURP N	TURP Mean(SD)	Laser N	Laser Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
1.2.1 12 months follow-up							
Anson 1995	70	5.1 (5.5)	67	7.7 (5.8)		29.78%	-2.6[-4.49,-0.71]

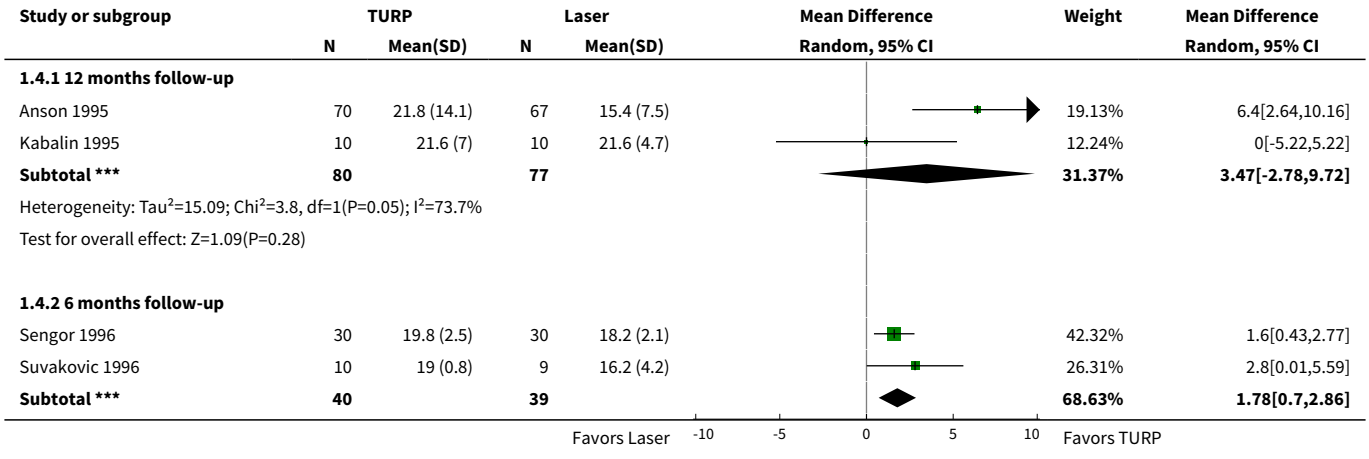


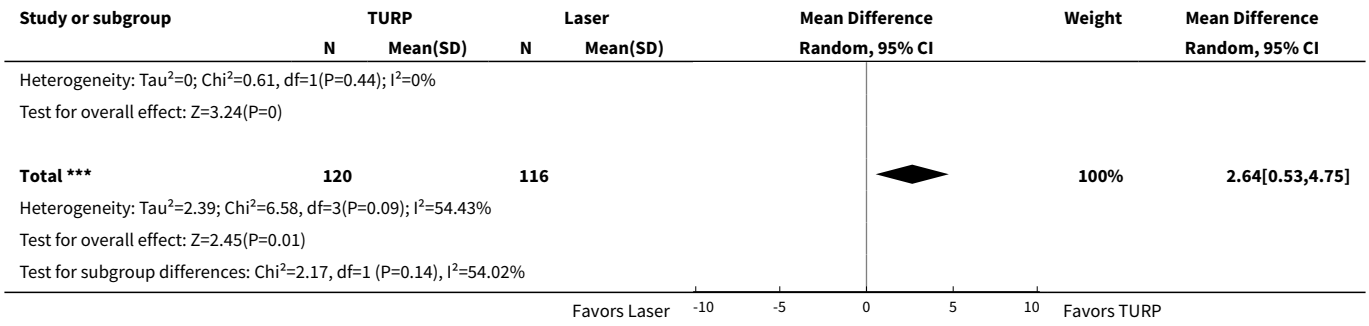


Analysis 1.3. Comparison 1 Non-contact Laser versus TURP, Outcome 3 Mean Change - Peak Urine Flow (mL/s): > 6 months follow-up.



Analysis 1.4. Comparison 1 Non-contact Laser versus TURP, Outcome 4 Peak Urine Flow (mL/s).

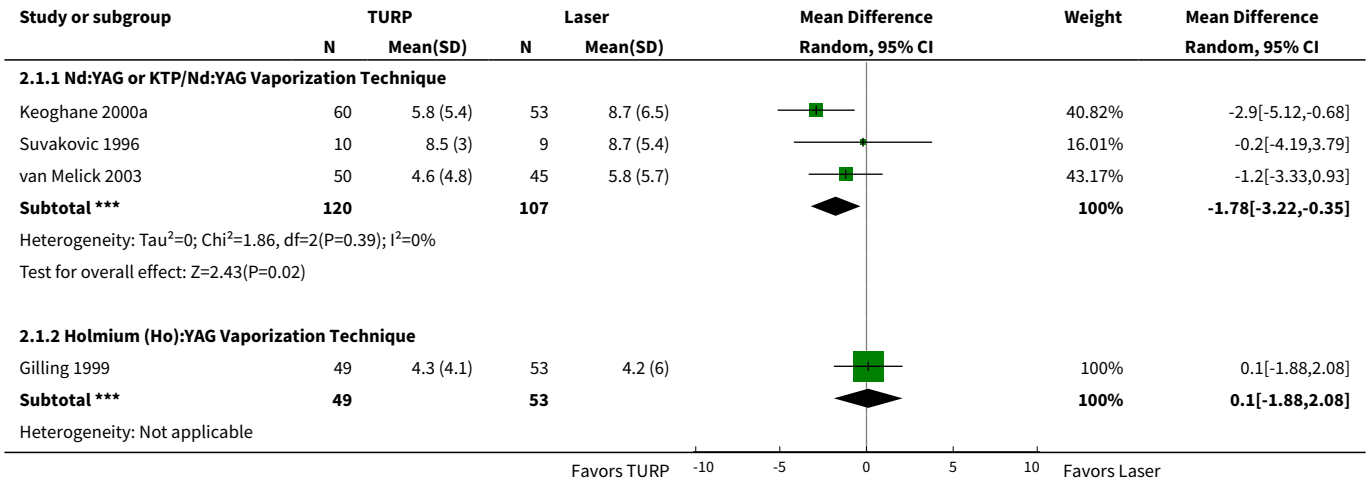


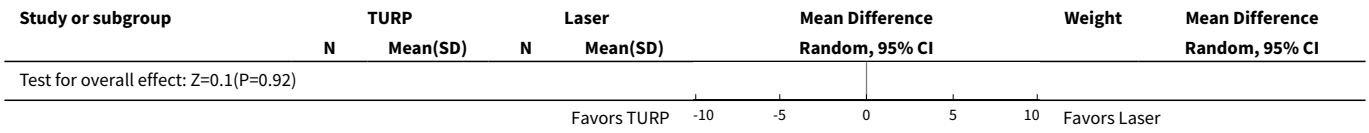


Comparison 2. Contact Laser versus TURP

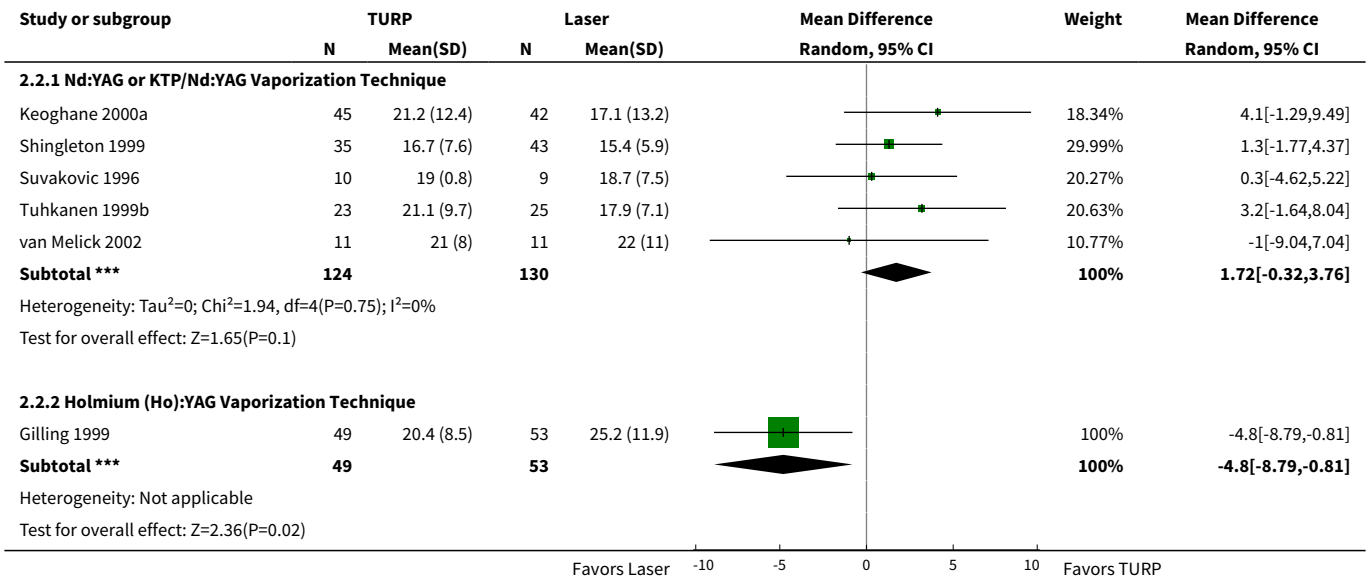
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 AUA (IPSS) Symptom Score:	4		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.1 Nd:YAG or KTP/Nd:YAG Vaporization Technique	3	227	Mean Difference (IV, Random, 95% CI)	-1.78 [-3.22, -0.35]
1.2 Holmium (Ho):YAG Vaporization Technique	1	102	Mean Difference (IV, Random, 95% CI)	0.10 [-1.88, 2.08]
2 Peak Urine Flow (mL/s)	6		Mean Difference (IV, Random, 95% CI)	Subtotals only
2.1 Nd:YAG or KTP/Nd:YAG Vaporization Technique	5	254	Mean Difference (IV, Random, 95% CI)	1.72 [-0.32, 3.76]
2.2 Holmium (Ho):YAG Vaporization Technique	1	102	Mean Difference (IV, Random, 95% CI)	-4.80 [-8.79, -0.81]

Analysis 2.1. Comparison 2 Contact Laser versus TURP, Outcome 1 AUA (IPSS) Symptom Score:.





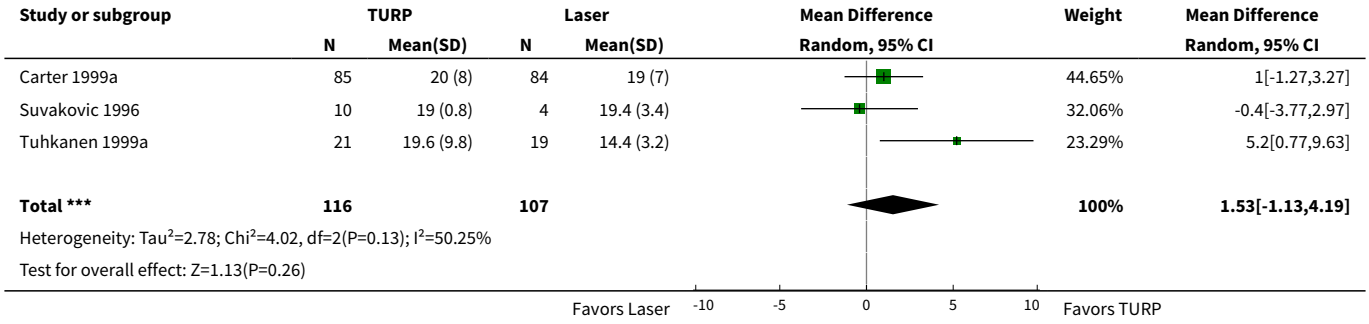
Analysis 2.2. Comparison 2 Contact Laser versus TURP, Outcome 2 Peak Urine Flow (mL/s).



Comparison 3. "Hybrid" Laser versus TURP

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Peak Urine Flow (mL/s)	3	223	Mean Difference (IV, Random, 95% CI)	1.53 [-1.13, 4.19]

Analysis 3.1. Comparison 3 "Hybrid" Laser versus TURP, Outcome 1 Peak Urine Flow (mL/s).



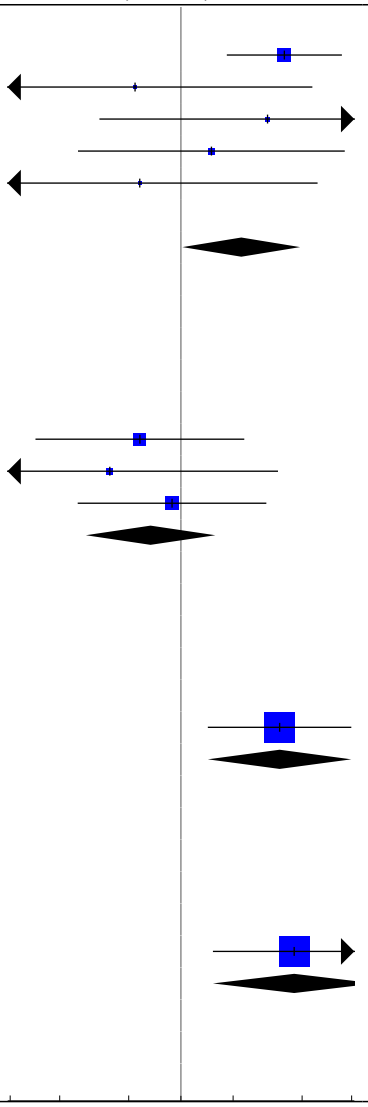
Comparison 4. Adverse Events

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Urinary Tract Infection	11		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
1.1 Non-contact Laser versus TURP	6	678	Risk Ratio (M-H, Random, 95% CI)	2.23 [1.02, 4.87]
1.2 Contact Laser versus TURP	3	332	Risk Ratio (M-H, Random, 95% CI)	0.67 [0.28, 1.58]
1.3 "Hybrid" Laser versus TURP	1	205	Risk Ratio (M-H, Random, 95% CI)	3.71 [1.43, 9.61]
1.4 Interstitial Laser versus TURP	1	66	Risk Ratio (M-H, Random, 95% CI)	4.5 [1.53, 13.22]
2 Urinary Retention	10		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
2.1 Non-contact Laser versus TURP	4	311	Risk Ratio (M-H, Random, 95% CI)	3.53 [1.45, 8.58]
2.2 Contact Laser versus TURP	4	344	Risk Ratio (M-H, Random, 95% CI)	1.97 [0.68, 5.72]
2.3 "Hybrid" Laser versus TURP	1	205	Risk Ratio (M-H, Random, 95% CI)	2.57 [0.51, 12.97]
2.4 Interstitial Laser versus TURP	1	66	Risk Ratio (M-H, Random, 95% CI)	2.0 [0.24, 16.84]
3 Retrograde ejaculation	10		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
3.1 Non-contact Laser versus TURP	4	160	Risk Ratio (M-H, Random, 95% CI)	4.84 [0.51, 45.93]
3.2 Contact Laser versus TURP	4	213	Risk Ratio (M-H, Random, 95% CI)	1.58 [0.36, 6.94]
3.3 "Hybrid" Laser versus TURP	1	40	Risk Ratio (M-H, Random, 95% CI)	2.67 [0.89, 7.98]
3.4 Interstitial Laser versus TURP	1	40	Risk Ratio (M-H, Random, 95% CI)	0.69 [0.33, 1.46]
4 Irritative symptoms/Dysuria	5		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
4.1 Non-contact Laser versus TURP	4	362	Risk Ratio (M-H, Random, 95% CI)	3.62 [1.00, 13.12]
4.2 "Hybrid" Laser versus TURP	1	205	Risk Ratio (M-H, Random, 95% CI)	0.84 [0.48, 1.47]
5 Erectile Dysfunction	5		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
5.1 Non-contact Laser versus TURP	3	211	Risk Ratio (M-H, Random, 95% CI)	1.58 [0.27, 9.11]

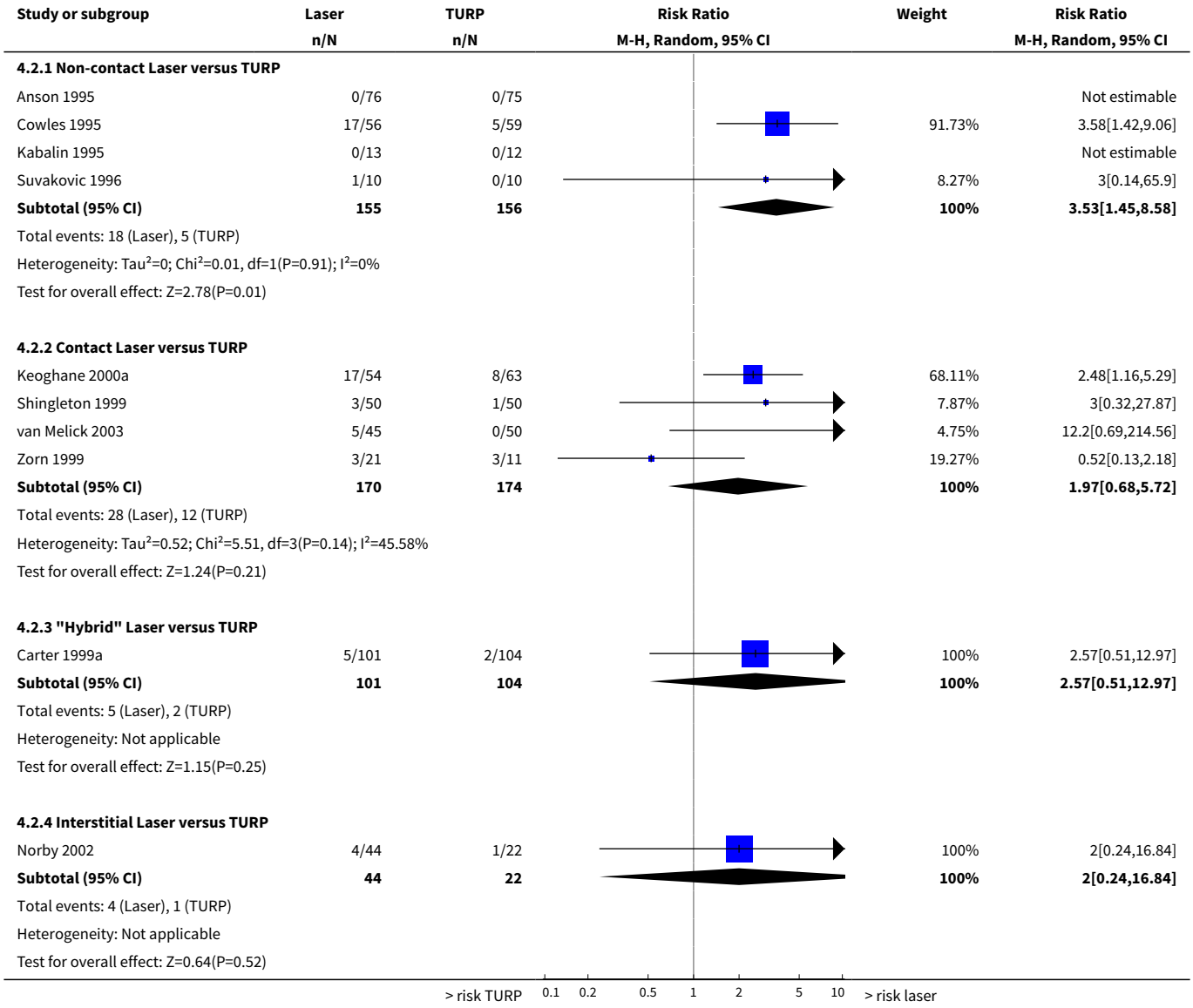
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
5.2 Contact Laser versus TURP	2	156	Risk Ratio (M-H, Random, 95% CI)	0.87 [0.27, 2.80]

Analysis 4.1. Comparison 4 Adverse Events, Outcome 1 Urinary Tract Infection.

Study or subgroup	Laser n/N	TURP n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
4.1.1 Non-contact Laser versus TURP					
Anson 1995	28/76	7/75		43.22%	3.95[1.84,8.48]
Costello 1995	1/34	2/37		12.3%	0.54[0.05,5.73]
Cowles 1995	3/56	1/59		13.38%	3.16[0.34,29.5]
Donovan 2000	3/117	2/117		18.85%	1.5[0.26,8.81]
Gujral 2000	1/38	2/44		12.25%	0.58[0.05,6.14]
Kabalin 1995	0/13	0/12			Not estimable
Subtotal (95% CI)	**334**	**344**		**100%**	**2.23[1.02,4.87]**
Total events: 36 (Laser), 14 (TURP)					
Heterogeneity: Tau^2=0.15; Chi^2=4.8, df=4(P=0.31); I^2=16.59%					
Test for overall effect: Z=2.01(P=0.04)					
4.1.2 Contact Laser versus TURP					
Gilling 1999	3/61	5/59		37.9%	0.58[0.15,2.32]
Keoghane 2000a	1/54	3/63		19.67%	0.39[0.04,3.63]
van Melick 2003	4/45	5/50		42.44%	0.89[0.25,3.11]
Subtotal (95% CI)	**160**	**172**		**100%**	**0.67[0.28,1.58]**
Total events: 8 (Laser), 13 (TURP)					
Heterogeneity: Tau^2=0; Chi^2=0.47, df=2(P=0.79); I^2=0%					
Test for overall effect: Z=0.92(P=0.36)					
4.1.3 "Hybrid" Laser versus TURP					
Carter 1999a	18/101	5/104		100%	3.71[1.43,9.61]
Subtotal (95% CI)	**101**	**104**		**100%**	**3.71[1.43,9.61]**
Total events: 18 (Laser), 5 (TURP)					
Heterogeneity: Tau^2=0; Chi^2=0, df=0(P<0.0001); I^2=100%					
Test for overall effect: Z=2.7(P=0.01)					
4.1.4 Interstitial Laser versus TURP					
Norby 2002	27/44	3/22		100%	4.5[1.53,13.22]
Subtotal (95% CI)	**44**	**22**		**100%**	**4.5[1.53,13.22]**
Total events: 27 (Laser), 3 (TURP)					
Heterogeneity: Not applicable					
Test for overall effect: Z=2.74(P=0.01)					

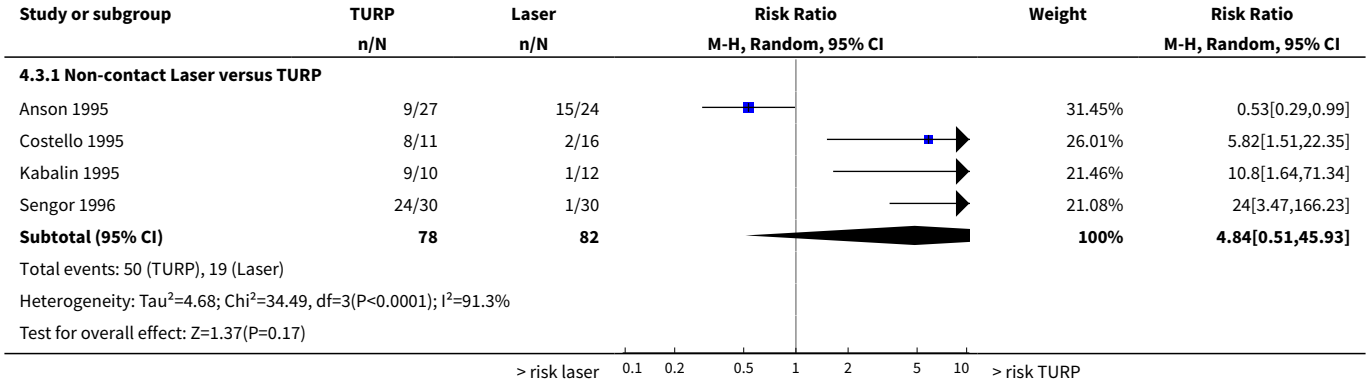


Analysis 4.2. Comparison 4 Adverse Events, Outcome 2 Urinary Retention.

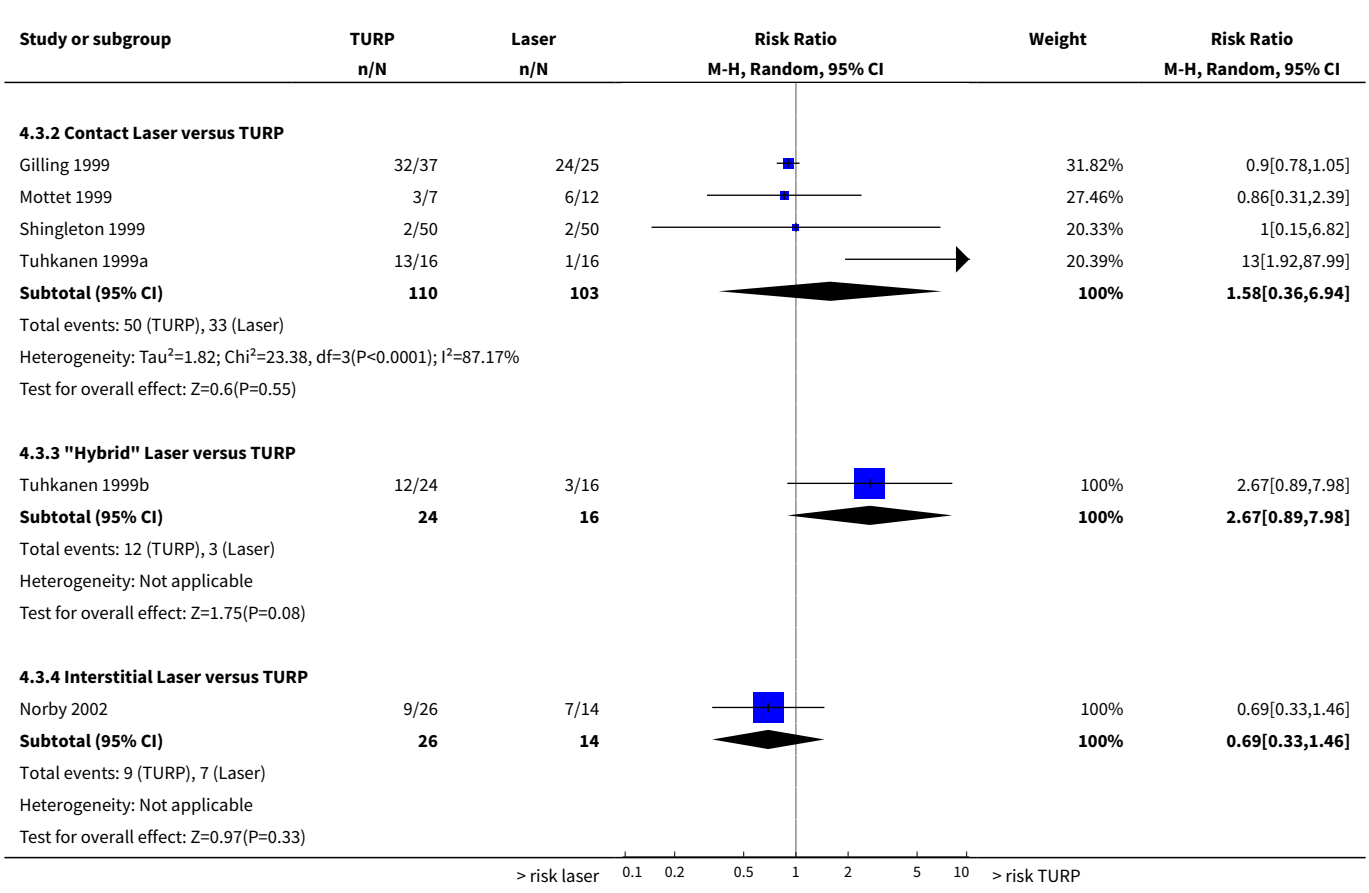


Study or subgroup	Laser n/N	TURP n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
4.2.1 Non-contact Laser versus TURP					
Anson 1995	0/76	0/75			Not estimable
Cowles 1995	17/56	5/59		91.73%	3.58[1.42,9.06]
Kabalin 1995	0/13	0/12			Not estimable
Suvakovic 1996	1/10	0/10		8.27%	3[0.14,65.9]
Subtotal (95% CI)	**155**	**156**		**100%**	**3.53[1.45,8.58]**
Total events: 18 (Laser), 5 (TURP)					
Heterogeneity: Tau^2=0; Chi^2=0.01, df=1(P=0.91); I^2=0%					
Test for overall effect: Z=2.78(P=0.01)					
4.2.2 Contact Laser versus TURP					
Keoghane 2000a	17/54	8/63		68.11%	2.48[1.16,5.29]
Shingleton 1999	3/50	1/50		7.87%	3[0.32,27.87]
van Melick 2003	5/45	0/50		4.75%	12.2[0.69,214.56]
Zorn 1999	3/21	3/11		19.27%	0.52[0.13,2.18]
Subtotal (95% CI)	**170**	**174**		**100%**	**1.97[0.68,5.72]**
Total events: 28 (Laser), 12 (TURP)					
Heterogeneity: Tau^2=0.52; Chi^2=5.51, df=3(P=0.14); I^2=45.58%					
Test for overall effect: Z=1.24(P=0.21)					
4.2.3 "Hybrid" Laser versus TURP					
Carter 1999a	5/101	2/104		100%	2.57[0.51,12.97]
Subtotal (95% CI)	**101**	**104**		**100%**	**2.57[0.51,12.97]**
Total events: 5 (Laser), 2 (TURP)					
Heterogeneity: Not applicable					
Test for overall effect: Z=1.15(P=0.25)					
4.2.4 Interstitial Laser versus TURP					
Norby 2002	4/44	1/22		100%	2[0.24,16.84]
Subtotal (95% CI)	**44**	**22**		**100%**	**2[0.24,16.84]**
Total events: 4 (Laser), 1 (TURP)					
Heterogeneity: Not applicable					
Test for overall effect: Z=0.64(P=0.52)					

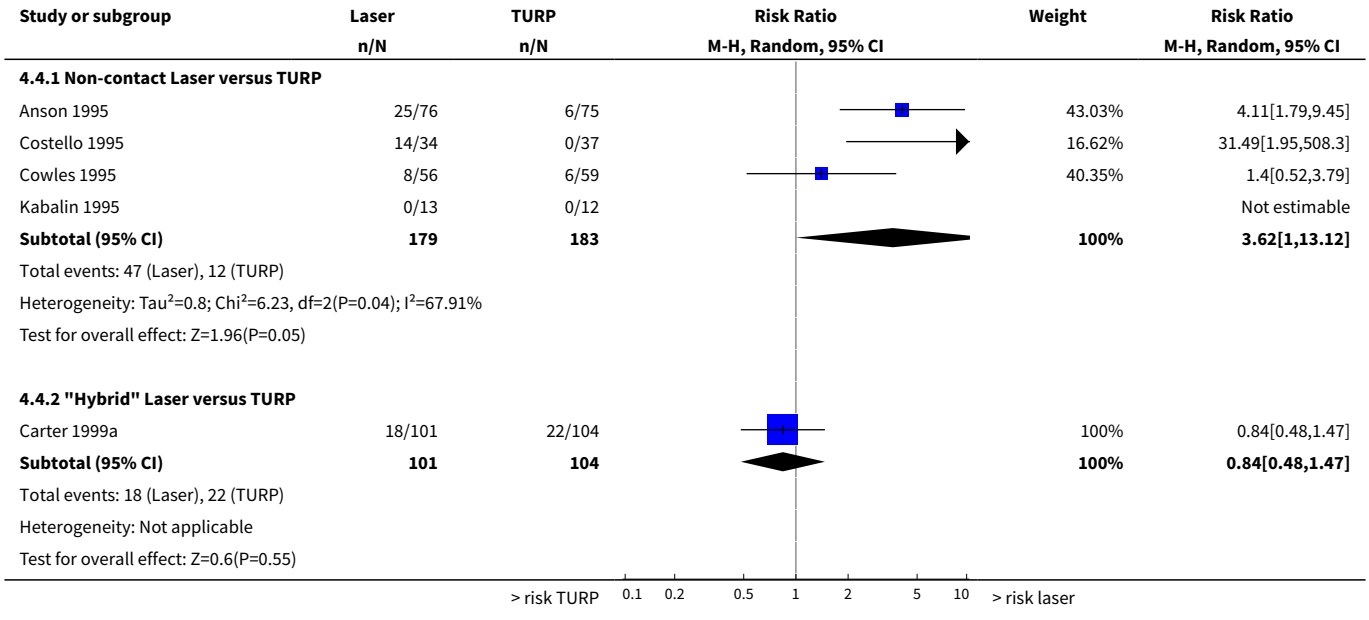
Analysis 4.3. Comparison 4 Adverse Events, Outcome 3 Retrograde ejaculation.



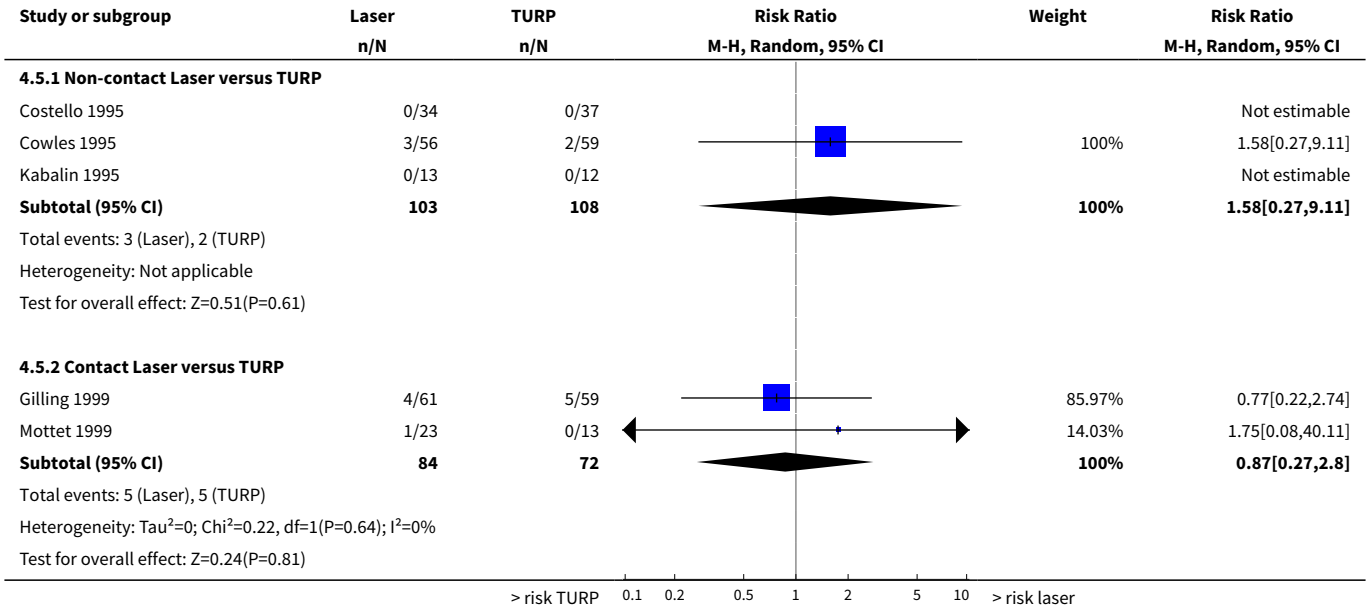
Study or subgroup	TURP n/N	Laser n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
4.3.1 Non-contact Laser versus TURP					
Anson 1995	9/27	15/24		31.45%	0.53[0.29,0.99]
Costello 1995	8/11	2/16		26.01%	5.82[1.51,22.35]
Kabalin 1995	9/10	1/12		21.46%	10.8[1.64,71.34]
Sengor 1996	24/30	1/30		21.08%	24[3.47,166.23]
Subtotal (95% CI)	**78**	**82**		**100%**	**4.84[0.51,45.93]**
Total events: 50 (TURP), 19 (Laser)					
Heterogeneity: Tau^2=4.68; Chi^2=34.49, df=3(P<0.0001); I^2=91.3%					
Test for overall effect: Z=1.37(P=0.17)					



Analysis 4.4. Comparison 4 Adverse Events, Outcome 4 Irritative symptoms/Dysuria.



Analysis 4.5. Comparison 4 Adverse Events, Outcome 5 Erectile Dysfunction.



ADDITIONAL TABLES

Table 1. Laser vs. TURP: Operating Time (minutes)

Study	Laser	TURP	p-value
Anson	NA	NA	
Costello	NA	NA	
Cowles	23.4	45.2	< 0.01
Donovan	NA	NA	
Gujral	NA	NA	
Kabalin	24.2	58.3	NA
Sengor	43	56	NA
Suvakovic (Non-Contact)	12.5	20.1	NS
Gilling	26	106	< 0.001
Mottet	75	40	< 0.04
Keoghane	36	39	NS
Shingleton	NA	NA	
Suvakovic (Contact)	18.9	20.1	NS

Table 1. Laser vs. TURP: Operating Time (minutes) *(Continued)*

Tukhanen (Contact)	51	34	< 0.01
Zorn (Contact)	70	68	NS
Carter	37.4	35.7	NS
Suvakovic (Hybrid)	13.1	20.1	NS
Tukhanen (Hybrid)	75	44	< 0.001
Zorn (Hybrid)	88	68	< 0.05

Table 2. Laser vs. TURP: Hospital lenght of stay (days)

Study	Laser	TURP	p-value
Anson	2.7	4.3	< 0.05
Costello	6.2	5.8	NA
Cowles	1.8	3.1	< 0.01
Donovan	2.2	3.9	< 0.0001
Gujral	2.2	4.4	< 0.0001
Kabalin	NA	NA	
Sengor	1.6	5.9	NA
Suvakovic (Non-contact)	1.3	3.5	< 0.05
Gilling	1.1	2.0	< 0.001
Mottet	1.6	3.1	NA
Keoghane	3	4	< 0.005
Shingleton	NA	NA	
Suvakovic (Contact)	1.3	3.5	< 0.05
Tukhanen (Contact)	3.4	2.9	NS
Zorn (Contact)	1.2	2.5	< 0.05
Carter	2.7	3.7	NA
Suvakovic (Hybrid)	1.0	5.8	< 0.05
Tukhanen (Hybrid)	4	3.5	NS
Zorn (Hybrid)	1.4	2.5	< 0.05

Table 3. Laser vs. TURP: Catheter duration (days)

Study	Laser	TURP	p-value
Anson	14.7	2.7	< 0.05
Costello	2.2	NA	
Cowles	NA	NA	
Donovan	11.8	2.4	< 0.0001
Gujral	25.5	3	< 0.0001
Kabalin	4.7	2.7	NA
Sengor	4.8	3.8	NA
Suvakovic (Non-contact)	1.0	2.0	< 0.05
Gilling	0.8	1.6	< 0.001
Mottet	2.2	2.1	NA
Keoghane	1	2	< 0.001
Shingleton	NA	NA	
Suvakovic (Contact)	1.0	2.0	< 0.01
Tukhanen (Contact)	4.3	1.7	<0.01
Zorn (Contact)	1.1	1.7	<0.05
Carter	2	2	NS
Suvakovic (Hybrid)	0.8	2.0	< 0.05
Tukhanen (Hybrid)	10.6	2.2	< 0.01
Zorn (Hybrid)	1.3	1.7	< 0.05

Table 4. Laser vs. TURP: Re-operations (%)

Study	Laser	TURP	p-value
Anson	7.5	0	< 0.02
Costello	12.5	0	NS
Cowles	10.9	0	< 0.01
Donovan	NA	NA	

Table 4. Laser vs. TURP: Re-operations (%) *(Continued)*

Gujral	8.3	0	NS
Kabalin	20.0	0	NS
Sengor	NA	NA	
Suvakovic (Non-contact)	NA	NA	
Gilling	1.9	8.2	NS
Mottet	8.3	0	NS
Keoghane	11.3	0	< 0.01
Shingleton	NA	NA	
Suvakovic (Contact)	NA	NA	
Tukhanen (Contact)	0	0	NS
Zorn	0	0	NS
Carter	2.4	1.2	NS
Suvakovic (Hybrid)	NA	NA	
Tukhanen (Hybrid)	0	0	NS
Zorn (Hybrid)	0	0	NS

Table 5. Laser vs. TURP Baseline and Follow-up Urinary Symptom Scores (points)

Study	Mean baseline score	Mean follow-up/ 6 mo	Mean follow-up/ 1 yr
Anson Laser TURP	AUA 6 18.1 18.2	7.9 5.9 (p = NS)	7.7 5.1 (p = 0.046)
Costello Laser TURP	AUA 7 NA NA	9.3 4.4 (p = 0.01)	NA NA
Cowles Laser TURP	AUA 6 18.7 (6.0) [SD] 20.8 (4.8)	NA NA	9.7 7.5 (p < 0.04)
Donovan Laser TURP	IPSS 19.1 (6.6) 19.2 (6.7	7.5 months 8.3 6.9 (p = NS)	NA NA
Gujral Laser TURP	IPSS 20.9 (6.4) 19.5 (7.2)	7.5 months 8.7 5.3 (p = 0.048)	NA NA
Kabalin	AUA 7	4.6 (0.7)	4.3 (1.7)

Table 5. Laser vs. TURP Baseline and Follow-up Urinary Symptom Scores (points) *(Continued)*

Laser TURP	20.9 (1.9) [SE] 18.8 (1.8)	5.7 (1.2) (p = NS)	6.3 (1.3)
Sengor Laser TURP	AUA 7 15.7 (5.1) 18.8 (4.5)	8.0 (5.7) 8.5 (3.0) (p = NS)	NA NA
Suvakovic (Non-contact) Laser TURP	AUA 7 15.7 (5.1) 18.8 (4.5)	8.0 (5.7) 8.5 (3.0)	10.0 (4.9) 7.2 (6.1) (p = NS)
Gilling Laser TURP	AUA 7 21.9 (6.2) 23.0 (5.9)	3.8 (3.8) 5.0 (4.5) (p=NS)	4.2 (6.0) 4.3 (4.1) (p=NS)
Mottet Laser TURP	IPSS 20.0 23.7	6.2 7.7 (p = NS)	5.9 4.7 (p = NS)
Keoghane Laser TURP	AUA 7 19.9 (7.7) 19.4 (6.5)	NA NA	8.7 (6.5) 5.8 (5.4) (p = 0.006)
Shingleton Laser TURP	AUA 7 22.0 (6.0) 21.0 (6.0)	7 4 (p = 0.01)	7 3 (p=0.01)
Suvakovic (Contact) Laser TURP	AUA 7 18.0 (6.0) 18.8 (4.5)	8.7 (5.4) 8.5 (3.0) (p = NS)	8.7 (4.9) 7.2 (6.1) (p = NS)
Tukhanen (Contact) Laser TURP	DanPSS-1 20.0 (11.0) 21.0 (11.0)	6.0 (9.0) 5.0 (7.0) (p = NS)	NA NA
Zorn (Contact) Laser TURP	AUA 7 24.0 24.7	9.1 8.3 (p = NS)	8.4 4.7 (p < 0.05)
Carter Laser TURP	IPSS 20.3 19.8	6.7 6.4 (p = NS)	6.6 5.9 (p = NS)
Suvakovic (Hybrid) Laser TURP	AUA 7 17.0 (6.0) 19.0 (0.8)	7.4 (4.3) 8.5 (3.0) (p = NS)	NA NA
Tukhanen (Hybrid) Laser TURP	DanPSS-1 18.6 23.3	5.5 4.7 (p = NS)	NA NA
Zorn (Hybrid) Laser TURP	AUA 7 24.2 24.7	8.3 8.2	13.7 4.7 (p < 0.05)

Table 6. Laser vs. TURP Baseline and Follow-up Peak Urinary Flow rate (mL/s)

Study	Mean baseline score	Mean follow-up/ 6 mo	Mean follow-up/ 1 yr
Anson Laser TURP	9.5 10.0	15.6 19.9 (p = 0.037)	15.4 21.8 (p = 0.009)
Costello Laser TURP	8.8 9.5	15.8 19.1 (p = NS)	NA NA
Cowles Laser TURP	8.9 (3.6) [SD] 9.5 (3.2)	NA NA	14.2 16.5 (p = NS)
Donovan Laser TURP	10.4 (2.9) 10.3 (2.7)	7.5 months 16.2 20.0 (p < 0.05)	NA NA
Gujral Laser TURP	11.2 (5.3) 8.5 (3.6)	7.5 months 16.9 17.0 (p = NS)	NA NA
Kabalin Laser TURP	8.5 (1.1) [SE] 9.0 (1.1)	20.5 (1.8) 22.9 (2.8)	21.6 (1.5) 21.6 (2.2)
Sengor Laser TURP	8.7 (2.3) 8.4 (2.8)	18.2 (2.1) 19.8 (2.5)	NA NA
Suvakovic (Non-contact) Laser TURP	10.5 (3.7) 11.1 (6.4)	16.2 (4.2) 19.0 (0.8) (p = NS)	12.6 (3.7) 15.2 (2.7) (p = NS)
Gilling Laser TURP	8.9 (3.0) 9.1 (3.2)	23.9 (8.7) 22.4 (9.0) (p = NS)	25.2 (11.9) 20.4 (8.5) (p = NS)
Mottet Laser TURP	8.5 7.7	17.5 16.6 (p = NS)	19.3 17.6 (p = NS)
Keoghane Laser TURP	11.8 (4.5) 11.4 (5.0)	NA NA	17.1 (13.2) 21.2 (12.4) (p = NS)
Shingleton Laser TURP	7.6 (3.4) 6.5 (4.0)	15.8 (6.9) 16.3 (6.4) (p = NS)	15.4 (4.9) 16.7 (7.6) (p = NS)
Suvakovic (Contact) Laser TURP	12.2 (3.8) 11.1 (6.4)	18.7 (7.5) 19.0 (8.0 (p = NS)	25.3 (5.9) 15.2 (2.7) (p = NS)
Tukhanen (Contact) Laser TURP	9.0 (3.8) 8.2 (3.2)	17.9 (7.1) 21.1 (9.7) (p = NS)	NA NA

Table 6. Laser vs. TURP Baseline and Follow-up Peak Urinary Flow rate (mL/s) *(Continued)*

Zorn (Contact) Laser TURP	8.7 9.0	20.0 23.1 (p = NS)	20.0 26.9 (p = NS)
Carter Laser TURP	9.5 10.0	18.5 19.0 (p = NS)	18.0 19.5 (p = NS)
Suvakovic (Hybrid) Laser TURP	11.8 (4.1) 11.1 (6.4)	19.4 (3.4) 19.0 (0.8)	NA NA
Tukhanen (Hybrid) Laser TURP	8.5 7.2	14.4 19.6 (p = NS)	NA NA
Zorn (Hybrid) Laser TURP	6.2 9.0	28.2 23.1 (p = NS)	20.5 26.9

WHAT'S NEW

Date	Event	Description
2 June 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 1, 2000
Review first published: Issue 1, 2004

Date	Event	Description
29 September 1999	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

R Hoffman made contributions to acquisition, analysis and interpretation of data, and drafting of manuscript. R MacDonald made contributions to analysis and interpretation of data, statistical expertise, and administrative, technical and material support. T Wilt contributed to conception and design of the study, analysis and interpretation of data, critical revision of the manuscript for important intellectual content, statistical expertise, obtaining funding, and overall supervision.

DECLARATIONS OF INTEREST

None

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INDEX TERMS

Medical Subject Headings (MeSH)

Laser Therapy [*methods]; Prostatectomy [*methods]; Prostatic Hyperplasia [complications] [*surgery]; Randomized Controlled Trials as Topic; Urinary Bladder Neck Obstruction [etiology] [*surgery]

MeSH check words

Aged; Humans; Male