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Comparison of Holmium Laser and Cold Knife Internal Urethrotomy in the Treatment of Urethral Strictures: A Retrospective Study

Üretra Darlıklarının Tedavisinde Holmium Lazer ve Soğuk Bıçak İnternal Üretrotomisinin Karşılaştırılması: Retrospektif Çalışma

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ABSTRACT Objective: This retrospective study aimed to compare the efficacy and safety of Holmium:YAG laser urethrotomy with conventional cold knife internal urethrotomy in the treatment of urethral strictures, with particular attention to stricture location and its impact on treatment outcomes, as well as the specific effects on continence in patients with membranous urethral strictures. **Material and Methods:** The study included 612 male patients with primary urethral strictures (membranous, bulbar, or penile). Patients were divided into 2 groups: Group 1 (n=304) underwent cold knife internal urethrotomy, and Group 2 (n=308) received Holmium:YAG laser urethrotomy. Preoperative evaluation, standardized surgical techniques, and postoperative follow-up were conducted. Outcomes were measured objectively and subjectively using recurrence rates, functional parameters, and quality of life assessments. **Results:** The holmium laser group exhibited significantly lower recurrence rates compared to the cold knife group (16.9% vs. 32.2%, p<0.001), with marked differences noted in membranous urethral strictures (19.6% vs. 38.4%, p<0.001). Improvements in functional outcomes such as maximum flow rate, International Prostate Symptom Score, and post-void residual volume were greater with the laser technique. Additionally, the incidence of post-procedure stress urinary incontinence was lower in the laser group for membranous urethral strictures (4.9% vs. 12.7%, p=0.008). **Conclusion:** Holmium:YAG laser urethrotomy suggests superior outcomes over cold knife urethrotomy in managing urethral strictures, yielding lower recurrence rates, reduced complications, and enhanced functional outcomes and quality of life, notably for patients with membranous urethral strictures.

Keywords: Urethral stricture; lasers, solid-state; urologic surgical procedures

ÖZET Amaç: Bu retrospektif çalışma, üretra darlıklarının tedavisinde Holmium:YAG lazer üretrotomisinin etkinliğini ve güvenliğini, darlık yeri ve tedavi sonuçları üzerindeki etkisi ile membranöz üretra darlığı olan hastalarda kontinans üzerindeki spesifik etkilere özel dikkat göstererek, geleneksel soğuk bıçaklı internal üretrotomi ile karşılaştırmayı amaçlamıştır. **Gereç ve Yöntemler:** Çalışmaya primer üretra darlığı (membranöz, bulbar veya penil) olan 612 erkek hasta dâhil edildi. Hastalar 2 gruba ayrıldı: Grup 1 (n=304) soğuk bıçaklı iç üretrotomi operasyonu geçirdi ve Grup 2 (n=308) Holmium:YAG lazer üretrotomi operasyonu geçirdi. Ameliyat öncesi değerlendirme, standart cerrahi teknikler ve ameliyat sonrası takip yapıldı. Sonuçlar, tekrarlama oranları, fonksiyonel parametreler ve yaşam kalitesi değerlendirmeleri kullanılarak objektif ve subjektif olarak ölçüldü. **Bulgular:** Holmium lazer grubu, soğuk bıçak grubuna kıyasla önemli ölçüde daha düşük tekrarlama oranları sergiledi (%16,9'a karşı %32,2, p<0,001), membranöz üretra darlıklarında ise belirgin farklılıklar kaydedildi (%19,6'ya karşı %38,4, p<0,001). Maksimum akış hızı, Uluslararası Prostat Semptom Skoru ve işeme sonrası kalan hacim gibi işlevsel sonuçlardaki iyileşmeler lazer tekniği uygulanan hastalarda daha fazlaydı. Ek olarak, lazer grubunda membranöz üretra darlıkları için işlem sonrası stres idrar kaçırma insidansı daha düşüktü (%4,9'a karşı %12,7, p=0,008). **Sonuç:** Holmium:YAG lazer üretrotomisi, üretra darlıklarının tedavisinde soğuk bıçak üretrotomisine göre daha üstün sonuçlar gösterdiği düşünülmektedir; daha düşük tekrarlama oranları, azaltılmış komplikasyonlar ve özellikle membranöz üretra darlığı olan hastalarda gelişmiş fonksiyonel sonuçlar ve yaşam kalitesi sağlamaktadır.

Anahtar Kelimeler: Üretra darlığı; lazerler, katı-hal; ürolojik cerrahi işlemler

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Urethral stricture disease presents a significant challenge in urological practice, characterized by narrowing of the urethral lumen that results in various urinary symptoms and diminished quality of life.[1] The condition in males is commonly associated with urethral infections, traumatic history, previous endoscopic interventions, catheterization, and mechanical implantation procedures, though a considerable number of cases remain idiopathic.[2,3] Since Sachse introduced internal urethrotomy in 1974, it has become the most frequently performed procedure for urethral strictures due to its minimally invasive approach and relatively straightforward technique.[4] However, traditional cold knife urethrotomy has demonstrated high recurrence rates (32-50%) within the first year of follow-up, prompting exploration of alternative therapeutic approaches.[5]

The integration of laser technology into urological surgery has created new possibilities for managing urethral strictures. The Holmium:YAG laser, with its exceptional cutting precision and hemostatic capabilities, has emerged as a promising alternative to conventional cold knife methods.[6,7] Theoretical benefits of laser urethrotomy include reduced scarring, decreased bleeding, and potentially lower stricture recurrence.[8] Nevertheless, comprehensive comparative data examining the effectiveness of these techniques, particularly regarding different anatomical stricture locations, remains insufficient in current literature.

The anatomical position of urethral strictures significantly influences treatment outcomes.[9] Specifically, membranous urethral strictures present unique challenges due to their proximity to the external sphincter and associated risk of post-procedure incontinence.[10] While various studies have compared aspects of cold knife and Holmium:YAG laser urethrotomy, there is a notable scarcity of large-scale research evaluating outcomes based on stricture location, particularly regarding post-procedure continence status in membranous urethral strictures.

This retrospective analysis has two primary aims. First, we seek to compare the efficacy and safety profiles of Holmium:YAG laser urethrotomy versus conventional cold knife internal urethrotomy for treating urethral strictures. Second, we focus specifically on stricture location and its impact on treatment outcomes. Additionally, we evaluate the effects of both techniques on continence status in patients with membranous urethral strictures.

MATERIAL AND METHODS

STUDY DESIGN

We conducted this retrospective study between January 2022 and January 2024 at Mersin University Urology Department. The research received ethical approval from the Local Ethics Committee of the Faculty of Medicine (date: April 9, 2025, no: 2025/385), and all participants provided written informed consent. All procedures adhered to ethical principles outlined in the Declaration of Helsinki. A single urologist performed all operations, while postoperative evaluations were conducted by urologists blinded to the treatment method.

STATISTICAL ANALYSIS

Using the G*Power analysis tool version 3.1, we calculated a required sample size of 64 for each group based on similar studies in literature (Figure 1). Statistical analysis employed SPSS version 25.0 (IBM Corp., Armonk, NY, USA). We expressed continuous variables as mean±standard deviation, analyzing them with Student's t-test for normally distributed data or Mann-Whitney U test for non-normal distributions (confirmed by Shapiro-Wilk test). Categorical variables underwent comparison using chi-square or Fisher's exact test as appropriate. We evaluated recurrence-free survival through Kaplan-Meier analysis with log-rank test and performed multivariate analysis using Cox proportional hazards model to identify independent predictors of recurrence, including age, stricture location, length, etiology, and previous catheterization history. For quality of life assessments, we used repeated measures one-way analysis of variance (ANOVA) to compare changes in Urethral Stricture Surgery Patient-Reported Outcome Measure (USS-PROM) scores over time. Statistical significance was established at $p<0.05$.

Patient Selection

Initially, 650 male patients with urethral strictures participated in the study. Group 1 (n=325) underwent

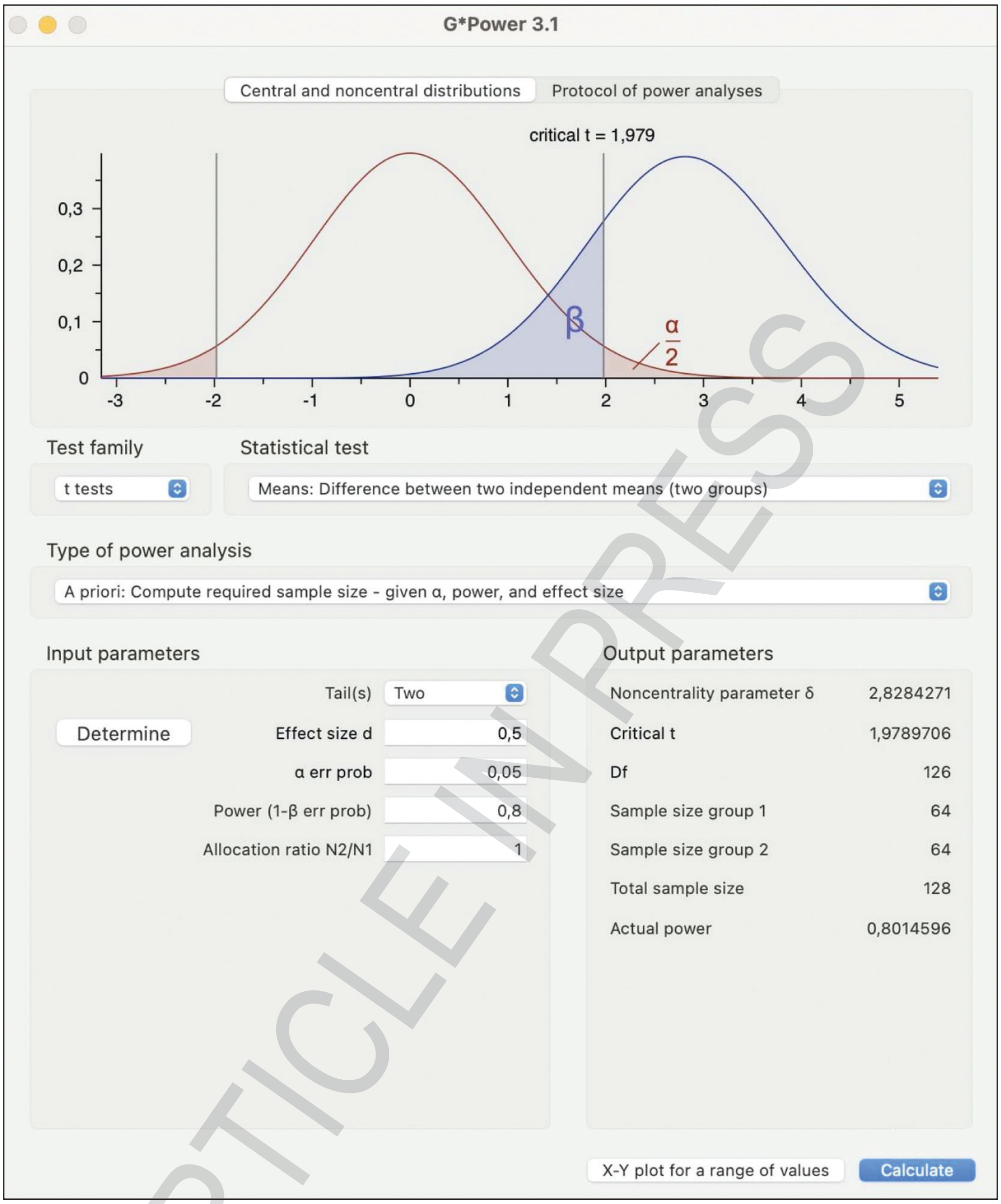

FIGURE 1: Sample size calculated using G*Power program version 3.1

cold knife internal urethrotomy, while Group 2 (n=325) received Holmium:YAG laser urethrotomy. During follow-up, 38 patients (21 from Group 1 and 17 from Group 2) were lost to follow-up or withdrew, leaving 612 patients (304 in Group 1 and 308 in Group 2) for final analysis.

The study included male patients aged ≥18 years with primary urethral strictures in the membranous, bulbar, or penile urethra. Only patients with stricture length ≤2 cm and no previous urethral surgery qualified for inclusion. While urethroplasty is generally the preferred approach for penile urethral strictures according to current guidelines, we included selected penile stricture cases (24.3% in Group 1 and 25.3% in Group 2) based on specific inclusion criteria: strictures were short (<1.5 cm), non-obliterative, and isolated (not part of panurethral disease). Additionally, patient factors including preference for minimally invasive procedures, comorbidities precluding more extensive surgery, and desire to avoid the cosmetic impacts of open surgery influenced treatment selection for this subgroup. All patients with penile strictures were thoroughly counseled regarding all available treatment options, including urethroplasty, and provided informed consent for the selected approach.

Exclusion criteria encompassed previous urethral surgery, active urinary tract infection, hematological disorders, previous pelvic radiation therapy, or lichen sclerosis. Additionally, we excluded patients with complex strictures >2 cm in length, urethral fistula, or complete obliteration of the urethral lumen.

Preoperative Evaluation

All patients underwent comprehensive medical history review and physical examination, urine analysis and culture, complete blood count, and coagulation profile. Imaging studies included retrograde and voiding urethrography. Functional assessment comprised uroflowmetry with post-void residual measurement, International Prostate Symptom Score (IPSS) assessment, and the condition-specific USS-PROM. We also recorded detailed stricture characteristics including length and location.

Surgical Technique

We performed all procedures under spinal or general anesthesia with patients in lithotomy position. A single experienced urologist performed all procedures in each group to minimize operator-dependent variables. For cold knife internal urethrotomy (Group 1), the procedure began with urethroscopy using a 21F cystoscope to identify the stricture, followed by guide wire placement through the stricture under direct vision. After introducing the Sachse urethrotome, the surgeon incised the stricture at the 12 o'clock position using a cold knife, with additional incisions at 3 and 9 o'clock positions when necessary. The team confirmed adequate lumen caliber with a 21F cystoscope and placed an 18F silicone catheter.

In the Holmium:YAG laser urethrotomy group (Group 2), initial steps mirrored the cold knife approach, including urethroscopy and guide wire placement. For laser procedures, we used a Quanta System Cyber Ho 100 Holmium:YAG laser system (Quanta System S.p.A., Varese, Italy) with a wavelength of 2100 nm, pulse duration of 250-350 μs, and a 550 μm end-firing laser fiber (SlimLine™, Lumenis Ltd., Yokneam, Israel). The surgeon introduced the laser fiber through the working channel and incised the stricture at the 12 o'clock position using Holmium:YAG laser. Based on preliminary experience with the first 50 cases, we established optimal energy settings of 1.8-2.0 J with frequency 12-15 Hz, providing effective tissue cutting with minimal collateral damage. These parameters were applied to all remaining cases. Additional incisions at 3 and 9 o'clock positions were made, when necessary, followed by confirmation of lumen caliber and placement of an 18F silicone catheter.

Post-operative Care and Follow-up Protocol

Post-operative management included urethral catheter removal after 7 days in uncomplicated cases. All patients received oral antibiotics for 7 days and anti-inflammatory medications as needed. We provided detailed instructions regarding proper hydration and voiding habits to optimize healing and minimize complications.

Patient follow-up occurred at 1, 3, 6, and 12-months post-operation. Each follow-up visit included comprehensive evaluation of urinary function through maximum flow rate measurement (Qmax), IPSS assessment, and post-void residual volume determination. Retrograde urethrography was performed at 3 and 12 months to evaluate anatomical outcomes. We assessed continence status at each visit and documented complications according to the Clavien-Dindo classification system.

Treatment success was evaluated using multiple criteria: achievement of maximum flow rate exceeding 15 mL/s, absence of need for additional urethral procedures, post-void residual volume less than 50 mL, documented improvement in IPSS score, and patient-reported satisfaction with urination.

RESULTS

PATIENT DEMOGRAPHICS AND BASELINE CHARACTERISTICS

Of the 650 patients initially enrolled, 612 completed the 12-month follow-up period (Group 1: n=304, Group 2: n=308). Baseline demographic and clinical characteristics were comparable between groups. The mean age was 62.4±13.2 years in Group 1 and 63.1±12.8 years in Group 2 (p=0.56). Stricture location distribution was similar between groups, with bulbar urethra being the most common site. The mean stricture length was 1.4±0.4 cm in Group 1 and 1.3±0.5 cm in Group 2 (p=0.45) (Table 1).

OPERATIVE OUTCOMES

Mean operative time was significantly shorter in Group 2 (35.7±7.2 minutes) compared to Group 1 (42.3±8.5 minutes) (p<0.001). Intraoperative bleeding requiring intervention occurred in 15 patients (4.9%) in Group 1 versus only 4 patients (1.3%) in Group 2 (p=0.008) (Table 2).

FUNCTIONAL OUTCOMES

As shown in Table 2, Qmax improved significantly in both groups from baseline to 12 months. Group 1 showed improvement from 7.2±2.8 mL/s to 19.4±5.6 mL/s (p<0.001), while Group 2 improved from 7.4±2.6 mL/s to 22.8±5.2 mL/s (p<0.001). The improvement in Qmax was significantly greater in Group 2 at all follow-up points (p<0.05). Table 3 presents the progression of key outcome parameters throughout follow-up, demonstrating consistent improvement in both groups, with superior results maintained in the laser group across all time points. IPSS scores showed significant improvement in both groups, with Group 1 improving from 22.3±4.2 to 8.4±3.1 (p<0.001) and Group 2 from 21.9±4.5 to 6.8±2.9 (p<0.001). Post-void residual volumes decreased significantly in both groups, with no significant difference between groups at 12 months (p=0.34).

TABLE 1: Baseline patient characteristics and stricture details

Characteristic	Group 1 (n=304)	Group 2 (n=308)	p value
Age (years)*	62.4±13.2	63.1±12.8	0.56
Stricture length (cm)*	1.4±0.4	1.3±0.5	0.45
Stricture location (n, %)			
Membranous urethra	102 (33.6)	102 (33.1)	0.91
Bulbar urethra	128 (42.1)	128 (41.6)	0.89
Penile urethra	74 (24.3)	78 (25.3)	0.84
Baseline Qmax (mL/s) *	7.2±2.8	7.4±2.6	0.78
Baseline IPSS*	22.3±4.2	21.9±4.5	0.67

*Values presented as mean±standard deviation. Continuous variables were compared using Student's t-test or Mann-Whitney U test based on normality (Shapiro-Wilk test). Categorical variables were compared using chi-square test or Fisher's exact test as appropriate.
Qmax: Maximum flow rate; IPSS: International Prostate Symptom Score

TABLE 2: Comparison of outcomes between groups at 12-month follow-up

Outcome Measure	Group 1 (n=304)	Group 2 (n=308)	p value
Overall recurrence rate	98 (32.2%)	52 (16.9%)	<0.001
Qmax (mL/s)*	19.4±5.6	22.8±5.2	<0.001
IPSS*	8.4±3.1	6.8±2.9	<0.001
Operative time (min)*	42.3±8.5	35.7±7.2	<0.001
Overall complications	90 (29.6%)	55 (17.9%)	0.003

*Values presented as mean±standard deviation. Independent samples t-test was used for continuous variables, chi-square test for categorical variables. Effect sizes were calculated using Cohen's d for continuous variables and odds ratios for categorical outcomes.
Qmax: Maximum flow rate; IPSS: International Prostate Symptom Score

RECURRENCE RATES AND LOCATION-BASED OUTCOMES

At 12-month follow-up, 98 patients (32.2%) in Group 1 experienced recurrence compared to 52 patients (16.9%) in Group 2 (p<0.001, Table 2). Kaplan-Meier analysis demonstrated significantly better recurrence-free survival in the laser group (log-rank test, p<0.001; Figure 2). Subgroup analysis of recurrence rates by stricture location revealed varying success rates across different anatomical sites (Figure 3). In the membranous urethra subgroup (n=204), recurrence rates were 38.4% (39/102) in Group 1 and 19.6% (20/102) in Group 2 (p<0.001). Post-procedure stress urinary incontinence occurred in 12.7% (13/102) of Group 1 and 4.9% (5/102) of Group 2 patients with membranous strictures (p=0.008), with all cases resolving within 6 months of follow-up.

TABLE 3: Follow-up results at different time points

Parameter	Group	Baseline	1 month	3 months[‡]	6 months	12 months[‡]	p value[†]
Qmax (mL/s)*	Group 1	7.2±2.8	15.8±4.9	17.2±5.2	18.6±5.4	19.4±5.6	<0.001
	Group 2	7.4±2.6	18.4±4.7	20.1±4.9	21.5±5.0	22.8±5.2	
IPSS*	Group 1	22.3±4.2	12.4±3.8	10.2±3.5	9.1±3.3	8.4±3.1	<0.001
	Group 2	21.9±4.5	10.2±3.5	8.4±3.2	7.5±3.0	6.8±2.9	
PVR (mL)*	Group 1	125±45	65±35	45±30	40±28	38±25	0.34
	Group 2	128±42	60±32	42±28	37±25	35±23	
Cumulative	Group 1	-	15 (4.9)	45 (14.8)	72 (23.7)	98 (32.2)	<0.001
Recurrence n (%)	Group 2	-	5 (1.6)	22 (7.1)	38 (12.3)	52 (16.9)	

*Values presented as mean±standard deviation; [†]p value for between-group comparison at 12 months; [‡]Retrograde urethrography performed at these time points;
Qmax: Maximum flow rate; IPSS: International Prostate Symptom Score; PVR: Post-void residual volume
Repeated measures ANOVA with "post hoc" Bonferroni correction was used for continuous variables over time. Mixed-effects model was applied for longitudinal data analysis. Between-group comparisons at each time point were performed using independent samples t-test.

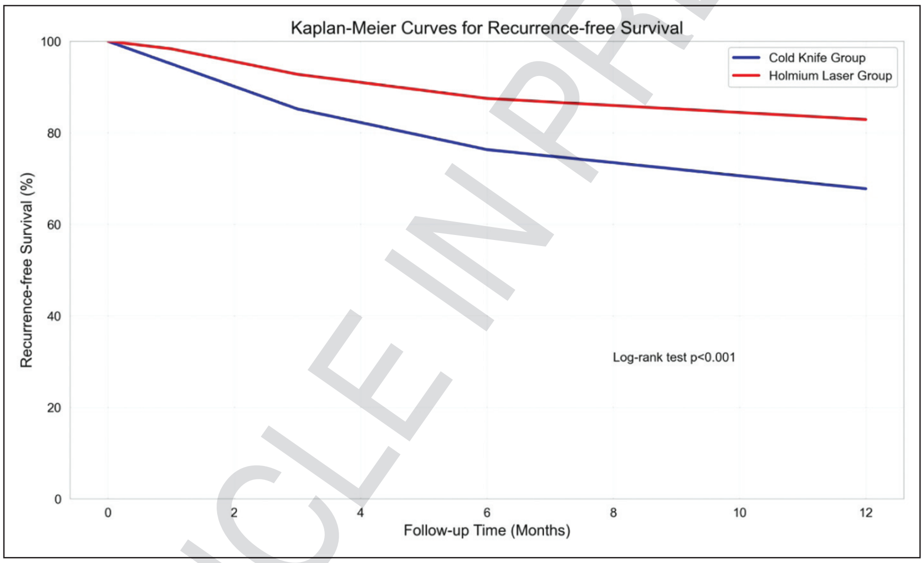

FIGURE 2: Kaplan-Meier curves for recurrence-free survival in holmium laser versus cold knife internal urethrotomy groups. The graph demonstrates significantly better outcomes in the laser group throughout the follow-up period (log-rank test, p<0.001). Cumulative recurrence rates at different time points were: 1 month (laser vs cold knife: 1.6% vs 4.9%, p=0.032), 3 months (7.1% vs 14.8%, p<0.001), 6 months (12.3% vs 23.7%, p<0.001), and 12 months (16.9% vs 32.2%, p<0.001). The superior recurrence-free survival in the laser group (83.1% vs 67.8% at 12 months) was maintained across all subgroups. Cox proportional hazards analysis identified treatment modality as an independent predictor of recurrence (HR: 2.45, 95% CI: 1.78-3.38, p<0.001 for cold knife vs laser). Vertical marks indicate censored cases. Survival analysis was performed using Kaplan-Meier method with log-rank test for between-group comparisons. Cox proportional hazards model was used for multivariate analysis, adjusting for age, stricture location, length, etiology, and previous catheterization history. Hazard ratios are presented with 95% confidence intervals.
HR: Hazard ratio; CI: Confidence interval

STRICTURE LENGTH ANALYSIS

Analysis based on stricture length revealed that for strictures <1 cm (n=198), recurrence rates were 25.3% in Group 1 and 12.1% in Group 2 (p=0.005). For strictures 1-1.5 cm (n=242), recurrence rates were 32.8% and 16.7% respectively (p<0.001), while for strictures 1.5-2 cm (n=172), rates were 39.8% and 22.5% respectively (p=0.002).

MULTIVARIATE ANALYSIS

Cox proportional hazards analysis identified several independent predictors of recurrence. Significant fac-

FIGUGE 3: Recurrence rates stratified by urethral stricture location in holmium laser versus cold knife internal urethrotomy groups. Bar graph illustrating the comparison of recurrence rates between laser and cold knife techniques across different anatomical locations. The laser group demonstrated consistently lower recurrence rates across all locations: membranous (19.6% [20/102] vs 38.4% [39/102], χ^2 test p<0.001, OR: 0.39, 95% CI: 0.21-0.73), bulbar (16.9% [22/128] vs 32.2% [41/128], p<0.001, OR: 0.43, 95% CI: 0.24-0.77), and penile (15.0% [11/78] vs 30.3% [23/74], p=0.015, OR: 0.41, 95% CI: 0.18-0.91). Post-procedure stress urinary incontinence in membranous strictures was significantly lower in the laser group (4.9% [5/102] vs 12.7% [13/102], p=0.008). Multivariate analysis confirmed that the treatment effect was independent of stricture length (adjusted OR: 0.42, 95% CI: 0.28-0.63, p<0.001). Error bars represent 95% confidence intervals. Chi-square test was used for categorical comparisons. Odds ratios with 95% confidence intervals were calculated. Multivariate logistic regression was performed to adjust for potential confounders. Error bars represent 95% confidence intervals.

OR: Odds ratio; CI: Confidence interval

tors included treatment modality (Hazard ratio (HR): 2.45, 95% Confidence Interval (CI): 1.78-3.38, p<0.001 for cold knife vs laser), stricture location (HR: 1.86, 95% CI: 1.34-2.58, p<0.001 for membranous vs bulbar), stricture length (HR: 1.52 per cm, 95% CI: 1.23-1.88, p=0.002), and previous catheterization history (HR: 1.43, 95% CI: 1.12-1.82, p=0.004).

COMPLICATIONS

In Group 1 (n=304), complications were documented and classified according to the Clavien-Dindo system. Grade I complications affected 45 patients (14.8%), comprising transient hematuria (n=28), mild urinary tract infection (n=12), and temporary urinary retention after catheter removal (n=5). Grade II complications occurred in 28 patients (9.2%), including severe urinary tract infection requiring antibiotics (n=20) and significant hematuria requiring transfusion (n=8). Grade IIIa complications affected 12 patients (3.9%), all requiring suprapubic catheterization under local anesthesia for urinary retention. Grade IIIb complications occurred in 5 patients (1.6%), all requiring surgical intervention under anesthesia for early recurrence.

Regarding the eight patients in Group 1 who required blood transfusions, the majority (n=6) had strictures in the membranous urethra, with the remaining two cases involving the proximal bulbar urethra. Most of these patients (n=5) had underlying comorbidities including anticoagulant use for cardiac conditions (n=3), and thrombocytopenia due to hematologic conditions (n=2), which were appropriately managed perioperatively but may have contributed to increased bleeding risk. The mean hemoglobin drop in these patients was 3.2±0.7 g/dL. All transfusion events were managed without further complications, and no surgical reintervention was required for hemorrhage control. Pre-operative coagulation profile was normal in all patients, with temporary discontinuation of anticoagulants according to current guidelines.

In Group 2 (n=308), the complication profile was more favorable. Grade I complications affected 32 patients (10.4%), including transient hematuria (n=20), mild urinary tract infection (n=8), and temporary urinary retention (n=4). Grade II complications occurred in 15 patients (4.9%), with severe urinary tract infection requiring antibiotics (n=12) and significant hematuria requiring transfusion (n=3). Grade IIIa complications affected 6 patients (1.9%), all requiring suprapubic catheterization under local anesthesia. Grade IIIb complications occurred in only 2 patients (0.6%), who required surgical intervention under anesthesia for early recurrence. No Grade IV (life-threatening complications) or Grade V (death) complications occurred in either group. The overall complication rate was significantly lower in Group 2 (17.9% vs 29.6%, $p=0.003$).

The 3 transfusion cases in Group 2 all occurred in patients with membranous urethral strictures and had similar risk factors to those in Group 1, including anticoagulant use (n=2) and a history of hematologic disorder (n=1). The mean hemoglobin drop in these patients was 2.9±0.5 g/dL. The hemostatic properties of the Holmium:YAG laser likely contributed to the reduced transfusion rate observed in Group 2 (1.0% vs 2.6% in Group 1, $p=0.032$), particularly in high-risk patients.

QUALITY OF LIFE ASSESSMENT

USS-PROM scores demonstrated greater improvement in the laser group, improving from baseline scores of 45.6±10.2 to 85.4±8.6 at 12 months, compared to the cold knife group's improvement from 46.1±9.8 to 72.6±9.2 ($p<0.001$ for between-group difference). Patient satisfaction scores at 12 months were significantly higher in the laser group. The mean time to return to normal activities was shorter in the laser group (8.2±2.4 days vs 10.8±3.2 days, $p<0.001$), and work productivity assessment showed earlier return to full employment in the laser group (mean difference: 2.4 days, $p=0.008$).

DISCUSSION

Our study demonstrates that Holmium:YAG laser urethrotomy provides superior outcomes compared to cold knife urethrotomy for managing urethral strictures, particularly regarding recurrence rates, operative parameters, and functional outcomes. We observed significantly lower recurrence rates with Holmium laser urethrotomy (16.9%) compared to cold knife urethrotomy (32.2%), with this difference being particularly pronounced in membranous urethral strictures (19.6% vs 38.4%).

These findings align with Chi et al.'s comprehensive analysis, which reported that Holmium:YAG laser internal urethrotomy demonstrated favorable outcomes regarding perioperative complications and bleeding compared to cold knife optical internal urethrotomy.[11] While Chi and colleagues observed similar efficacy in improving postoperative mean maximum Qmax between techniques, our research found superior functional outcomes in the Holmium laser group across all follow-up time points, with significant improvements in Qmax, IPSS, and post-void residual volumes.[11]

Chen et al.'s research further supports our observations regarding the advantages of minimally invasive approaches in urethral stricture management. Their work emphasized the importance of technique selection based on stricture characteristics, corresponding with our finding that stricture location and length significantly influence treatment outcomes.[12] Our study extends these observations by demonstrating that Holmium:YAG laser urethrotomy not only provides better surgical outcomes but also results in improved quality of life measures and faster return to normal activities.

A notable finding in our research was the lower incidence of post-procedure stress urinary incontinence in membranous urethral strictures treated with Holmium laser. This observation is particularly significant given that Chi et al. identified perioperative complications as a crucial factor in technique selection, with Holmium:YAG laser internal urethrotomy showing superior safety outcomes in their analysis.[11] The shorter operative times and reduced intraoperative bleeding observed in our Holmium laser group (17.9% overall complication rate versus 29.6% in the cold knife group) further validate these findings.

Our multivariate analysis identified treatment modality, stricture location, stricture length, and previous catheterization history as independent predictors of recurrence. These findings complement Chi et al.'s observations regarding the importance of considering individual patient characteristics in technique selection.[11] The comprehensive preoperative evaluation and standardized follow-up protocol employed in our study allowed for detailed assessment of these prognostic factors.

Several limitations warrant consideration. Despite our robust sample size (612 patients) and systematic follow-up, the retrospective design introduces potential selection bias. Additionally, while our 12-month follow-up period provided significant insights, longer-term outcomes would further validate the durability of these results. Future prospective, multicenter studies with extended follow-up periods would be valuable in further validating these findings and establishing standardized treatment protocols.

CONCLUSION

This study suggests that Holmium laser urethrotomy may offer advantages over cold knife urethrotomy for treating urethral strictures. The observed lower recurrence rates, reduced complications, and improved functional outcomes indicate that Holmium laser urethrotomy could be considered a preferred approach, particularly for membranous urethral strictures. These findings contribute to the growing evidence supporting laser technology in urological procedures and may help inform clinical decision-making in urethral stricture management.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

***Idea/Concept:** Ali Nebioğlu, Can Arici; **Design:** Erdem Akbay, Mert Başaranoğlu; **Control/Supervision:** Erdem Akbay, Ali Nebioğlu; **Data Collection and/or Processing:** Can Arici, Mert Başaranoğlu; **Analysis and/or Interpretation:** Erdem Akbay, Mert Başaranoğlu; **Literature Review:** Mert Başaranoğlu, Ali Nebioğlu; **Writing the Article:** Ali Nebioğlu; **Critical Review:** Erdem Akbay; **Materials:** Can Arici, Mert Başaranoğlu.*

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