Engineering and Urology Society

30th Annual Meeting

Saturday May 16th, 2015

New Orleans, LA

http://engineering-urology.org/
The Engineering and Urology Society offers a unique opportunity for collaboration where engineering innovation meets clinical demand. This leads to exchange of ideas and routes to address clinical problems with engineering solutions. The ultimate forum where these interchanges occur is at the Annual Meeting of the Society held in conjunction with the Annual American Urological Association Meeting. The EUS meeting is also the only dedicated section of the Endourology Society at the AUA. The Annual Meeting offers the delegates an opportunity to present and learn about the latest research developments in urologic technology.

This year's 30th Annual Meeting has been organized by program chairmen Peter Schulam and Jean Zheng. The morning sessions will begin with an update on stent development from biodegradable to antimicrobial and new stent commercialization. Next advances in regenerative medicine and engineering of an ileal conduit will be discussed, followed by award presentations. The third session will be presented by our colleagues from the European Association of Urology (EAU), Uro-Technology section (ESUT) on CT navigated robotic surgery, robotic flexible ureteroscopy, a novel use of ultrasound for kidney stones. Next the overlap between technology and urologic oncology will be reviewed during the interventional oncology session. Innovations in prostate imaging and fusion biopsy as well as renal biopsy and ablation. The session will be concluded with a presentation on prostate embolization and review of focal therapy for prostate cancer. After lunch break, a controversial session on LESS and NOTES followed by a session on innovations in urology. The plenary session will conclude with a report by the image guided working group.

Two poster session during the afternoon will provide a forum for uro-technology researchers to present and discuss their latest findings. The review of the abstracts for the poster sessions was performed online by a group of 72 reviewers from around the world. Each paper received between 17 and 19 reviews. We would like to thank the reviewers, listed at the end of this program book, for their essential contribution to the quality of the meeting and their constructive comments that they made for the research.

The selection of the Best Paper Awards was made by a committee among the top 5 ranked scientific score abstracts. The society awards two abstracts this year, the “Scanning Fiber Technology for Rapid Volumetric Optical Coherence Tomography Cystoscopy” and “MR-Guided Boiling Histotripsy of the Kidney Using a Clinical High Intensity Focused Ultrasound System”, both from the University of Washington in collaboration with Stanford University respectively Philips Healthcare. Top 10 abstracts are also awarded, and listed at the end of this program book. The authors of all awarded abstracts are invited to submit full length articles to the Journal of Endourology on the respective topics.

We gratefully thank all reviewers for their hard work, objective scoring, and contribution to the success of the meeting. The society also presents Best Reviewer Awards, presented to Cosmin Ene, Arvind Ganpule, Louis Kavoussi, Thomas Lawson, Wesley Ludwig, Razvan Multescu, Sutchin Patel, Arnoud Postema, Ioanell Sinescu, and Cristian Surcel.

We congratulate all award winners and welcome all urologists, engineers, and scientists to join us for this unique multi and interdisciplinary experience. As always, we are grateful to Dr. George Nagamatsu, the founder and first president of the society for setting the foundations based upon which we meet.

Please visit the website http://engineering-urology.org for a complete version of this program including the abstracts presented.

Thank you for your continued scientific support,

Raymond Leveillee
Arieh Shalhav
Dan Stoianovici
AUA ACCREDITATION INFORMATION

Accreditation: The American Urological Association (AUA) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

Credit Designation: The American Urological Association designates this live activity for a maximum of 7.75 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Evidence Based Content: It is the policy of the AUA to ensure that the content contained in this CME activity is valid, fair, balanced, scientifically rigorous, and free of commercial bias.

AUA Disclosure Policy: All persons in a position to control the content of an educational activity (i.e., activity planners, presenters, authors) participating in an educational activity provided by the AUA are required to disclose to the provider any relevant financial relationships with any commercial interest. The AUA must determine if the individual’s relationships may influence the educational content and resolve any conflicts of interest prior to the commencement of the educational activity. The intent of this disclosure is not to prevent individuals with relevant financial relationships from participating, but rather to provide learners information with which they can make their own judgments.

Resolution of Identified Conflict of Interest: All disclosures will be reviewed by the program/course directors or editors for identification of conflicts of interest. Peer reviewers, working with the program directors and/or editors, will document the mechanism(s) for management and resolution of the conflict of interest and final approval of the activity will be documented prior to implementation. Any of the mechanisms below can/will be used to resolve conflict of interest:

- Peer review for valid, evidence-based content of all materials associated with an educational activity by the course/program director, editor, and/or Education Content Review Committee or its subgroup.
- Limit content to evidence with no recommendations
- Introduction of a debate format with an unbiased moderator (point-counterpoint)
- Inclusion of moderated panel discussion
- Publication of a parallel or rebuttal article for an article that is felt to be biased
- Limit equipment representatives to providing logistics and operation support only in procedural demonstrations
- Divestiture of the relationship by faculty

Off-label or Unapproved Use of Drugs or Devices: It is the policy of the AUA to require the disclosure of all references to off-label or unapproved uses of drugs or devices prior to the presentation of educational content. The audience is advised that this continuing medical education activity may contain reference(s) to off-label or unapproved uses of drugs or devices. Please consult the prescribing information for full disclosure of approved uses.

Disclaimer: The opinions and recommendations expressed by faculty, authors and other experts whose input is included in this program are their own and do not necessarily represent the viewpoint of the AUA.

Audio, Video and Photographic Equipment: The use of audio, video and other photographic recording equipment by attendees is prohibited inside AUA meeting rooms.

Reproduction Permission: Reproduction of written materials developed for this AUA course is prohibited without the written permission from individual authors and the American Urological Association.

Special Assistance/Dietary Needs: The American Urological Association complies with the Americans with Disabilities Act §12112(a). If any participant is in need of special assistance or has any dietary restrictions, please see the registration desk.
### Faculty Disclosures:

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<td>Breda, Alberto</td>
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<td>Chew, Ben</td>
<td>Boston Scientific Corporation: Consultant or Advisor, Cook Urological: Consultant or Advisor, Scientific Study or Trial, Olympus-ACMI: Consultant or Advisor, PercSys: Consultant or Advisor, Scientific Study or Trial, Poly-Med Inc: Consultant or Advisor, Scientific Study or Trial, Urotech: Consultant or Advisor</td>
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<td>Su, Li-Ming</td>
<td>Titan Medical Inc: Consultant or Advisor, AUA-Advanced Robotic Urology: Improving Technique and Outcome: Meeting Participant or Lecturer, Mauna Kea Technologies: Consultant or Advisor, MiMedx Group, Inc: Consultant or Advisor, University of Florida Dept of Urology CME Seminar Series: Meeting Participant or Lecturer, Florida Urological Society: Meeting Participant or Lecturer, World Congress of Endourology: Meeting Participant or Lecturer, Springer- Atlas of Robotic Urologic Surgery: Health Publishing, Dannemiller/4th Annual Pacific NW Robotic Urology Symposium: Meeting Participant or Lecturer</td>
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<td>Journal of Endourology and Videourology: Leadership Position, Sonacare, Inc: Scientific Study or Trial, OnTarget, Inc: Scientific study or trial</td>
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<td>Vourganti, Srinivas</td>
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EXHIBITORS

Boston Scientific – Urology

Boston Scientific is a leading developer of less-invasive medical technologies. Products for the Urology/Women's Health division include devices for the diagnosis and treatment of kidney stones, BPH, female urinary incontinence, and pelvic floor reconstruction. Please visit our exhibit to learn about our newest technologies and our commitment to physician education.

Cook Medical

Cook Medical has been a leading supplier of medical devices for urologists for over 35 years. Offering interventional and Biodesign® technologies that support diagnostic and therapeutic procedures in adult and pediatric urology, Cook has placed particular emphasis on stone management as well as both male and female pelvic health.
PROGRAM

30th Annual Meeting
Saturday, May 16, 2015
Hilton New Orleans Riverside
Napoleon Ballooom
New Orleans, Louisiana

Program Chairs: Peter G. Schulam and Jean Zheng

7:15am  Registration Opens

7:25 - 7:30am  Welcome – Program Chairmen
Peter Schulam

7:30 - 8.20am  SESSION 1: Advances in Ureteral Stent Development
Ravi Kulkarni

7:30 - 7:40am  Biodegradable Materials in Urology
Ben Chew

7:40 – 7:50am  Antimicrobial Approaches to Rendering Urinary Biomaterial Surfaces Sterile
Dirk Lange

7:50 – 8:00am  A New Stent
Ravi Kulkarni

8:00 – 8:10am  Commercializing New Stent Technology: Challenges & Opportunities
Tim Harrah

8:10 – 8:20am  Questions & Discussions

8:20 – 9:15am  SESSION 2: Regenerative Medicine
Peter Schulam

8:20 – 8:50am  Update on Regenerative Medicine
Anthony Atala

8:50 – 9:10am  Christopher Loose

9:10 – 9:15am  Questions & Discussions

9:15 - 10:15am  SESSION 3: ESUT Session
Alberto Breda
Jens Rassweiler
Pilar Laguna

9:15 – 9:30am  Dyna-CT-navigated Robotic Surgery
Dogu Teber

9:30 – 9:45am  New Developments in Robotic Flexible Ureteroscopy
Jens Rassweiler

9:45 – 10:00am  Novel Use of Ultrasound for Kidney Stone Management – First Clinical Study
Jonathan Harper

10:00 – 10:15am  Latest News from the IRCAD – NOTES, LESS & More
Roland Van Velthoven

10:15 – 10:30  AWARDS PRESENTATIONS
Dan Stoianovici

10:15 – 10:20am  Awards
Kristen L. Lurie

10:20 – 10:25am  Scanning Fiber Technology for Rapid Volumetric Optical Coherence Tomography Cystoscopy
George R. Schade

10:25 – 10:30am  MR-Guided Boiling Histotripsy of the Kidney Using a Clinical High Intensity Focused Ultrasound System

10:30 - 12:00pm  SESSION 4: Interventional Urologic Oncology
Brian Shuch

10:30 – 10:45am  The New Frontier of Prostate Cancer Imaging, Beyond Multi-Parametric MRI
Peter Choyke

10:45 – 11:00am  Latest Advances in Prostate Fusion Biopsy
Srinivas Vourganti

11:00 – 11:15am  The Current and Emerging Role of Renal Biopsy for the Renal Mass
Jaime Landman

11:15 – 11:30am  Renal Tumor Ablation: What’s New on the Horizon
Brian Shuch

11:30 – 11:45am  Current and Emerging Indications for Prostate Embolization
Art Rastinhad

11:45 - 12:00pm  Current Status of Focal Therapy Modalities for Prostate Cancer
Peter Pinto

12:00 – 1:00pm  LUNCH BREAK
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<td><strong>SESSION 5: Less and Notes</strong></td>
<td>Abhay Rane</td>
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<td>1:00 – 1:10pm</td>
<td>LESS: The Egyptian Experience</td>
<td>Aly Abdel-Karim</td>
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<td>1:10 – 1:20pm</td>
<td>LESS and NOTES Publications Update</td>
<td>Brian Irwin</td>
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<td>1:20 – 1:30pm</td>
<td>“New” Robotic LESS is the Way Forward</td>
<td>Jihad Kaouk</td>
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<td>1:30 – 1:40pm</td>
<td>LESS in the Developing World</td>
<td>P.P. Rao</td>
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<td>1:40 – 1:50pm</td>
<td>LESS Donor Nephrectomy</td>
<td>Ricardo Autorino</td>
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<td>1:50 – 2:00pm</td>
<td>Is LESS Here to Stay</td>
<td>Lee Ponsky</td>
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<td>2:00 – 3:00pm</td>
<td><strong>SESSION 6: Imaged Guided Working Group</strong></td>
<td>James Borin</td>
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<td>2:00 – 2:10pm</td>
<td>MRI/US Fusion for Diagnosis and Treatment of Prostate Cancer in the office setting</td>
<td>Samir Taneja</td>
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<td>2:10 – 2:20pm</td>
<td>Technical Solutions to Improve the Management of Non-Muscle Invasive Transitional Cell Carcinoma</td>
<td>Evangelos Liatsikos</td>
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<td>2:20 – 2:30pm</td>
<td>Fiberoptic Confocal Laser Endomicroscopy: Optical Tissue Characterization of Renal Tumors</td>
<td>Li-Ming Su</td>
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<td>2:30 – 2:40pm</td>
<td>3D Printing of Urological Malignancies</td>
<td>Jonathan Silberstein</td>
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<td>2:40 – 2:50pm</td>
<td>Laparoscopic HiFu for the treatment of small renal masses</td>
<td>Chandru Sundaram</td>
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<td>2:50 – 3:00pm</td>
<td>New Horizons for Imaging of Kidney Stones to Guide Therapy</td>
<td>Ojas Shah</td>
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<td>2:00 – 4:00pm</td>
<td><strong>“Innovations in Urology”</strong></td>
<td>Bodo Knudsen</td>
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<td>2:00 – 2:05pm</td>
<td>Welcome and Instruction</td>
<td>Peter Schulam</td>
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<td>2:05 – 2:15pm</td>
<td>Lecture on Grants Process and Availability</td>
<td>Jeffrey Cadeddu</td>
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<td>2:15 – 2:30pm</td>
<td>SBIR Grant and How he Benefitted/Used It</td>
<td>Ziya Kirkali</td>
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<td>2:25 – 2:45pm</td>
<td>Talk on Startups, Lessons Learned and Alternatives to SBIR</td>
<td>Hassan Razvi</td>
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<td>2:45 – 3:05pm</td>
<td>Keynote – The Collaboration Paradox, Inventing Solutions in a Hyper-Connected Environment</td>
<td>Errol Singh</td>
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<td>John Abele</td>
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<td>3:05 – 3:20pm</td>
<td>Corporation View on Patents</td>
<td>Robert Behl</td>
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<td>3:35 – 4:00pm</td>
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<td>George R. Schade</td>
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<td>Oscar Fugita</td>
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<td>Room: Melrose</td>
<td>Thomas Lawson</td>
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<td>Cristian Surcel</td>
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<td>3:00–4:30PM</td>
<td>Poster Session 2</td>
<td>Sutchin Patel</td>
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<td>Room: Melrose</td>
<td>Nathaniel Fried</td>
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<td>Arvind Ganpule</td>
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<td>Petrisor Geavlete</td>
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<td>Petrisor Geavlete</td>
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<td>Mayura Nakano</td>
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<td>Mahesh Desai</td>
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<td>Christopher R. Mitchell</td>
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<td>Dae Keun Kim</td>
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| 24 | **BEST PAPER AWARD**
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ABSTRACT 1

BIPOLAR PLASMA ENUCLEATION VERSUS OPEN PROSTECTOMY WITHIN A 4 YEARS’ FOLLOW-UP – A TECHNOLOGICAL ADVANCEMENT IN LARGE BPH ENDOSCOPIC APPROACH

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Introduction: A long term, prospective, randomized-controlled trial assessed the viability of the bipolar plasma enucleation of the prostate (BPEP) by comparison to open transvesical prostatectomy (OP) in cases of large prostates.

Methods: A total of 140 benign prostatic hyperplasia (BPH) patients with prostate volume over 80 mL, maximum flow rate ($Q_{\text{max}}$) below 10 mL/s and International Prostate Symptom Score (IPSS) over 19 were equally randomized in 2 study arms for BPEP and OP (70 cases each). All patients were evaluated every 6 months after surgery for a period of 4 years by IPSS, $Q_{\text{max}}$, quality of life score (QoL), post-voiding residual urinary volume (PVR), postoperative prostate volume and PSA level evolution.

Results: BPEP and OP emphasized similar mean operating times (91.4 versus 87.5 minutes) and resected tissue weights (108.3 versus 115.4 grams). The postoperative hematuria rate (2.9% versus 12.9%), mean hemoglobin level drop (1.7 versus 3.1 g/dL), catheterization period (1.5 versus 5.8 days) and hospital stay (2.1 versus 6.9 days) were significantly reduced in the BPEP group. Re-catheterization for acute urinary retention was more frequent after OP (8.6% versus 1.4%), while the early irritative symptoms’ rates were similar subsequent to BPEP and OP (11.4% versus 7.1%). During the 4 year’ follow-up, no statistically significant differences were determined in terms of IPSS, $Q_{\text{max}}$, QoL, PVR, PSA level and prostate volume between the two series. Consequently, the calculated prostate volume decreases and PSA level reductions by comparison to preoperative measurements were statistically equivalent in the BPEP and OP study arms.

Conclusion: BPEP was characterized by similar surgical efficiency as well as BPH tissue removal capabilities when compared to OP. Plasma enucleation patients benefited from a superior perioperative safety profile, significantly fewer complications, shorter convalescence period and satisfactory long term symptom scores and voiding parameters.
ABSTRACT 2

SPIES VERSUS NBI TECHNOLOGY IN BLADDER TUMOR DIAGNOSIS – FIRST COMPARATIVE EVALUATION

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Introduction: The trial was aimed to assess the reliability of SPIES (Storz professional image enhancement system) technology by comparison to NBI (narrow band imaging) from the perspective of non-muscle invasive bladder cancer (NMIBC) diagnostic.

Methods: A total of 20 NMIBC suspected consecutive cases were enrolled in this initial series. The inclusion criteria were represented by hematuria, positive urinary cytology and/or ultrasound suspicion of bladder tumors. Following the standard white light cystoscopy (WLC), all patients underwent SPIES (using all 4 available modes) and NBI evaluation of the bladder mucosa. Conventional transurethral resection (TURBT) was performed for all white light visible lesions, while SPIES and NBI guided resection were distinctively performed for tumors exclusively visible in the respective vision modes.

Results: The overall NMIBC lesions detection rate was significantly improved for SPIES (95.3%) and NBI (93%) cystoscopy by comparison to WLC (83.7%). A total of 5 and respectively 4 patients were described subsequent SPIES and NBI as presenting supplementary tumors when drawing a parallel to classical endoscopy. Two patients were only diagnosed with bladder cancer by applying SPIES and/or NBI. No significant differences were determined between SPIES and NBI regarding NMIBC diagnostic accuracy regardless of tumor stage. A total of 7 (3 CIS, 3 pTa and 1 pT1) and respectively 6 (2 CIS and 4 pTa) lesions were solely discovered using SPIES and NBI modes.

Conclusion: SPIES and NBI cystoscopic alternatives were emphasized as presenting a substantially improved NMIBC diagnostic accuracy when compared to standard WLC. On a lesions related basis, the present study confirmed the detection advantages of both SPIES and NBI over conventional endoscopy.
MORPHOLOGICAL ANALYSIS OF THE EFFECTS OF INTRA-OPERATIVE TRANSRECTAL COMPRESSION OF THE PROSTATE DURING HIGH-INTENSITY FOCUSED ULTRASOUND FOR LOCALIZED PROSTATE CANCER: IMPLICATION FOR LESION TARGETED FOCAL THERAPY

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Introduction: In previous reports, prostatic swelling and shift occurred during whole gland high-intensity focused ultrasound (HIFU) as a result of diffuse coagulative degeneration and diffuse stromal edema of the prostate. Therefore, intra-operative adjustment of the treatment plan in patients with intra-operative prostatic swelling is required for precise treatment with HIFU. However, intra-operative tracking of the small target zone during HIFU is difficult because of the blurred ultrasound image affected by HIFU. The objective of this study is to evaluate the effects of transrectal compression of the prostate for intra-operative prostatic swelling and shift during HIFU of localized prostate cancer.

Methods: Patients treated with whole-gland HIFU as primary monotherapy for localized prostate cancer were enrolled in the study. Using the standard and compression method, the volumes of degassed water in the balloon covering the HIFU probe were 50 mL and 80–160 mL, respectively. To identify prostatic swelling and shift during HIFU and the volume occupied by the non-enhanced area, three-dimensional prostate models were reconstructed using ultrasound and contrast-enhanced magnetic resonance imaging.

Results: In comparison with the standard (n=40) and compression (n=48) methods, intra-operative increase in the prostate volume (21% vs. 5.3%; p=0.044), intra-prostatic point shift (4 mm vs. 2 mm, p=0.040 in the transition zone; 3 mm vs 0 mm; p=0.001 in the peripheral zone) and the volume occupied by the non-enhanced area (89% vs. 96%; p=0.001) were significantly suppressed. The biochemical disease-free survival rate in patients treated using the compression method were significantly improved relative to the standard method (92.6% vs. 76.5%; p=0.038). Regarding complications, there was no significant difference in the rate of urethral stricture (p=0.9), urinary tract infection (p=0.9), incontinence (p=0.3), erectile dysfunction (p=0.9), or recto-urethral fistula between the patients treated using the standard and compression methods.

Conclusion: Intra-operative transrectal compression suppressed intra-operative increase in the prostate volume and intra-prostatic point shift during HIFU, and has the potential to achieve precise whole gland and lesion-targeted focal therapy.
PERFORMING HIFU ONE MONTH AFTER TURP RATHER THAN IMMEDIATELY AFTER TURP DECREASES TREATMENT MORBIDITY

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Introduction: Transurethral prostate resection (TURP) prior to Ablatherm® High Intensity Focused Ultrasound (HIFU) is performed to both reduce urinary obstructive morbidity and to ensure complete prostate ablation. TURP optimizes larger prostates to match the technical limit of the HIFU penetration depth. We studied differences of "concomitant" HIFU and TURP (immediately before HIFU under the same anesthesia) or "delayed" HIFU (performed 1 month after TURP) in terms of side effects, HIFU dose, treatment time as well as the influence of TURP technology (mono-/bipolar) and technical changes since 2000.

Methods: 1,529 patients were treated with TURP & HIFU. 1,346 patients with complete data were included in the analysis. The prospective data collection includes 140 individual data/HIFU treatment since 1996, divided into annual cohorts. TURP was introduced as a routine adjuvant in 2000 to remove calcifications, middle lobes, abscesses and adenomas before HIFU and also to right-size the prostate when needed. Monopolar TURP was used until 2007 when it was replaced by bipolar Video-TURP. The HIFU device used was the Ablatherm Integrated Imaging® (EDAP-TMS, Lyon).

Results: In 2001, only 10% of patients had delayed HIFU. This increased to 54% in 2010 and 66% in 2013. HIFU delay did not impact treatment time: in 1 105 concomitant cases, ablation lasted 94 minutes on average (range: 72-115), in the delayed population it was 92 minutes (range: 65-119). HIFU dose was 562 (range: 433-682) lesions and 549 (range: 391-717) in the concomitant and delayed groups respectively. An increase in TURP relative volume was observed over time from 53% (range: 48-63) prior to 2007 and 66% (range: 63-70) after, when bipolar Video-TURP was utilized. Analysis of the adverse event data demonstrated delayed HIFU to reduce the already low side effect rate (secondary obstruction, tissue sludging, UTI and catheter time) by 50% to 0.24/patient.

Conclusion: TURP is necessary to avoid side effects with all HIFU technology and to ensure efficacy for complete HIFU ablation of larger glands with Ablatherm Integrated Imaging®. Whether HIFU is performed concomitant or delayed does not influence efficacy (PSA-Nadir) but side effect rate is reduced to 50% in delayed HIFU cases.
ABSTRACT 5

LASERCLAST: LASER WITH SUCTION AS AN ENERGY SOURCE IN MINI PCNL

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Introduction: Laser is the preferred method of stone fragmentation in mini PCNL. Laser with Suction in PCNL has been used but the size of the unit available in market is 10 Fr or more, making it unsuitable to be used in Mini PCNL. Laser is an optimal energy source in mini PCNL but the dust generated, along with clots, poses significant difficulty in visualization during the procedure. If the stone dust were suctioned it would expedite the procedure as well as remove the nidus for recurrent stone. To validate this, we propose using a Laser with a suction device.

Methods: We retrospectively evaluated data of patients who underwent mini PCNL using laser with suction from February 2014 to February 2015. A total of 50 patients were operated using suction with laser by EMS™ using standard mini PCNL assembly by storz. For doing mini PCNL standard steps were followed and after nephroscopy laser with suction device manufactured by EMS™ was used. The device consists of a 4.5 Fr suction tube with suction control valve. The suction tube includes a laser fibre guidance cannula through which a 200-365 micron fibre can be passed. The suction device can be passed through the 5 Fr. working channel of a mini PCNL Storz scope. A 272 micron end firing optical fibre with pulsed holmium:yttrium-aluminum-garnet (Ho:YAG) laser was used with setting of a long pulse, 0.8 J and 15 Hz.

Results: The average age of the patients was 40 years, and the mean stone size was 20.26 mm. Average operative time was 55.5 min, and average hospital stay was 1.87 days. Average tract size was 18 Fr and stone clearance rate was 100%. There were no major postoperative complications. The visibility during nephroscopy was markedly improved and the nephroscopy time shortened, as compared to our standard mini PCNL, and clearance rate comparable.

Conclusion: From this initial study, EMS™ Laser with suction is an extremely useful device, it improves vision, and significantly decreases the nephroscopy time as compared to the standard literature, and has comparable clearance rates. We propose a randomized control trial to prove the efficacy of this device.
ABSTRACT 6

A NOVEL CONCENTRIC TUBE ROBOTIC PLATFORM FOR TRANSURETHRAL PROSTATE SURGERY

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Introduction: While many consider transurethral resection of the prostate (TURP) the gold standard treatment for benign prostate hyperplasia (BPH), recent evidence has shown that holmium laser enucleation of the prostate (HoLEP) is at least as effective as TURP, with less perioperative morbidity including shorter length of catheter use, lower transfusion rates, and shorter hospital stay. Despite the advantages of HoLEP, there has been reluctance of the urologic community to adopt the procedure, primarily as a result of a perceived steep learning curve. Thus, we sought to design and develop a novel transurethral endoscopic robotic platform for HoLEP.

Methods: An intensive clinical collaboration between Vanderbilt engineers and urologists was undertaken to develop a handheld robot that passes through a standard endoscope with the specific goal of improving the ease with which HoLEP is able to be performed.

Results: The robotic system design consists of 3 main modules: the user interface, the transmission, and the endoscope (Figure 1). The user interface consists of 2 handles, each with an embedded joystick and trigger which are linked to motors responsible for driving the concentric tube manipulators. The transmission section converts the motion of the motors into translation and rotation of the tubes. The endoscope contains optics, inflow/outflow channels, and a 5mm working channel through which 2 concentric tube robots are passed. Each concentric tube consists of a straight outer tube and superelastic nitinol inner tube that is pre-shaped into a curved configuration. When these tubes are translated and rotated, their elastic interaction creates a “tentacle-like” motion. The entire hand-held robot is mounted on a counterbalanced arm to allow for manual manipulation and positioning of the entire robot by the surgeon.

Conclusions: We have developed a concentric tube robotic platform passed through a standard endoscope capable of producing complex movements of the end effectors. Through these motions, it possible to retract tissue with one arm and aim a laser with the other, thus alleviating one of the major challenges encountered during HoLEP.
ABSTRACT 7

ROBOTIC HEMINEPHRECTOMY: A MATCHED COMPARISON OF OUTCOMES TO RADICAL NEPHRECTOMY
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Introduction: With the growing experience in the robotic partial nephrectomy (RPN), the complexities of cases are also increasing, at times involving extensive resection of renal volume. It has been proposed that PN in such setting might not provide any tangible benefit compared to radical nephrectomy (RN). Our objective was to compare outcomes of RPN and RN in patients where nephron-sparing surgery (NSS) would have mandated more than 30% of parenchymal resection (heminephrectomy).

Methods: Patients undergoing robotic heminephrectomy (RH) from 2006 to 2014 were identified from our prospectively maintained RPN database. The extent of parenchymal resection was determined subjectively by the operating surgeon at the time of NSS. We matched this cohort with patients undergoing laparoscopic RN (LRN) based on tumor R.E.N.A.L nephrometry score. Pre and postoperative CT based volumetric assessment of the operated kidney was performed in the RH group. Demographics, perioperative, functional and oncological outcomes were compared between the groups. Multivariable analysis of factors predicting chronic kidney disease upstaging (type of surgery, Charlson score, tumor size, baseline eGFR, R.E.N.A.L score) was performed.

Results: From 809 RPNs performed during the study period, 91 patients met our inclusion criteria. The median R.E.N.A.L score was 9 (IQR 8-10). Demographic variables were comparable between the groups with higher Charlson score in the LRN group (5 vs. 3; p=0.002). Patients in the LRN group had lower baseline eGFR (70.6 vs. 83.8 ml/min/1.73m2; p=0.008) and larger tumor sizes (5.7 vs. 5 cm; p=0.006). The rates of overall and major complications were comparable between LRN and RH (43.8 vs. 32.2%; 7.9 vs. 10.3%). The median renal volume preservation in the RH group was 58.4% (IQR 50.6-69.5). The RH group had higher overall GFR preservation (79.2 vs. 68.7%; p=0.005). The rate of CKD upstaging to stage III-V was significantly higher in the LRN group (51 vs. 27.5%; p=0.001). On multivariable analysis LRN was a predictor of CKD upstaging (OR 2.9 95% CI (1.5-5.8); p=0.002). During the median follow up time of 20 months, local recurrence (0 vs. 2.2%; p=0.49) and all-cause mortality (13.2 vs. 6.6%; p=0.13) were comparable between LRN and RH respectively.

Conclusion: Robotic heminephrectomy provides renal functional preservation without significant increase in surgical complications or compromising intermediate-term oncological outcomes when compared to LRN. Even when relatively large parenchymal resection is anticipated (heminephrectomy), NSS might be worthy of consideration.
ABSTRACT 8

ASSESSING FEASIBILITY OF A NEW FUNDICIAL MARKER (BioXmark) FOR BLADDER TUMOR LOCALIZATION AND POSITION VERIFICATION DURING RADICAL RADIOTHERAPY IN A PORCINE PHANTOM

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Introduction: Radical radiotherapy is an alternative to cystectomy in appropriately selected patients with localized muscle invasive bladder cancer as part of a multi-modality strategy. Reducing radiation dose to the uninvolved bladder while maintaining or increasing tumour dose has the potential to reduce side effects without compromise in local control. This approach necessitates accurate tumour localisation at the time of radiotherapy planning and position verification for treatment delivery in order to prevent geographical misses. We report on the first use of a novel radiographic fiducial marker (BioXmark) in an ex-vivo tissue equivalent bladder model to optimize bladder radiotherapy.

Methods: A porcine bladder with urethra attached was laid opened. A 1 cm inked lesion was marked as a tumour surrogate (Figure 1a). 0.1ml ready to use BioXmark (kindly provided by Nanovi Radiotherapy A/S) composed of three constituents; sucrose acetate isobutyrate (SAIB), x-SAIB and ethanol in the ratio 50:30:20 (w/w%) was injected sub-mucosally using a 25G needle at 8 equally spaced intervals 1cm from the surrogate tumour edge. The porcine bladder was sutured, catheterised and filled with 100mls of water. This was suspended within a central cylindrical cavity and inserted into a pelvic phantom, consisting of a water filled acrylic shell containing bone density equivalent structures (see Figure 1b). The phantom was imaged on the radiotherapy CT scanner, linear accelerator (cone beam CT, kilovoltage X-rays) and 1.5T MRI scanner acquiring T1-weighted (T1w), T2-weighted (T2w) and diffusion weighted images (DWI) to determine quality of 3D visualisation.

Results: The gelation process of the BioXmark was initiated immediately, after 90 seconds shape and localization was maintained at each sub-mucosal injection site. Within 90 minutes the gelation process was completed. BioXmark was easily visualised at all injection sites on the planning CT, cone beam CT and T1w MRI. BioXmark appeared dark on MRI, therefore was less easily seen on sequences not yielding high signal from the bladder wall (T2W and DWI). Although DWI appeared distorted, disturbance to the magnetic field homogeneity was not associated with BioXmark but because of an air bubble and other phantom materials.

Conclusion: BioXmark provides opportunity to aid bladder tumour localisation for radiotherapy planning and delivery. Further work in the clinical setting is now needed.
ABSTRACT 9

OPERATOR DISSATISFACTION WITH FLEXIBLE URETEROSCOPES RARELY RESULTS IN SCOPE REPAIR: A PROSPECTIVE MULTI-CENTER STUDY

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Introduction: Flexible ureteroscopy is routinely used to treat upper tract stones and other pathologies. Reusable scopes continue to pose a significant cost and administrative burden to hospital systems, but few studies have examined long-term performance and operator satisfaction. Flexible ureteroscope durability and operator satisfaction were assessed in a prospective study at six high volume institutions comprising the Western Endourology Stone (WESt) research consortium.

Methods: Surveys were performed using Research Electronic Data Capture (REDCap) software at the start and end of consecutive flexible ureteroscopic procedures to document case characteristics including ureteroscope properties, accessories used, patient characteristics, and stone location. Operator satisfaction with visualization and performance was reported on a Likert scale. Scope photographs at maximal flexion (up and down) were obtained at the start and end of each case and measured with a computerized protractor.

Results: Data from 112 flexible ureteroscopic cases (left, right, bilateral: 51, 43, 6% respectively) were collected. Cases were primarily performed by an attending, fellow or resident, with residents involved in 80% of cases. There were 80 (73%) stone cases; upper pole stones were involved in 22, mid pole in 23, lower pole in 40, and ureter in 29 cases. Previously repaired scopes were used in 25 (23%) cases; new scopes were used in 84 (76%). The average decrease in deflection between the start and end of each case was 3.9 degrees in downward deflection, and 3.5 degrees in upward deflection. Operators were “concerned” or “very concerned” about ureteroscope performance in 16 (15%) cases, in which only five were sent for repairs. Visibility was reported to be “somewhat compromised,” “severely compromised,” and “unusable” in 29 (27%) cases.

Conclusion: Compromised flexible ureteroscope flexion is a significant and progressive problem. Surgeons are often dissatisfied with the quality and function of the ureteroscope in use, but rarely send them for repair. This practice pattern may have implications for quality patient care. Additional investigation of case-specific risk factors for decreasing ureteroscope flexion is warranted.
ABSTRACT 10

FEASIBILITY OF TRANSABDOMINAL DYNAMIC CONTRAST-ENHANCED ULTRASOUND IMAGING OF THE PROSTATE

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² Urology Dept, Academic Medical Center, University of Amsterdam, Amsterdam, the Netherlands

Introduction: Several age-related pathologies affect the prostate gland, the most menacing of which is prostate cancer (PCa). The diagnostic tools for prostate investigation are invasive, requiring biopsies when PCa is suspected. Novel dynamic contrast-enhanced ultrasound (DCE-US) imaging approaches have been proposed recently that show promise for minimally invasive localization of PCa. Ultrasound imaging of the prostate is traditionally performed with a transrectal probe because the location of the prostate allows for high-resolution images using high frequency transducers. However, DCE-US imaging requires lower frequencies to optimize bubble resonance and, therefore, the contrast-to-tissue ratio. For this reason, this study investigates the feasibility of transabdominal DCE-US imaging of the prostate.

Methods: The study included 10 patients (age=60.7±5.7 years) referred for a needle-biopsy study. After having given informed consent, patients underwent DCE-US with both transabdominal and transrectal probes using an iU22 ultrasound scanner (Philips Healthcare). Following intravenous 2.4-mL bolus injections of SonoVue™ contrast agent (Bracco), time-intensity contrast curves were derived using both approaches and their model-fit quality was compared.

Results: Although further improvements are expected by optimization of the transabdominal settings, the results confirm the feasibility of transabdominal DCE-US, being closely comparable with the results obtained by transrectal DCE-US; transabdominal curve fitting by the local density random walk model showed an average determination coefficient r²=0.91 (r²>0.75 for 78.6% of all prostate pixels) compared to r²=0.91 (r² > 0.75 for 81.6% of all prostate pixels) by the transrectal approach. An example of transabdominal DCE-US scan of the prostate is shown in Figure 1.

Conclusion: Replacing the transrectal approach with more acceptable transabdominal scanning for prostate investigation is feasible and would improve patient comfort, representing a useful option for PCa localization and monitoring.

Figure 1: Example of transabdominal DCE-US scan in contrast and fundamental mode, showing time-intensity curves measured in different regions of interest and the correlation coefficient of the local density random walk model fits.
ABSTRACT 11

SURGEON RESECTION PERFORMANCE DURING TRANSURETHAL RESECTION OF BLADDER TUMOR (TURBT): A QUANTIFIED STUDY

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Introduction: Transurethral resection of bladder tumor (TURBT) is performed to diagnose and stage bladder cancers and surgically manage non-muscle invasive bladder cancer (NMIBC). The quality of TURBT technique is known to be variable based on studies reviewing short interval re-TURBT. Inadequate resection results in understaging, inappropriate treatment regimens, earlier recurrence and likely progression of disease. We aim to establish a baseline of resection performance with traditional rigid resectoscopes to use for future comparison of new assistive robotics technology performance.

Methods: A bladder tumor resection model was created using a petri dish filled with agar (the “tumor” appearing as a different color agar) and a 26 Fr Storz resectoscope. The model was set up in such a manner so the Urologist could only view the resection on a standard monitor display. The plate was positioned in six different configurations to represent different areas of the bladder. Two urologists were instructed to resect the entire “tumor” with a 3 mm margin. Given the tumor thickness was 6 mm, the optimal depth of resection was 9 mm. Measurement of the resected volume used a 3D non-contact laser scan of an extracted agar cast. A statistical analysis was performed to compare resection depth at each configuration.

Results: A total of 84 trials were performed by the two surgeons – 14 for each configuration. Figure 1 shows a box plot of depth means at each configuration. The red stars illustrate the mean of each area of resection. As noted in Figure 1, all configurations were under-resected. ANOVA and pairwise T-test showed the mean depth of resection to be significantly worse for the right posterior and right lateral configurations compared to the dome configuration ($P = 0.002$ and $0.04$ respectively).

Conclusion: Using a model system and traditional TURBT with a rigid resectoscope, we have established a baseline of resection performance. In the future, we will compare this baseline of resection to TURBT performance using our planned telerobotic system. We hope enhanced intravesicular dexterity will improve resection quality and outcomes of bladder cancer treatment.

Figure 1. Experimental setup: (a) manual resection with video display, (b) robot positions gel plate, (c) sample before resection, (d) sample after resection, (e) resected volume.

Figure 2. Box plot of mean resection depth: (1) anterior midline, (2) anterior right, (3) dome, (4) lateral right, (5) posterior midline, (6) posterior right
ABSTRACT 12

CT-ULTRASOUND FUSION USING AN IMAGE-FRAME-IMAGE REGISTRATION METHOD

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Introduction: Fusing computed tomography (CT) with real-time ultrasound (US) has the potential to synergize information contents for direct image guided interventions (DIGI) [PMC2668836]. We present an Image-Frame-Image (I-F-I) fusion as an alternative to the conventional Image-Image fusion. The benefit of this approach lies in its simplicity and accuracy that comes from the use of a rigid marker as an intermediary frame. Image fusion and needle targeting accuracy are evaluated.

Methods: A special CT marker is attached with a custom adaptor and needle-guide to an ultrasound probe. The probe is supported and manipulated by a robot [PMC24795525]. The marker is used as the intermediary coordinate frame for I-F-I fusion. It consists of two loops defining two planes (Figure 1a). The combined rigid transformations from one image to the marker (I-F), and from the marker into the other image (F-I) determine the I-F-I fusion. The transformation between the CT and marker (I-F) is found by imaging the robot with the marker in CT, and registering the model of the marker to the 3D reconstructed marker image (image-to-model). The US to marker transformation is pre-determined by a US probe calibration [PMC23358940]. Based on the fusion, the robot is then used to track realtime US images relative to the pre-acquired CT.

Validation of the fusion was performed in a reversed targeting experiment. The robot and a gelatin mockup were set on the CT table (Figure 1b). The robot was used to implant 12 cylindrical ceramic markers (0.8x15 mm) with an 18Ga trocar needle into the gelatin at digitally defined locations in the frame space (F). These markers can be seen in both images. The gelatin mockup was then scanned with the CT and US. 3D US scanning was performed by moving the probe with the robot and recording image-position pairs [PMC23358940]. Due to the I-F-I fusion, the two image sets were readily fused (Figure 2a). The locations of the ceramic markers from the CT and US sets were compared relatively to their planned locations (Figure 2b). The fusion error was defined as the distance between imaged target locations in CT and US ($e_1$). Targeting error was defined as the distance between planned and imaged target locations in CT ($e_2$) and US ($e_3$). The accuracy was calculated as the average of the errors and precision as the corresponding standard deviation.

Results: The fusion and targeting accuracy and precision results are:

<table>
<thead>
<tr>
<th></th>
<th>1.12</th>
<th>1.35</th>
<th>1.32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy [mm]</td>
<td>0.49</td>
<td>0.36</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Conclusion: At the time of the intervention, the I-F-I fusion requires only a simple I-F registration under CT. Mockup experiments show millimeter accuracy of the fusion. In-vivo motion is expected to deteriorate targeting accuracy relative to the pre-acquired CT, as usual. This underscores the added value of the US for real-time tracking during DIGI.
ABSTRACTS

ABSTRACT 13

3D TRUS RECONSTRUCTION BASED ON PERPENDICULAR 2D SWEEP VIDEOS

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Introduction: Nowadays there exist several ultrasound based techniques dedicated to prostate cancer localization. For validation, histopathology after radical prostatectomy is often used as a ground truth. However, accurate registration between transrectal ultrasound (TRUS) images and histology slices is complicated by the 2D nature of TRUS imaging typically used during a regular prostate examination, and due to the misalignment between TRUS planes and histology slices. A method able to accurately reconstruct 3D images from 2D TRUS imaging data would largely simplify and improve registration. Existing methods for 3D reconstruction require the use of additional sensors or the insertion of markers in the prostate, therefore complicating the clinical workflow. In this work, a novel method is presented requiring recordings by free-hand 2D TRUS only, without the need for additional sensors or markers.

Methods: TRUS images were made in 4 patients using a Philips iU22 scanner. In each patient, a transversal sweep video was acquired by transversally imaging the prostate with a 2D C10-3v end-fire probe, while steadily rotating the probe from base to apex. In a similar way, a sagittal sweep was acquired by imaging in the sagittal plane while rotating the probe from left to right. Next, one frame from the sagittal sweep at the center of the prostate was selected as a reference frame, and assumed to be perpendicular to the transversal sweep. For each frame in the transversal sweep, the intersection line with the reference frame was estimated by maximizing the correlation coefficient. A 3D TRUS image was thus reconstructed by placing the frames from the transversal sweep perpendicular to the reference frame and according to the estimated intersection lines. For validation, another 3D TRUS image was acquired using a 3D probe (3D9-3v). From both 3D TRUS images, 3D binary images of the prostate were made by manually drawing the contours in each plane. After rigid registration, the similarity between the two prostate images was determined by the Jaccard index $J(A, B) = \frac{|A \cap B|}{|A \cup B|}$.

Results: The resulting mean and standard deviation of $J$ was $0.79 \pm 0.02$, suggesting a good agreement between the prostate shapes obtained by the presented method and those obtained by the 3D probe. Because the posterior part of the prostate was differently deformed in the compared TRUS images as a result of the different acquisition methods (2D sweep versus 3D probe), $J$ was also calculated excluding the most posterior 10 mm, resulting in a mean and standard deviation of $J$ equal to $0.82 \pm 0.04$. An example of a reconstructed dataset is given in Figure 1.

Conclusion: The presented method showed promising results for reconstructing 3D TRUS images based on two sweep videos acquired by a 2D TRUS probe.

Figure 1: Three cross cuts of 3D TRUS obtained by a 3D probe and reconstructed from 2D sweep videos.
SAFETY AND FEASIBILITY OF ROBOT-ASSISTED DIRECT MRI-GUIDED TRANSPERINEAL PROSTATE BIOPSY

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Johns Hopkins University, Baltimore, MD

Introduction: Because of its superior imaging of localized cancer, MRI-guided prostate biopsy is an active area of investigation. While the majority of research are directed toward ultrasound-guided biopsy registered to preacquired MRI (ultrasound-MRI fusion), his technology may be limited by registration errors, motion and patient positioning, and does not have a direct feedback relative to the MRI. An alternative approach is real-time, in-gantry MRI targeted biopsy, the direct MRI-guided biopsy. We report the results of the first pilot study of MRI-guided biopsy using a robot-assisted technique (MR-Bot) [PMC17763098].

Methods: An MRI-Safe robot was developed (ASTM F2503). The Food and Drug Administration (FDA) approved an Investigational Device Exemption (IDE) for the robot. The Institutional Review Board (IRB) approved the clinical trial. A pilot study of five men with elevated PSA, prior negative prostate biopsy and cancer suspicious region (CSR) on MRI was conducted. The robot mounts on the MRI table beside the patient while in left lateral decubitus position and under general anesthesia (Figure). The cancer suspicious region (CSR) on the MRI is selected and the robotic device orients a needle-guide to the CSR and automatically presets the depth of needle insertion. The urologist inserts the needle manually through the needle-guide and collects the sample. Confirmation imaging of the needle location is acquired. The procedure then cycles to the next biopsy target.

Results: Five men underwent biopsy using MR-Bot. All patients tolerated the procedure well. Two men required Foley catheter insertion after the procedure, with no other complications and no subsequent adverse events. Patient characteristics are presented in the table. Biopsies confirmed the presence of clinically significant cancer in 2 patients. The biopsy needle was changed to a fully automated type after the first patient. With this, CSR targeting accuracy and precision relative to the MRI on a total of 30 biopsies was 2.97mm respectively 1.50mm.

<table>
<thead>
<tr>
<th>Case</th>
<th>PSA [ng/ml]</th>
<th>Prostate Size [cm³]</th>
<th>Prior Negative Biopsies</th>
<th># CSR</th>
<th>CSR Score (Pi-Rad)</th>
<th>Biopsy Result</th>
<th>Gleason Score</th>
<th>Complications</th>
</tr>
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<td>1</td>
<td>43.3</td>
<td>148</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>Benign</td>
<td></td>
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<tr>
<td>2</td>
<td>29</td>
<td>47</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>Adenocarcinoma</td>
<td>4+3</td>
<td></td>
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<tr>
<td>3</td>
<td>4.8</td>
<td>44</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>Adenocarcinoma</td>
<td>4+5</td>
<td>Foley catheter</td>
</tr>
<tr>
<td>4</td>
<td>8.9</td>
<td>42</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Benign</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>26</td>
<td>102</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>Benign</td>
<td></td>
<td>Foley catheter</td>
</tr>
</tbody>
</table>

Conclusion: In this initial report of robot-assisted direct MRI-guided prostate biopsy, the procedure appears safe and feasible. Direct confirmation of needle position in the CSR may present an advantage over fusion-based technology and gives more confidence in a negative biopsy result. The robot is sufficiently precise to target clinically significant tumors (0.5 cm³, 5mm radius). Precise localization of the biopsy sample relative to the CSR could further help validate prostate cancer imaging. A larger population study is needed to test the clinical significance of the approach.

Acknowledgement: The project described was supported by Award RC1EB010936 from the National Institute of Biomedical Imaging and Bioengineering.

Disclosure: Under a licensing agreement between Samsung and the Johns Hopkins University, Dr. Stoianovici has received income on an invention described in this article. This arrangement has been reviewed and approved by the JHU in accordance with its conflict of interest policies.

Figure: Patient and robot in the MRI scanner
ABSTRACT 15

A THREE-DIMENSIONAL SEGMENTATION TECHNOLOGY FOR PREDICTION OF RENAL VOLUME CHANGE AND RENAL FUNCTION AFTER ROBOT-ASSISTED PARTIAL NEPHRECTOMY

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Introduction: To analyze renal volumetric changes by 3-dimensional (3D) semi-automatic segmentation technology to predict renal volumetric change and renal function after robot-assisted partial nephrectomy (RPN).

Methods: Twenty patients underwent RPN and renal parenchymal volume was calculated by 3D semi-automatic segmentation technology. Arche (Seoul Women’s College of Computer Engineering, Seoul, Korea) program was used for 3D image semi-automatic segmentation of CT scan, and analyzed using regional growing technique for 3D visualization of renal parenchyma, multi-thresholding for differentiation of renal cortex and medulla, and connected component labeling technique for deletion of renal vessels. Predictive factors that correlated with eGFR and renal volume change at 2 years after RPN were analyzed.

Results: The median eGFR changes were -10.4%, -11.9%, and -2.4% at 6 months, 1 year and 2 years post-RPN, respectively. The contralateral renal volume changes were 2.3%, 9.6%, and 12.9%, respectively, and the renal volume was measured objectively by 3D segmentation within 5 minutes in each case. On multivariable linear analysis, preoperative eGFR was the best predictive factor for eGFR change on post-RPN 2 years (B =0.495; 95% CI -0.94 to 0.05; P = 0.033), and the parenchymal volume loss rate was the significant predictive factor for the degree of contralateral renal hypertrophy on post-RPN 2 years (B =0.529; 95% CI -0.99 to -0.06; P = 0.029).

Conclusion: 3D segmentation technology objectively and rapidly measured the loss of renal parenchymal volume after RPN, which predicts the volumetric hypertrophy on the contralateral kidney.

Figure 1. 3D semi-automatic segmentation of renal parenchyma, tumor mass and post-operative renal parenchyma
INTRODUCTION: The indications for flexible ureteroscopy for treatment of kidney stones have increased significantly in recent years, mainly due to the improvements in and greater durability of endoscopic equipment. There was also a considerable increase in the number of trained urologists to perform this procedure; however, because it is a long, grueling surgery and resulting in a great prevalence of hand problems, we developed a remote robotic ureterorenoscopy with low cost that simulates the movements of the hand in the manipulation of flexible ureteroscopes, which provides greater ergonomics and comfort.

MATERIALS AND METHODS: The prototype is based on a universal platform for fixing the ureteroscopes, its movements being performed by controlled engines that perform movements: bending and deflection, rotation and advancement within the kidney pelvis. Thus, the urologist can comfortably position the front surgery, controlling the movements of the ureteroscope with a joystick. A synthetic human model for training surgery in urology at ureteroscopy was used for the simulation of surgery. The total project cost was $1,000.

RESULTS: The simulated surgical procedure was successful, with the surgeon performing delicate and precise movements within the kidney, and achieving fragmentation of urinary calculi within the artificial kidney model. The cost of constructing the prototype is relatively low compared to the currently marketed model.

CONCLUSIONS: We present a universal robotic platform for flexible ureteroscopy surgery for kidney stones. This mechanism is inexpensive compared to robotic mechanisms already in use, can be directed to the resident training, providing good ergonomics for the surgeon. Thus, this initial experience was promising and should be encouraged.
DEFINING AND SIMULATING NEEDLE INSERTION FOR PERCUTANEOUS RENAL ACCESS

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Introduction: Gaining percutaneous renal access has a significant learning curve. Accurate representation of the forces encountered as the needle penetrates the tissue planes of the retroperitoneum is a key requirement for a training device. The objective of this study was to define and replicate the needle insertion forces for percutaneous access to the collecting system. The physical simulator model was also designed to be compatible with the SimPORTAL fluorless c-arm trainer (CAT) camera system.

Methods: Needle insertion force data were collected using a fresh cadaver within 72 hours of death. Ultrasound guidance was used to place “guide” needles that were subsequently utilized as a reference for angle and position in order to direct the needles inserted by a needle insertion force measurement device into the kidney (Figure 1). The device recorded axial force and displacement of the needle using an adjustable translational stage and load cell. The same procedure was repeated on the existing model and multiple potential synthetic materials for use in the simulator design. After comparison of forces measured in the human tissue and synthetic materials, a multilayer simulator model was designed using a combination of silicone and polyacrylamide gel (Figure 2).

Results: The new version of the simulator model incorporated multiple layers of synthetic materials and accurately replicates the relative tissue layers in the flank including skin, fascial layers and renal capsule. This is an improvement compared to the currently utilized existing block of silicone in which no variation in force can be achieved due to the homogeneous nature of the material used. In comparing the peak force associated with skin perforation, the difference between the outer layer of the new version of the model and the cadaveric skin was 36%. Important characteristics of the new version of the model included the ability to insert the needle into the same area of the model without visualizing tracks from previous insertions, translucency for compatibility with the existing camera system, and ability for the outer simulated skin layer to have no leakage after multiple trials. This reduces the need for model replacement and increases the cost-effectiveness of the model.

Conclusion: We have defined the forces for percutaneous access to the renal collecting system and successfully designed a percutaneous access model that accurately represents these forces and can be utilized for training access and PCNL with the SimPORTAL fluorless c-arm trainer (CAT).
ABSTRACTS

ABSTRACT 18

PILOT EVALUATION OF HISTROTROPSY ABLATION FOR PEYRONIE’S DISEASE: CHARACTERIZATION OF HISTOLOGIC EFFECTS IN EX VIVO PLAQUES

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Introduction: Current surgical management of Peyronie’s disease is invasive and involves penile shortening or excision and grafting of the fibrous plaque. Recent clinical trials have demonstrated therapeutic benefit of remodeling the plaque with collagenase. However, improvements in penile curvature are modest and can require up to 8 injections. As such, a more efficacious non-invasive technique to mechanically disrupt the plaque could be beneficial. We evaluated the feasibility of using histotripsy, a non-invasive non-thermal pulsed focused ultrasound technology that uses acoustic cavitation to mechanically fractionate targeted tissues, as a novel treatment for Peyronie’s plaques.

Methods: Using an IRB approved protocol, fresh excised Peyronie’s plaques (n=5) were obtained and processed into ~5 mm wide strips. Tissue was then submerged in degassed phosphate buffered saline and either exposed to histotripsy treatment (n=17 strips total) or saved as control tissue. Histotripsy treatments were conducted using a 1.0 MHz custom-built therapy transducer delivering pulses with repetition frequency of 1000 Hz, duty cycle of 0.5%, and peak +/- focal pressures of (+98/-17 MPa) under ultrasound image guidance. Treatments delivered 60,000-120,000 pulses/focus to a line or grid of foci spaced 1 mm apart within the plaque. Tissue was then formalin fixed and stained with Masson’s Trichrome, Verhoeff-van Gieson, or Hematoxylin and Eosin for histologic assessment.

Results: During histotripsy treatment, cavitation not only was observed on ultrasound in each case within the plaque, but also occurred prominently on either surface of the plaque. On gross inspection, there was evidence of plaque disorganization and decreased tissue integrity following treatment (Figure 1). On histologic assessment, evidence of histotripsy-induced disruption of collagen and elastin fibrils was evident in all fibrous portions of plaques resulting in fragments with a globular appearance. The sensitivity of the plaque to histotripsy varied with the extent of collagen deposition, but all demonstrated an effect with ≤120,000 pulses/focus. Despite fragmentation of fibrous portions, the calcified portions of two ossified plaques only demonstrated minor histologic evidence of any treatment effect.

Conclusion: Histotripsy ablation of Peyronie’s plaques is feasible and suggests further development of histotripsy could be beneficial as a novel Peyronie’s therapy. Future studies will evaluate the mechanical and functional tissue effects of treatment and aim to optimize transducer design and pulse parameters in anticipation of in vivo studies.

Disclosures: Work supported by NIH DK043881, EB007643, K01EB015745, and NSBRI through NASA-NCC-9-58

Figure 1. Peyronie’s plaque pre (a) and post (b) histotripsy. On histologic assessment (c), treated collagen fibrils were disrupted with loss of staining (Masson’s Trichrome)
INITIAL EXPERIENCE FOR PERINEAL ROBOT ASSISTED LAPAROSCOPIC RADICAL PROSTATECTOMY

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Introduction: Traditional retropubic approach of radical prostatectomy is a challenge in patients who had previous pelvic surgery. We aim to present Perineal Robot Assisted Laparoscopic Radical Prostatectomy (P-RALP) as an alternative technique in two patients; one had a past surgical history of abdominopelvic (AP) excision of rectum and another patient had a failed retropubic approach of radical prostatectomy.

Methods: Patients are placed in exaggerated lithotomy position; initial open perineal dissection is completed to place a single port and then the robot is docked. The endopelvic fascia is left intact during prostatectomy. Robotic grasper, scissors and harmonic scalpel are used for dissections. The anastomosis is completed using barbed sutures in a running fashion.

Results: First patient with AP excision of rectum was 62 years old. He did have bilateral inguinal meshes due to hernia repairs. His transperineal biopsy revealed Gleason score 3+4=7 adenocarcinoma of prostate. His operation was completed without any complication and he was discharged within 18 hours. Urethral catheter was removed one week after surgery and patient was immediately continent. Pathology result showed same Gleason score, but pT3a disease with margin focally positive at the extraprostatic extension area. His PSA follow up was <0.003 ng/dl 6 months after surgery. The second patient was elected for P-RALP after a failed robotic retropubic approach due to severe pelvic adhesions. Preoperative biopsy revealed a Gleason score 3+3=6 adenocarcinoma of prostate. P-RALP was completed without intraoperative complication but the urethral anastomosis was challenging due to previous bladder mobilization. Hospital stay was 16 hours. Foley catheter was removed 3 weeks after surgery. His PSA follow up was <0.003 ng/dl 4 months after surgery.

Conclusions: The robotic approach of perineal radical prostatectomy was a successful alternative way to employee radical prostatectomy in those patients who have contraindications to the more traditional retropubic approach.
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COMPUTATIONAL ANALYSIS OF RECOVERY FROM ISCHEMIC DAMAGE TO KIDNEY FUNCTION IN PATIENTS UNDERGOING ROBOTIC PARTIAL NEPHRECTOMY FOR RENAL TUMOR

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Introduction: We preliminary assessed functional recovery of ischemic-damaged kidney after robot-assisted partial nephrectomy using computational anatomy to investigate that conceptions of “Computer-aided diagnosis and therapy” could help the optimal presurgical simulation and predict the postoperative kidney function.

Methods: Four patients underwent robotic partial nephrectomy for clinically localized small kidney tumor. A three-dimensional kidney model was printed with a 3D printer before the robotic partial nephrectomy for each kidney. A volume segmentation model in each kidney was produced by contrast-enhanced abdominal CT was also prepared for making decisions of the optimal vessel clamping and for understanding the ratio of the kidney segment. Volumetry was made first by pointing all extra-pelvic renal arteries that were divided from the main renal artery or aorta and given the different color to each artery to divide the segment of the kidney, then second by fixing the boundary line by Volonoi diagram with the bisection between the visible intrarenal arteries, and thirdly by calculating the volume of each color-labeled area in which blood was supplied from the same colored artery (Figure 1). Renal scintigram was examined before and 1-month after surgery to check the affected kidney.

Results: All 4 patients were successfully treated robotically, with a mean ischemic time of 26.8 minutes (ranging from 18 to 40 minutes). According to the preoperative simulation, 3 patients underwent selective artery clamping and the remaining 1 underwent total artery clamping because of the divergence being close to the renal sinus. The ratio of the ischemic volume ranged from 36.6% to 100%. Compared to the preoperative status, the postoperative serum creatinine (s-Cr) and the estimated glomerular filtration rate (eGFR) averages worsened, 0.07ng/ml and 10.0 ml/min./1.73m², respectively. According to the computational analysis, renal effective plasma flow (ERPF) in the clamped area presented an average segmental function of 59.8% (range: 49.5-73%) compared to the preoperative status. These results indicated a smaller clamped kidney volume and shorter ischemic time, which contributed to better recovery of segmental kidney function.

Conclusion: Computational analysis of renal volumetry helps direct the optimal vessel clamping and might indicate residual kidney function.

Figure: Colored 3D volumetry and printed kidney model
IN VITRO EXPERIMENTS ON THE ETIOLOGY OF THE KIDNEY STONE TWINKLING ARTIFACT IN ULTRASOUND IMAGING

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Introduction: The “twinkling artifact” is a rapid color-shift that selectively highlights hard objects, such as kidney stones, in color-Doppler ultrasound. Though the twinkling artifact has the potential to improve kidney stone detection, its inconsistent appearance has limited clinical application. Our team’s previous work supports that crevice bubbles on the surface of stones cause twinkling, and that these bubbles are sensitive to changes in pressure. Here, we analyze the factors that modulate twinkling with an overall objective to enhance the twinkling artifact for improved stone detection.

Methods: A Verasonics Ultrasound Engine with an HDI L7-4 transducer was used to observe the effect of pressure on twinkling in ex vivo kidney stones. The custom-built pressure chamber is shown in Figure 1 (left). The overpressure threshold to diminish twinkling (though bubble suppression) was investigated in addition to exploring whether a reduction in the ambient pressure enhanced twinkling (though bubble expansion). A Photron high-speed camera with a high-magnification lens (resolution of 5 μm/pixel) was used to observe crevice bubbles on the stone’s surface.

Results: The overpressure required to diminish the twinkling artifact was dependent on a variety of factors, including the exact location and stability of twinkling on the individual stone, the gas content of the liquid and stone, and the amplitude and number of Doppler pulse cycles. In some twinkling locations, the artifact was observed to decrease at ambient pressures of 3 atm (absolute); in other locations even on the same stone, the twinkling artifact was only diminished when the static pressure exceeded 8 atm. An example of the effect of overpressure on the twinkling artifact is shown in Figure 1 (right). When stones were exposed to hypobaric conditions of 0.2 atm absolute, the amplitude of the twinkling artifact was observed to increase. Upon high-speed imaging of the stone surface during color-Doppler ultrasound, a bubble (max diameter of 30 μm) was observed to oscillate.

Conclusion: These results support the crevice-bubble hypothesis of the twinkling artifact, however we are continuing to investigate the origin of these bubbles. High-speed imaging revealed significant bacterial growth on the stones, which could explain the presence of these bubbles. Continuing studies are analyzing the presence of bubbles on ex vivo human kidney stones and are trying to determine whether their origin is bacterial. The results from these studies suggest that hypobaric conditions as well as increasing the amplitude and number of Doppler pulse cycles could be used to enhance the twinkling artifact for kidney stone detection. The impact of this technique can improve stone detection in the clinic and help guide stone management without necessitating further, costly, diagnostic procedures.

Acknowledgement: Work supported by NIH NIDDK grants DK43881 and DK092197, and the National Space Biomedical Research Institute through NASA NCC 9-58.

Figure 1: Left: Pressure chamber with the imaging transducer and hand-held hydraulic pump. Right: An example showing the decrease in twinkling as the ambient pressure increases. Pressures are absolute.
UNDERSTANDING THE ROLE OF FORCE FEEDBACK IN ROBOTIC SURGERY

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Introduction: Robotic surgery provides a number of advantages to patients and surgeons; however, many consider the absence of force feedback (FFB) to be a major limitation. In the literature, the role of FFB in robotic surgery is unclear. Results of prior studies utilizing modified commercial surgical robots or bench top manipulators provide conflicting information on how FFB is associated with parameters such as procedure duration, quality of surgical manipulations, or level of surgeon training. Furthermore, many tasks used in such studies (i.e., peg transfers) are not clinically relevant. Our objective was to better understand the role of FFB in robotic surgery by identifying a set of surgical tasks that may benefit from FFB, creating relevant ex vivo substitutes, and having expert surgeons perform the tasks with and without FFB. Task specific metrics, completion time, and applied forces were measured using prototype force sensing instruments on the da Vinci® Xi™ (Intuitive Surgical, Inc., Sunnyvale, CA) platform.

Methods: We identified basic maneuvers during surgical procedures that may be affected by FFB: dissection, suturing, retraction, and palpation. We then designed dry lab tasks with clinical scenarios to mimic these maneuvers. Dissection was tested at two levels: blunt dissection of an embedded simulated fluid-filled vessel and fine dissection of an orange peel (i.e., nerve-sparing in a prostatectomy). Suturing was also evaluated at two levels: enterotomy repair in simulated bowel with a large caliber running suture and anastomosis of a simulated ureter with small caliber interrupted stitches. To assess retraction, subjects had to identify which of 3 similar appearing simulated tissues with different tensile properties would result in a tension-free reattachment. Finally, subjects were asked to locate ‘masses’ hidden in a foam board to test palpation. Six expert robotic surgeons completed each task, with and without FFB at the surgeon console (though forces were always measured) in random order, using the da Vinci® Xi™ with prototype force-sensing instruments capable of measuring translational forces at the tool tips. We measured applied forces, time to completion, and task specific quality metrics (i.e., broken sutures, injury to tissues during dissection). In addition, subjects completed pre- and post-lab questionnaires.

Results: Statistically significant lower mean forces (p < 0.05) were measured with FFB on in 83% of subjects during dissection tasks and palpation, 50% of subjects during enterotomy repair and retraction, and 17% of subjects during ureteral anastomosis. Significantly higher maximum forces were measured across all subjects when FFB was off during fine dissection, retraction, and palpation. There was a significantly shorter duration with FFB on during retraction (1.2 vs. 2.2 minutes) but a significantly longer duration with FFB on during palpation (6.2 vs. 3.4 minutes). No differences were seen in quality measures. Surgeons subjectively indicated that FFB was helpful in all tasks except palpation.

Conclusion: In this preliminary study using prototype force sensing instruments with the da Vinci® Xi™, expert surgeons applied lower mean and maximum forces during ex vivo tasks mimicking dissection, suturing, retraction, and palpation. Minimal differences and low applied forces were seen with ureteral anastomosis, suggesting that FFB may be most useful in higher force maneuvers and/or that we were at the lower limits of our force sensors. Time to task completion was inconclusive. These results and the surgeon feedback suggest that FFB may have a beneficial role in robotic surgery and that differences with FFB can be seen in an appropriate ex vivo setting. Future research to better understand this role and the necessary range of force sensing may include performing similar tasks in the in vivo setting, testing of novices, measuring tissue effects, and evaluating differences in surgical technique.
ABSTRACTS

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BEST PAPER AWARD

SCANNING FIBER TECHNOLOGY FOR RAPID VOLUMETRIC OPTICAL COHERENCE TOMOGRAPHY CYSTOSCOPY

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Introduction: Researchers are currently investigating several optical imaging technologies for detecting bladder cancer as complementary techniques to white light cystoscopy (WLC). In particular, optical coherence tomography (OCT) is a promising adjunct technology that can obtain volumetric images of subsurface tissue morphology. Prior research has demonstrated that OCT can increase the accuracy for detecting bladder cancer -- especially early stage cancers -- and can stage cancers up to stage T2a. The ideal use-case of OCT would be as a clinical screening tool to identify tumors invisible to WLC and classify suspicious lesions; however, this goal is unrealizable with existing OCT cystoscopes as they are too large to fit into the standard working channel of the flexible WLC typically used in the clinic (diameter 2.2 mm) and are too slow (0.4 – 4 Hz) to enable sufficient image collection. In our work, we demonstrate an OCT cystoscope that enables rapid volumetric imaging and is sized appropriately to fit inside the standard working channel of the flexible WLC used in the clinic.

Methods: We constructed a scanning fiber endoscope (SFE) based on a novel piezoelectric actuator system that enables scanning in two dimensions. The SFE was attached to an off-the-shelf GRIN lens (Thorlabs) and the entire assembly was housed in a stainless steel tube. The SFE was integrated into a swept source OCT system with a laser centered at 1040 nm (Axsun Technologies). The SFE was driven in a spiral pattern at a rate of 12.5 Hz. Calibration and distortion corrections were performed using a quad-cell position-sensing detector.

Results: The outer diameter of the SFE was 1.07 mm (total package size: 3.0 mm OD and 24.6 mm rigid length), which is the smallest reported OD to date for forward-viewing scanning OCT probes. Given its resonance frequency of 2046 Hz, the system could acquire 6000 A-scans per volume and B-scans comprising 292 A-scans. The OCT-SFE has a sensitivity of 97 dB and a lateral and axial resolution of 20 μm and 8.7 μm, respectively. An en-face image of the 1951 USAF test chart (a) demonstrates our ability to accurately map the SFE scan pattern to correct lateral positions. Due to the A-scan rate (100 kHz), the frame rate for 6000 A-scans is limited to 12.5 Hz.

Conclusion: Our rapid volumetric scanning probe can enable more thorough scanning of the bladder wall to detect new tumors and classify suspicious lesions, and may also be used in the ureters. The OCT-SFE system has sufficient sensitivity and resolution to image biological samples such as a human fingertip and a bladder phantom with layer thicknesses and scattering properties similar bladder tissue. In the future, the total rigid package size will be reduced by 50%, enabling integration into a flexible WLC for in vivo imaging.

Figure: Representative images of OCT-SFE: (a) En-face image of 1951 test chart, (b) B-scan of human finger tip, and (c) three layer bladder phantom showing a healthy region with three distinct layers (urothelium (U), lamina propria (LP), and muscularis propria (M)) and a carcinoma in situ region where the urothelium and lamina propria layers combine. Layer thicknesses and scattering properties are chosen to mimic human bladder tissue. Red box represents an area of 100x100 μm².
MR-GUIDED BOILING HISTOTRIPSY OF THE KIDNEY USING A CLINICAL HIGH INTENSITY FOCUSED ULTRASOUND SYSTEM

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¹Department of Urology, ²Center for Industrial and Medical Ultrasound, ³Department of Gastroenterology, University of Washington, Seattle, W, ⁴Clinical Science MR Therapy, Philips Healthcare, Andover, MA

Introduction: We have been evaluating boiling histotripsy (BH), an experimental non-invasive high intensity focused ultrasound (HIFU) technique distinct from cavitation-cloud histotripsy, as a novel renal ablative technology. BH uses milliseconds-long HIFU pulses delivered at low-duty cycle to produce non-thermal mechanical tissue ablation. Preliminary studies have suggested that B-mode ultrasound may be inadequate for targeting centrally located tumors. Additionally, the pulse parameters required for BH may allow translation of existing clinical HIFU systems into BH devices. As a result, we evaluated the feasibility of using a clinical MR-guided HIFU system to generate renal BH lesions.

Methods: Experiments were conducted using the Sonalleve V1 3.0 T MR-guided HIFU system (Philips Healthcare, Vantaa, Finland), which includes an integrated MRI platform and a 256 element 1.2 MHz trans-abdominal HIFU transducer. Fresh ex vivo porcine kidneys (n=7) were submerged in degassed phosphate-buffered saline in a custom holder and then imaged using T2 weighted (T2W) MRI for treatment planning. Volumetric lesions (~5 x 20 x 6 mm) were created by generating a planar grid of focal volumes spaced 2 mm apart. BH pulses were delivered at 300W, 10 ms duration, duty cycle 1% or 600W, 1 ms duration, duty cycle 0.4%. Sonifications were monitored in real time with MR thermometry. Post-BH, kidneys were imaged with T1W turbo spin echo, T2W 3D fast field echo, and diffusion weighted imaging (DWI). Kidneys were then processed for gross or histologic assessment.

Results: Generation of BH lesions was achieved at all three power settings. During treatment MR-thermometry provided reliable real-time feedback of BH exposures, with T max of 45.0 C for 300W exposures and 56.7 C for 600 W exposures. On post-treatment MRI, lesions appeared mildly hyper-intense on T1W and T2W imaging, while on DWI images appeared as well defined discrete areas of less restricted diffusion. Qualitatively, MRI characteristics did not differ significantly between settings. On gross inspection, BH lesions created with 250W and 300W sonifications contained a low-viscosity liquid of homogenized tissue without evidence of thermal damage. Conversely, lesions generated at 600W contained blanched paste suggesting combined thermal and mechanical effect. Histologically, all lesions demonstrated homogenized tissue with clear demarcation between treated and untreated tissue consistent with histotripsy effects. Anatomic correlation between MRI, gross, and histology was excellent (Figure 1).

Conclusion: MR-guided BH of the kidney is feasible with a clinical HIFU system. MR-guidance offers excellent spatial resolution that could improve treatment planning and targeting with close correlation between MRI and histology. Further work will be aimed at improving real-time MR feedback during treatments.

Disclosures: Work supported by NIH DK043881, EB007643, K01EB015745, and NSBRI through NASA-NCC-9-58

Figure 1. T2W MRI appearance of BH lesion (blue area) with corresponding histology demonstrating homogenization of medulla and collecting system
HELICAL™ URETERAL STENTS RESULT IN LESS ANALGESIC USE COMPARED TO CONTROL STENTS

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Introduction: Stent symptoms are experienced by the majority of patients with ureteral stents. Softer materials, adjuvant drugs, drug-eluting stents, and new stent designs have been attempted to reduce stent symptoms. There has not been any clear advantage in any one stent or new technology. The Helical™ stent, a spirally cut stent made of proprietary Percuflex material was designed to conform better to the shape of the ureter and move with the patient. We prospectively sought to compare unscheduled visits, analgesic use and pain scores in patients who received a Percuflex Helical ureteral stent following ureteroscopy compared to a historical control group.

Methods: Fifteen (n=15) patients scheduled to undergo ureteroscopy for the treatment of kidney stones were consented for the study. A Percuflex Helical ureteral stent was inserted after successfully treating the urinary stone. The control group consisted of thirty (n=30) patients, from a previous (ketorolac-eluting) ureteral stent study utilizing the same protocol and clinical monitoring forms who received a regular Percuflex ureteral stent. The control patients were age and sex-matched to the study patients. The primary study outcomes were to compare unscheduled visits and the number of pain pills consumed. Secondary outcomes included comparison of Visual Analog Scale pain scores.

Results: There were no differences in the gender, age, or stone characteristics (Table). Both groups underwent retrograde ureteroscopy using holmium:YAG laser lithotripsy and successful stone fragmentation by dusting and not basketing. There was a significant reduction in the amount of analgesics required in the Helical group compared to controls (p=0.0035) to achieve similar VAS scores. There was no difference in unscheduled visits (20%). Limitations of this study include its small size, non-randomized approach and control group from a previous study. However, this current study followed the exact protocol of the previous study so that the control group could be adequately compared.

Conclusion: Patients who received a Percuflex Helical ureteral stent required significantly less analgesics than those who received a Percuflex stent and both had equivalent pain scores. The spirally cut Helical stent appears to improve patient comfort compared to the regular Percuflex stents.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Helical</th>
<th>Control</th>
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<tbody>
<tr>
<td>Number</td>
<td>15</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>Age (y)</td>
<td>58.47</td>
<td>52.37</td>
<td>NS</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>28.74</td>
<td>27.82</td>
<td>NS</td>
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<tr>
<td>Unscheduled visits</td>
<td>20% (3/15)</td>
<td>20% (6/30)</td>
<td>p = 1.000</td>
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<tr>
<td>Analgesic use (morphine equivalent mg)</td>
<td>4.4 ±7.9</td>
<td>16.75 ±18.31</td>
<td>**p = 0.0035</td>
</tr>
<tr>
<td>Visual Analog Scale Score</td>
<td>13.84 ±13.68</td>
<td>14.29 ±11.58</td>
<td>p = 0.791</td>
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</tbody>
</table>
ABSTRACTS

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3D PRINTED PHYSICAL MODELS OF RENAL MALIGNANCIES FOR OPERATIVE PLANNING AND SURGICAL SIMULATION

Jonathan Silberstein, Raju Thomas, Michael Maddox
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Introduction: Construction of high fidelity individualized physical three-dimensional (3-D) models of renal units with enhancing renal lesions may aid patients, trainees and clinicians in their appreciation, characterization, localization and extirpation of suspicious renal masses. Additionally these tools may serve as a patient specific model for surgical simulation prior to operative intervention.

Methods: Pre-operative computerized tomographies were used to import images into various 3-D printers. The printers were then used to explore various properties, textures, materials and colors to print individualized patient specific 3D models to aid in robot assisted nephron sparing surgery. More than thirty unique renal tumors were printed utilizing various properties to aid in both pre-operative planning and surgical simulation. Each printer utilized a unique methodology to print the models but each cured subsequent layers atop one another to construct the final models.

Results: One printer (Figure a) allowed visualization that assisted in intraoperative assessment of depth of tumor and proximity to critical structures such as collecting system and blood vessels. While these prints were flexible the materials had a gummy quality and could not be used to reliable perform surgical simulation, additionally all of the structures could only be made in two colors. Another printer allowed multiple unique colors but the prints were made of a firm material that had no malleability (Figure b). A third printer allowed the construction of the models in an opaque model with two colors but allowed robotic surgical simulation (Figures c-e). Patients, their families and trainees consistently stated that the models enhanced their understanding of the renal tumor in relation to surrounding normal renal parenchyma and hilar structures.

Conclusions: Pre-operative physical 3-D models using readily available printing techniques can be constructed and may potentially influence both patients’ and trainees’ understanding of renal malignancies. Additionally the various properties of these printers may play different roles in assisting surgeons.
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3D PRINTED MOLDS FOR THE STUDY OF PROSTATE CANCERS: PATHOLOGY TUMORS ‘MATCHED’ AND ‘MISSED’ ON MRI

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2 David Geffen School of Medicine Department of Pathology
3 David Geffen School of Medicine Department of Radiology
4 David Geffen School of Medicine Department of Urology

Introduction: Multiparametric MRI can prospectively identify prostate cancer (CaP). Following radical prostatectomy, cancer distribution is evaluated on whole-mount pathology, but the cutting planes can differ greatly from in vivo MR images. To improve the accuracy of MR-pathology correlations, patient-specific 3D-printed molds were used to slice the specimen. Custom software analyzed contours in 3D, enabling pathological lesions to be ‘matched’ with corresponding MRI targets.

Methods: Prior to radical prostatectomy each patient received a multiparametric MRI, from which an expert radiologist contoured the prostate and regions suspicious for cancer. The contours were used to 3D-print patient-specific molds, which precisely fitted the excised prostate (Figure 1). The molds guided slicing of the prostate, such that each slide was aligned with the orientation and depth of an MR image. Custom software then automatically imported the annotated slides, reconstructed the tumors in 3D, and registered them with the patient’s MRI. If the centroids of an MR target and pathology tumor were within 10 mm and their volumes intersected (within an error margin), the pair was considered matched.

Results: Clinical significance was investigated using 2 criteria: Gleason > 3 + 3 or volume > 0.5 cc (CS1) vs. Gleason > 3+3 and volume > 0.5 cc (CS2). In 30 patients, 53% of tumors were detected overall, while 70% and 88% of significant tumors were detected using CS1 and CS2, respectively. The predictive accuracy of MRI is summarized in Table 1. The mean tumor volume on histology was greater than on MR (2 cc vs. 0.8 cc), and matched tumors were larger than missed ones (2 cc vs. 0.2 cc) (Figure 2). Matched and missed tumors were found to have highly dissimilar Gleason distributions (Figure 3).

Conclusion: Although many small tumors are missed, MRI has a high sensitivity for significant disease; only 2 in 30 patients had significant unmatched tumors using CS2. However, since the specificity of MRI and its ability to discern disease severity is limited, biopsy of MR targets remains required. 3D tumors were larger than their MRI matches, indicating a systematic underestimation in tumor volume. Matched tumors were much larger than unmatched ones, demonstrating a lower-limit for which lesions are MR-visible. Furthermore, the probability of detection increased substantially with Gleason Grade.

![Fig 1. Prostate in 3D-printed mold](image1.png)

![Fig 2. Matched and missed tumor volumes](image2.png)

![Fig 3: Gleason grade distributions](image3.png)
ONCOLOGICAL OUTCOMES AFTER ROBOT-ASSISTED RADICAL PROSTATECTOMY IN PROPENSITY SCORE-MATCHED HIGH-RISK PATIENTS STRATIFIED BY AGE

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Purpose: To report the oncological outcomes after robot-assisted radical prostatectomy (RARP) in high-risk prostate cancer patients in propensity-matched retrospective study stratified by age.

Materials and methods: Total 160 patients who underwent RARP at our institution were stratified by high risk features (by D’Amico definition) and age as of under 70 year old (first group) and equal or more than 70 year old (second group), i.e. 80 patients in each group. Patients were matched by following preoperative characteristics: BMI, PSA, SHIM score, AUA score, clinical stage and biopsy Gleason score. Intra- and perioperative data, functional and oncological outcomes were compared between propensity-matched cohorts. Biochemical failure was registered as of 0.2 or higher and other validated instrument (SHIM, nerve-sparing grade-partial or full, AUA and EPIC- question 3) were used to define oncological and functional outcomes. Median follow-up period was 36 months (range: 21-42).

Results: Comparison of intraoperative results demonstrated only significant difference in mean estimated blood loss 156.1±84.2 ml in first group vs. 113.6±67.7 ml in second group (p=0.002). Final pathology characteristics such as pT stage, Gleason score, positive surgical margins, extracapsular extension, seminal vesicle invasion, tumor volume and dimension did not demonstrated significant difference. Postoperative complication according to Clavien system, pain score length of hospital stay and time for Foley catheter stay were not different. Biochemical disease free survival were almost identical 86% in first group vs. 84% in second group in long-rank test (p=0.564). Erectile function was restored at 24 month after RARP in 70% in first group vs. 53%- in second group, respectively (p=0.003). Continence was completely recovered at 24 month in 93% in first group and 87%- in second group (p=0.04).

Conclusions: RARP in high-risk patients stratified by age as of under 70 year old and equal or higher have excellent and similar rate of intraoperative and postoperative complications, oncological and functional outcomes except erectile function. Therefore, age threshold as of 70 year should be carefully considered in preoperative consulting of patients regarding recovery of sexual function.
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COMPARISON OF FLOW CHARACTERISTICS BETWEEN A NOVEL THREE-DIMENSIONALLY PRINTED URETERAL STENT AND CONVENTIONAL URETERAL STENTS IN AN EX VIVO PORCINE MODEL

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Introduction: We evaluated the flow characteristics of novel three-dimensionally (3D) printed ureteral stent prototypes to four conventional double-pigtail stents (6Fr Universa® Soft, 7Fr Percuflex™, 7/10Fr Applied Endopyelotomy, and 8.5F Filiform Double Pigtail) in an ex vivo porcine model.

Methods: We created a computer aided design for ureteral stents using Solidworks software. The stents were then printed using an EOSINT P395 3D printer. We evaluated five standard stents using 6 ex vivo porcine urinary systems with kidneys and ureters intact. We deployed a 5Fr occlusion catheter in the interpolar calyx for each renal unit. In each renal unit antegrade irrigation with a 0.9% saline bag was placed 35 cm above the renal pelvis. Total, extra-luminal, and intra-luminal flow rates were measured in ml/min for each stent (Table 1).

Results: The mean total flow rates for the 9Fr stents were significantly higher compared to the 6Fr, 7Fr, and 7/10Fr stents (p<0.05). No significant difference was seen in total flow rate for the 3D printed stent compared to the 8.5F stent. The mean extra-luminal flow rates for the 9Fr stents were similar to the 7Fr stents, but significantly lower than the 6Fr stents (p<0.001) and 8.5F stents (p<0.05) and significantly higher than the 7/10Fr stents (p<0.001). The mean intra-luminal flow rates for the 9Fr stents were significantly higher than all stents tested (p<0.05).

Conclusion: The 3D printed 9Fr stents demonstrated adequate upper urinary tract drainage in a porcine model and showed mean flow rates comparable to the flow rates of contemporary stents. Continued advances in 3D printing technology may permit clinically viable 3D printed ureteral stents in the future.

<table>
<thead>
<tr>
<th>Stent</th>
<th>Total Flow*</th>
<th>Extra-luminal Flow</th>
<th>Intra-luminal Flow</th>
<th>Total Flow as a % of Unstented Ureter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstented Ureter</td>
<td>4.88 ± 0.153</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6Fr Universa</td>
<td>5.13 ± 0.215</td>
<td>4.40 ± 0.093</td>
<td>4.99 ± 0.199</td>
<td>105.12%</td>
</tr>
<tr>
<td>7Fr Percuflex</td>
<td>5.50 ± 0.124</td>
<td>4.00 ± 0.146</td>
<td>5.18 ± 0.227</td>
<td>112.70%</td>
</tr>
<tr>
<td>7/10Fr Endopyelotomy</td>
<td>5.18 ± 0.136</td>
<td>2.52 ± 0.305</td>
<td>4.79 ± 0.138</td>
<td>106.15%</td>
</tr>
<tr>
<td>8.5 Fr Filiform</td>
<td>5.61 ± 0.149</td>
<td>4.25 ± 0.188</td>
<td>5.36 ± 0.390</td>
<td>114.96%</td>
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<tr>
<td>9Fr 3D Printed</td>
<td>5.68 ± 0.143</td>
<td>3.99 ± 0.170</td>
<td>5.51 ± 0.309</td>
<td>116.39%</td>
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</table>

*Combined Extra-luminal and Intra-luminal
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CROWD SOURCED ASSESSMENT OF CONFOCAL LASER ENDOMICROSCOPY IMAGING OF BLADDER CANCER

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Introduction: Confocal laser endomicroscopy (CLE) is an optical imaging technology that provides dynamic in-vivo microscopic characterization comparable to histology. Optical biopsy using CLE requires real-time interpretation of endomicroscopic images and videos. Crowdsourcing is a data acquisition method that uses the collective intelligence of networked communities for problem solving. We applied crowdsourcing to assess the adoptability of CLE as a diagnostic tool for cancer, hypothesizing that a non-medically trained crowd can learn to differentiate between benign and cancerous tissue quickly and accurately.

Methods: A training curriculum followed by 12 patient-derived CLE videos (high-grade=5, low-grade=4, benign=3) was selected for review by Amazon.com Mechanical Turk crowd-workers, with a target of 100 evaluations for each video. Classification of a video as cancer required 70% of the crowd to make this designation. A threshold of 70% agreement between crowd responses and expert users was also used to categorize microscopic features with 2 categories (papillary structure, organization, morphology, cellular cohesiveness, and cellular borders). Vascular features with 3 categories were categorized based on a lower threshold of 35%. Crowd-workers were blinded to patient history and final pathology. To reduce random classification, crowd-worker responses were excluded if they incorrectly answered a screening question following the training curriculum. For each video assessed, crowd-workers received 0.50 USD.

Results: 1,283 ratings from crowd-workers were received in 9 hours 27 minutes. 1,173 ratings were eligible and used for further analysis. The crowds were able to accurately discriminate between cancer and benign in 11/12 (92%) videos, with 1 low-grade cancer video incorrectly classified as benign. For cellular characteristics, the crowds agreed most with expert classification for cellular borders (10/12, 83%) and least for flat vs. papillary characterization (6/12, 50%).

Conclusion: Crowdsourcing efficiently evaluated the adoptability of CLE for optical biopsy of bladder cancer. Within a short time, a large sample size was obtained and the crowd correctly categorized 92% of videos following a brief training module. The single erroneous classification resulted from misidentification of papillary structures, for which diagnostic accuracy was low. Cellular cohesiveness and organization likewise demonstrated low accuracy, indicating the need for further refinement in the training curriculum to distinguish these features. In contrast, cellular borders, vasculature, and cellular morphology demonstrated diagnostic accuracy greater than 70%. Through crowdsourcing, we show that CLE can be easily learned to enhance the detection of bladder cancer.
CONTEMPORARY FIBEROPTIC AND DISTAL SENSOR ENDOSCOPIC DEVICES PRODUCE HEAT CAPABLE OF CAUSING THERMAL INJURY

Brittany Uribe, Kyle Spradling, Renai Yoon, Zhamshid Okhunov, Martin Hofmann, Michael Del Junco, Christina Hwang, Caden Gruber, Ramy F. Youssef, Jaime Landman

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Introduction: Illumination during contemporary endoscopic procedures is produced from powerful light sources such as contemporary xenon, halogen, and light emitting diodes (LED). These light sources produce thermal energy, which have resulted in thermal injury and ignition of flammable materials when improperly used in the operating room. Hence we evaluate the ignition and burn risks associated with contemporary fiberoptic and distal sensor endoscopic technologies.

Methods: New and used SCB Xenon 300 light sources were used to illuminate a 4.8 mm fiberoptic cable, 10 mm laparoscope, 5 mm laparoscope, rigid cystoscope, semi-rigid ureteroscope, flexible cystoscope, flexible fiberoptic ureteroscope and distal sensor cystoscope (Karl Storz, Inc., Tuttlingen, Germany). Peak temperatures were measured at the distal end of each endoscopic instrument, including a distal sensor ureteroscope equipped with a built-in LED light source. Ignition risk was then evaluated by placing each device on a flat and folded surgical drape. Lastly, human cadaver skin covered with surgical drape was exposed to each device at its peak temperature to investigate the risk of thermal injury.

Results: The peak temperatures for each device ranged from 26.9°C (flexible fiberoptic ureteroscope) to 194.5°C (fiberoptic cable) using a used xenon bulb (Figure 1) and 28.1°C (flexible fiberoptic ureteroscope) to 192.4°C (fiberoptic cable) using a new xenon bulb. Drape ignition was noted when the fiberoptic cable was placed against a fold of the drape. Underlying cadaver skin damage occurred when in contact with the fiberoptic cable, 10 mm laparoscope, 5 mm laparoscope, and distal sensor cystoscope; however, little to no visible damage was observed on the surgical drape used. No effect was observed on surgical drape or cadaver skin when exposed to rigid and flexible fiberoptic cystoscopes and flexible fiberoptic ureteroscopes.

Conclusion: Fiberoptic light cables and endoscopic devices have the potential to generate high temperatures with the ability to cause cutaneous thermal injury and drape ignition. Thermal injury may occur without visible damage to drapes. Surgeons should remain vigilant regarding the risks associated with these devices, and should take necessary safety precautions to prevent patient injury.
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TANDEM-ROBOT ASSISTED LAPAROSCOPIC RADICAL PROSTATECTOMY (T-RALP) IN 49 MEN

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Robotics Laboratory, Urology Department, Johns Hopkins University, Baltimore, MD

Introduction and Objectives: The preservation of the neurovascular bundle (NVB) during radical prostatectomy improves the postoperative recovery of sexual potency. The accompanying blood vessels in the NVB can serve as a macroscopic landmark to localize the microscopic cavernous nerves in the NVB. We examined the feasibility and safety of image-guided navigation using transrectal ultrasound (TRUS) to visualize NVB during robot assisted laparoscopic radical prostatectomy (RALP).

Methods: A novel, robotic transrectal ultrasound probe manipulator (TRUS Robot) was used concurrently with the daVinci® surgical robot (Intuitive Surgical Inc., Sunnyvale, CA) in a tandem-robert assisted laparoscopic radical prostatectomy (T-RALP) [PCM21067797]. We performed T-RALP on 49 subjects with prostate cancer, median age 59 years. TRUS Robot steadily held the TRUS probe and allowed remote manipulation by the surgeon. We utilized the TilePro function of the daVinci system to visualize both the surgical field and the TRUS images simultaneously.

The location of NVBs was correlated between their estimated location by the surgeon and Doppler imaging. In ultrasound, the point of the instrument appears as a hyperechoic mark. Doppler ultrasound images were recorded. The distance $d_1$ between the hyperechoic mark (red dot $P_1$) and Doppler activity signals (green dot $P_2$) was measured in the ultrasound image, as shown in the Figure. In the same image, we also measured the distance $d_2$ between the Doppler activity (green dot $P_2'$) and the periphery of the prostate (blue dot $P_3$).

Results: Each T-RALP portion added an average of 15 minutes to surgery. With the TRUS Robot, the surgeon was able to remotely control the TRUS probe and utilize the ultrasound images at critical points of the operation. Thirty three image series of the T-RALP cases that displayed a clear view of both NVB and instrument tip were selected for the analysis. Total number of images chosen from these series was 120, (49 in left and 71 in right). The result are presented in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
<th>Overall</th>
</tr>
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<tbody>
<tr>
<td>$d_1$ [mm]</td>
<td>3.68 (2.43)</td>
<td>4.23 (2.66)</td>
<td>4.01 (2.58)</td>
</tr>
<tr>
<td>$d_2$ [mm]</td>
<td>3.48 (2.70)</td>
<td>3.97 (2.49)</td>
<td>3.77 (2.58)</td>
</tr>
</tbody>
</table>

The mean distance between estimated and actual location of the NVB was 4.01 (SD 2.58) mm.

Conclusion: TRALP is safe and feasible. Experimental data suggests that the Doppler activity recorded near the prostate capsule is generated by the NVB, and that the method may be used for intraoperative navigation. The use of TRUS imaging during radical prostatectomy can potentially improve the visualization of the NVB and subsequently improve postoperative recovery of potency in men.

Acknowledgement: Study supported by award CA141835 from the National Cancer Institute, the Sidney Kimmel Comprehensive Cancer Center at Johns Hopkins, and Hitachi-Aloka Medical Systems.

Figure: Schematic and ultrasound image of distance measurements between the daVinci instrument tip pointing the NVB, Doppler activity presumed to be the NVB, and prostate capsule.
ABSTRACTS

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ENDOSCOPIC IMAGING IMPROVEMENT LEADING TO BETTER TUMOR ABLATION – NBI GUIDED TURBT IN NMIBC MANAGEMENT

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“Saint John” Emergency Clinical Hospital, Department of Urology, Bucharest, Romania

Introduction: The standard bladder cancer management is often marked by unsatisfactory outcomes. This prospective, single-center study compared the diagnostic accuracy specific for narrow band imaging (NBI) and respectively white light cystoscopy (WLC) among non-muscle invasive bladder cancer (NMIBC) patients.

Methods: 81 consecutive NMIBC suspected cases were included, based on the presence of hematuria and/or ultrasound suspicious aspect. All patients were evaluated by both WLC and NBI cystoscopy. WL-visible lesions were removed by classical transurethral resection of bladder tumors (TURBT), while NBI resection was exclusively applied in tumors solely detected in this particular vision mode.

Results: Subsequent to NBI cystoscopy, substantially improved CIS (100% versus 66.7%) and overall NMIBC (97.1% versus 89.7%) in patients’ detection rates were determined. A significant proportion of additional lesions was identified in NBI regardless of the bladder cancer stage (26.5% versus 7.4% for overall NMIBC lesions; 50% versus 0% for CIS; 22.2% versus 8.9% for pTa; 29.4% versus 5.9% for pT1). Improved tumors’ detection rates were established for NBI when compared to white light concerning all NMIBC categories of patients (CIS – 94.1% versus 58.8%; pTa – 94% versus 83.2%; pT1 – 96.8% versus 90.3%; overall NMIBC – 93.9% versus 81.9%). The more numerous false-positive results affected the NBI-TURBT related specificity within a parallel to the standard investigation protocol (15.8% versus 10.7%).

Conclusion: NBI cystoscopy and TURBT were outlined as providing an efficient modality of significantly improving NMIBC detection, thus optimizing tumor ablation. The solely NBI diagnosed NMIBC cases and tumors largely supported this conclusion.
FIBEROPTIC CONFOCAL LASER ENDO MICROSCOPY OF SMALL RENAL MASSES: TOWARDS REAL TIME OPTICAL DIAGNOSTIC BIOPSY

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²Department of Pathology, Immunology and Laboratory Medicine, University of Florida College of Medicine, Gainesville, FL

Introduction: The incidence of small renal masses is on the rise; however not all require treatment as up to 20% are benign with an additional 60% harboring indolent features. Improved diagnostics are needed to differentiate those tumors with high malignant potential that may require aggressive treatment from those with benign or indolent features that may be more suitable for surveillance. We sought to evaluate the utility of a real time, fiberoptic, high resolution fluorescence imaging technology, confocal laser endomicroscopy (CLE), to image ex-vivo renal tumors as compared to standard histopathology as a proof of principle towards diagnostic optical biopsy.

Methods: Following IRB approval, 20 patients with solitary small solid renal tumors scheduled for surgery were enrolled. Following surgical excision (16 partial and 4 radical), ex-vivo CLE imaging (2.6 mm probe, 1 µm resolution, 60 µm depth of focus) was performed on all tumors and surrounding normal kidney both on the external tumor surface and en face once the tumor was bivalved. Two kidneys were infused with fluorescein dye via intraoperative peripheral intravenous injection while 18 were bathed ex-vivo in a dilute fluorescein bath to allow for passive tissue uptake of fluorescence prior to imaging. Corresponding areas were evaluated by routine histology with side-by-side comparison to CLE.

Results: Ex-vivo CLE imaging provided superb discrimination of normal renal structures (glomeruli, tubules, sinus fat and collecting system) with excellent correlation to histology. Tumor tissue was readily distinguishable from normal kidney with unique features between angiomyolipoma, clear cell and papillary renal carcinoma (Figure). Topical fluorescein administration provided better CLE imaging than the intravenous route and en face tumor imaging was superior to external imaging due to the limited depth of CLE imaging penetration.

Conclusion: We report the first feasibility study of using CLE optical biopsy for ex-vivo evaluation of solid renal tumors and provide a preliminary atlas of various renal neoplasms with corresponding histology. These findings serve as an initial step towards real time diagnostic optical biopsy of small renal masses.
WOLF® PIRANHA VERSUS LUMENIS® VERSACUT™
PROSTATE MORCELLATION DEVICES:
A PROSPECTIVE, CONTROLLED, RANDOMIZED TRIAL

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Introduction: Holmium laser enucleation of the prostate (HoLEP) for the management of benign prostatic hyperplasia (BPH) involves 2 steps: enucleation and morcellation. There are few prostate morcellation devices (PMDs) available. Our aim is to compare the Richard Wolf® Piranha and Lumenis® Versacut™ PMDs.

Methods: After IRB approval and patient consent, a prospective, randomized trial of 74 patients who had symptomatic BPH requiring HoLEP was done. HoLEP was performed by a single surgeon (JEL) at IU Health Methodist Hospital using either the Wolf® or Lumenis® PMD for the morcellation. Patient’s demographics, preoperative, intraoperative, and postoperative data, as well as morcellation related complications, were documented, assessed, and analyzed.

Results: Seventy-four patients were enrolled. Age, PSA, and gland size were comparable for both groups (Table 1). Intraoperative, postoperative characteristics and cost analysis are demonstrated in Table 2. Morcellation rates (gm/min) were: Piranha 6.5 (1.4-18) and Versacut™ 5.3 (0.3-9.5), p=0.14. The average cost of disposable instruments (USD/patient) was: Piranha $471 and Versacut™ $241, p=<0.001.

Conclusion: The morcellation rates for the Wolf® Piranha PMD and the Lumenis® Versacut™ were similar. However, the Piranha appears better at morcellating tougher more dense prostatic tissues. The blades for the Piranha PMD are disposable, making it more expensive to use.

<table>
<thead>
<tr>
<th>Table 1: Patient’s demographics and pre-operative characteristics</th>
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<tbody>
<tr>
<td><strong>Richard Wolf® Piranha</strong> (n %)</td>
</tr>
<tr>
<td>Total patients</td>
</tr>
<tr>
<td>Age (years), average (range)</td>
</tr>
<tr>
<td>Pre-HoLEP PSA (ng/ml), mean (range)</td>
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<td>TRUS volume (g), mean (range)</td>
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<table>
<thead>
<tr>
<th>Table 2: Patients undergoing HoLEP intraoperative, postoperative characteristics and cost analysis</th>
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<tr>
<td><strong>Richard Wolf® Piranha</strong> (n %)</td>
</tr>
<tr>
<td>Enucleation time (min), average (range)</td>
</tr>
<tr>
<td>Morcellation time (min), average (range)</td>
</tr>
<tr>
<td>Pathological HoLEP specimen weight (g), average (range)</td>
</tr>
<tr>
<td>Enucleation rate (g/min), average (range)</td>
</tr>
<tr>
<td>Morcellation rate (g/min), average (range)</td>
</tr>
<tr>
<td>Morcellator bladder injury (mucosal)</td>
</tr>
<tr>
<td>Beach ball identified</td>
</tr>
<tr>
<td>Difficult visualization</td>
</tr>
<tr>
<td>Difficult morcellation</td>
</tr>
<tr>
<td>Device malfunction</td>
</tr>
<tr>
<td>Duration of catheterization (hours), average (range)</td>
</tr>
<tr>
<td>LOS (hours), average (range)</td>
</tr>
<tr>
<td>Cost of disposable instruments (USD/patient), average</td>
</tr>
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</table>
INITIAL EXPERIENCE AND OUTCOMES OF NATURAL ORIFICE TRANSLUMENAL ENDOSCOPIC RADICAL PROSTATECTOMY

Michael S. Borofsky, Jessica A. Mandeville, Naeem Bhojani, Jessica E. Paonessa, Marawan M. El Tayeb, James E. Lingeman

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Introduction: Preclinical studies have demonstrated natural orifice translumenal endoscopic radical prostatectom y (NOTES RP) is feasible. To date, no oncologic or functional outcomes have been described in human patients undergoing this procedure.

Methods: Five patients with low-risk prostate cancer underwent NOTES RP between 2011 and 2013. A 100W, 550μm Holmium laser (Versapulse®; Lumenis Surgical, USA) was used to dissect the prostate through a 28F laser resectoscope. Once free, the gland was removed via cystotomy. Vesicourethral anastomoses were performed through an offset nephroscope using an endoscopic suturing device (LSI Solutions, USA). Outcomes were assessed at 3, 6, and 12 months.

Results: Dissection was successfully performed solely using the laser in all cases. Immediate complications were minimal with only one patient requiring transfusion. Two patients had positive margins, though at nearly two years mean follow-up, there have been no detectable PSA recurrences. The most common post-operative complication was bladder neck contracture. Four patients underwent a total of nine bladder neck incisions. Two of three men with pre-operative erectile function regained potency by one year. Four patients noted persistent stress incontinence at one year.

Conclusions: Oncologic efficacy of NOTES RP appears encouraging. High rates of anastamotic related complications are likely due to difficulty with endoscopic suturing and indicate that modifications in technique are necessary.
INSTRUMENT LIFE FOR ROBOT-ASSISTED LAPAROSCOPIC RADICAL PROSTATECTOMY AND PARTIAL NEPHRECTOMY: ARE TEN LIVES FOR MOST INSTRUMENTS JUSTIFIED?

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The James Buchanan Brady Urological Institute and Department of Urology, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Introduction: Robotic surgery has permeated urological practice. At present, the Da Vinci system (Intuitive Surgical, Sunnyvale, CA) remains the only robotic platform on the market. As predetermined by the manufacturer, the majority of robotic instruments have a lifespan of 10 uses regardless of how they are used during a procedure. In this study we sought to investigate the rate of instrument exchange during Robot Assisted Laparoscopic Radical Prostatectomy (RALRP) and Robot Assisted Partial Nephrectomy (RAPN) cases as a marker of premature instrument failure.

Methods: Consecutive RALRP and RAPN cases performed by high-volume robotic surgeons at a single institution between January 2011 and October 2014 were retrospectively reviewed. The number of each instrument used per case was recorded by evaluating the robotic console log. Any instance where an additional instrument was utilized (i.e., >1 monopolar curved scissor, >1 Prograsp forceps, >1 fenestrated bipolar forceps and/or >2 needle drivers) was suggestive of a premature instrument failure and was noted. Operative times for cases in which an instrument was exchanged were compared to cases in which a particular instrument was used but not exchanged.

Results: During the study period, three surgeons performed 1579 RALRP procedures and two surgeons performed 313 RAPN procedures. Among the four instruments studied in RALRP, the curved monopolar scissors had the highest rate of exchange with 193 of 1556 (12.4%) cases requiring >1 instrument. An extra Prograsp forceps, fenestrated bipolar grasper or needle driver were required in only 1.8%, 1.3% and 0.8% of cases, respectively. These exchange rates were similar for RAPN. The rate at which monopolar curved scissors, fenestrated bipolar graspers and needle drivers were exchanged remained stable in time, suggesting no association with surgeon learning curve. Exchange of prograsp forceps did decrease with increasing surgeon experience (p=0.02). Notably, cases in which an instrument was exchanged was not associated with significantly longer operative times (p > 0.05 for all instruments).

Conclusions: During RALRP and RAPN, Prograsp forceps, fenestrated bipolar forceps and needle drivers uncommonly required premature exchange. In contrast, the monopolar curved scissors required exchange in approximately 10% of cases. Our findings imply that the actual lifetime of robotic instruments is not uniformly 10 uses. These data should be incorporated to potentially change the preset lifetime of robotic instruments and/or change pricing. Additional clinical data are needed to more precisely define the actual lifetime of robotic instruments.
ABSTRACTS

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TRENDS IN THE SURGICAL MANAGEMENT OF LOCALIZED PROSTATE CANCER IN EUROPE: A CRITICAL ASSESSMENT OVER THE LAST 10 YEARS—RESULTS FROM THE PROSTATE CANCER WORKING GROUP OF THE YOUNG ACADEMIC UROLOGISTS WORKING PARTY OF THE EUROPEAN ASSOCIATION OF UROLOGY

Surcel C\(^1\), Mirvald C\(^1\), Giannarini G\(^2\), Briganti A\(^3\), Ploussard G\(^4\), Ost P\(^5\), Ghadjar P\(^6\), Isbarn H\(^7\), Sooriakumaran P\(^8\)

\(^1\)Centre of Urological Surgery, Dialysis and Renal Transplantation, Fundeni Clinical Institute, Bucharest, Romania.
\(^2\)Department of Experimental and Clinical Medical Sciences, University of Udine, Udine, Italy.
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\(^4\)Department of Urology, Saint-Louis Hospital, Paris, France.
\(^5\)Department of Radiation Oncology and Experimental Cancer Research, Ghent University Hospital, Ghent, Belgium.
\(^6\)Department of Radiation Oncology, Charité Universitätsmedizin Berlin, Berlin, Germany.
\(^7\)Department of Urology, Regio Clinic Wedel, Wedel, Germany; Martini-Clinic, Prostate Cancer Center Hamburg-Eppendorf, Germany.
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Background: Localized prostate cancer represents a widely-researched disease, with numerous abstracts accepted annually at the European Association of Urology meeting. The aim of this study is to describe trends regarding the abstracts reporting on the management of localized prostate cancer.

Methods: We searched the online abstract books of the European Association of Urology meeting from 2005 until 2014 (available on www.uroweb.org), and found and assessed 1487 abstracts reporting on the management of localized prostate cancer. All papers were classified according to the type of management (surgical vs non-surgical) and then sub-grouped by type of procedure. Paired sample t-test analysis was used to evaluate the differences among groups.

Results: Open radical prostatectomy covered 4.23% of all abstracts, with no significant change in proportion over the years of the analysis. While abstracts on laparoscopic and robotic assisted prostatectomy had similar percentages in the last 10 years (9.21% and 12.71% respectively), there was a significant downward trend of accepted abstracts regarding laparoscopy over the years (31/153 papers in 2005 vs 1/130 papers in 2014), while the robotic approach increased in popularity with a maximum of 21.14% (36/170) of all abstracts in 2012. Papers regarding experimental procedures (cryotherapy/HIFU, etc.) and hormonal therapy covered 4.23% and 3.29% respectively, from all abstracts, with small variations in the number of abstracts accepted each year. The number of abstracts reporting the usage of EBRT as primary/salvage treatment was consistent up until 2009 followed by a decline with a minimum in 2014 (2/130 papers).

Conclusions: Robotic assisted radical prostatectomy represents the highest researched area among the European Urological community. Although laparoscopic assisted radical prostatectomy and primary EBRT were very popular a decade ago, research interest in these procedures is declining. Open radical prostatectomy still generates some research output, with a consistent number of papers accepted each year.
CLASSIFICATION AND MANAGEMENT OF INFRAVESICAL SECONDARY OBSTRUCTION AFTER COMBINED TURP AND HIFU

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²Dept. Urology, Klinikum Harlaching, Munich, Germany
³Harlachinger Krebshilfe, Munich, Germany

Introduction: The most common side effect following combined transurethral resection of the prostate (TURP) and high intensity focused ultrasound (HIFU) is secondary infravesical obstruction. It is caused either by necrotic debris or, as is more often the case, by fibrotic stenosis. The latter can occur in different locations of the prostatic urethra.

Methods: Beginning in 1996, we performed HIFU for prostate cancer with Ablatherm® HIFU (EDAP-TMS, Lyon-France) with adjuvant TURP. We analyzed our prospective HIFU database (n=2 735) and identified 684 cases (25.0 %) with secondary obstruction which required a secondary endourological intervention. All OR reports and follow-up files were reviewed in detail. Obstruction was categorized according to type, frequency and management strategy were analyzed.

Results: Of the 2,735 HIFU/TURP cases, obstruction occurred from necrotic tissue in 6% (n=164) within short term (6 months) and in 19% (n=520) from secondary infravesical fibrotic stenosis. Four typical types of late stenosis locations were identified:

- Type I (bladderneck stenosis): 12% (n=328)
- Type II (intraprostatic sandclock-stenosis): 5% (n=137)
- Type III (apical-retrosphincteric stenosis): 2% (n=55)
- Type IV (classical urethral stenosis): <5% (n=13)

Endoscopical repair by specific ante-retrograde resection (ENDO-V repair) proved to be fast, effective, and simple. Nevertheless there were few cases 0.7% (n<20) with recurrent stenosis that needed multiple resections or routine urethral dilatations.

Conclusion: Infravesical secondary obstruction after combined adjuvant TURP and whole gland HIFU was mostly correlated to small prostates and excellent oncological outcome but did occur in approximately one-quarter of the cases. Fortunately, it can be managed simply and effectively. HIFU induces solid shrinkage of the prostate capsule, typically down to 10cc or less and can provoke intraprostatic stenosis in 3 different locations. This typically occurs 6 to 9 months after treatment. ENDO-V repair is a safe method for effective stenosis repair, while cold-loop curettage was the adequate therapy for necrosis/sludge tissue evacuation.
ABSTRACTS

ABSTRACT 40  TOP 10 ABSTRACT

PILOT STUDY EVALUATING $^{99m}$Tc-SESTAMIBI SPECT/CT FOR THE DIFFERENTIATION OF ONOCYTOMA FROM RENAL CELL CARCINOMA

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Johns Hopkins University School of Medicine, Baltimore, MD, USA

Introduction: Currently available cross-sectional imaging techniques are unable to reliably distinguish oncocytomas apart from renal cell carcinoma (RCC). As a result, a large number of patients harboring an oncocytoma undergo unnecessary surgical resection. Compared to RCC, oncocytomas are unique in that at the ultra-structural level these tumors are comprised of cells with numerous densely packed mitochondria. In this study we tested the hypothesis that oncocytomas can be differentiated from RCC on the basis of increased uptake of the mitochondrial imaging agent $^{99m}$Tc-sestamibi.

Methods: In total, 6 patients (3 with oncocytoma and 3 with renal cell carcinoma) were imaged with $^{99m}$Tc-sestamibi SPECT/CT. Relative quantification was performed by measuring tumor to normal renal parenchyma background ratios.

Results: All 3 oncocytomas demonstrated radiotracer uptake near or above that of the normal renal parenchymal (uptake ratios: 0.85, 1.10 & 1.78). In contrast, the three renal cell carcinomas were profoundly photopenic relative to renal background (uptake ratios: 0.21, 0.26 & 0.31).

Conclusion: $^{99m}$Tc-sestamibi SPECT/CT appears to be of value in distinguishing oncocytoma from renal cell carcinoma. To more rigorously assess the diagnostic accuracy of this imaging modality, we have initiated a trial (ClinicalTrials.gov identifier NCT02160925) to prospectively study patients with clinical T1 renal tumor scheduled to undergo surgical resection.

Figure 1. Contrast enhanced CT (A&E), SPECT (B&F), fused SPECT/CT (C&G) and histology sections (D&H) from a patient with a biopsy-proven oncocytoma (A-D) and a clear cell renal cell carcinoma (E-H).
MONTE CARLO SIMULATIONS OF LIGHT TRANSPORT FOR TRANSVAGINAL AND TRANSURETHRAL APPROACHES TO LASER TREATMENT OF FEMALE STRESS URINARY INCONTINENCE

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² McKay Department of Urology, Carolinas Medical Center, Charlotte, NC

Introduction: Over 13 million women in the U.S. suffer from Stress Urinary Incontinence (SUI), but only ~ 260,000 women have surgery annually. Many women avoid surgical therapy for SUI due to the risk of anesthesia, mesh concerns, prolonged recovery time, treatment failure with future pregnancy, and inherent procedure morbidity. Radiofrequency (RF) energy has been used for transurethral thermal shrinkage and remodeling of submucosal collagen in the bladder neck and proximal urethra as a nonsurgical SUI treatment. However, due to its limited penetration depth, RF treatment of SUI may still be more invasive than desired. Subsurface thermal denaturation of tissues can be achieved using deeply penetrating near-infrared (IR) laser energy in combination with surface cooling, to preserve up to 2 mm of the tissue surface. This study uses computer simulations to model light transport through tissue for future development of endoscopic laser probes for transvaginal and transurethral laser treatment of SUI.

Methods: A Monte Carlo (MC) model provided the spatial distribution of absorbed photons in female urinary tissue layers (vaginal mucosa, endopelvic fascia, urethral wall). Refractive index (n), absorption coefficient (μₐ), scattering coefficient (μₛ), and anisotropy factor (g) were assigned to each tissue layer for 1075 nm laser wavelength (λ) (Table 1). MC simulations used 1 million photons, a cylindrical coordinate system with 3 mm radius and 1 cm depth, and 350 x 350 bins. A 5-mm-diameter Gaussian laser beam and total output energy of 108 J (7.2 W for 15 s) was used, based on experiments. Absorbed energy density (J/cm³) was plotted as a function of radius and depth.

Results: Percent energy absorbed in the endopelvic fascia layer was 39% and 15% for transvaginal and transurethral approaches, with only 0.58% and 0.14% deposited beyond this layer for each case. A probe capable of cooling about 2 mm of the tissue surface will be required to prevent thermal damage.

Conclusion: A significant fraction of optical energy was delivered to endopelvic fascia for thermal remodeling using near-IR lasers, but applied cooling of the tissue surface will be necessary to prevent overheating. Further simulations coupling MC photon distributions with a heat transfer model to provide temperature maps, and an Arrhenius integral model to quantify tissue thermal damage are planned.

Table 1. Optical properties of tissue layers at λ = 1075 nm.

<table>
<thead>
<tr>
<th>Tissue</th>
<th>n</th>
<th>μₐ (cm⁻¹)</th>
<th>μₛ (cm⁻¹)</th>
<th>g</th>
<th>Thickness (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginal Mucosa</td>
<td>1.38</td>
<td>0.43</td>
<td>21.6</td>
<td>0.9</td>
<td>0.27</td>
</tr>
<tr>
<td>Endopelvic Fascia</td>
<td>1.39</td>
<td>0.35</td>
<td>484</td>
<td>0.9</td>
<td>0.43</td>
</tr>
<tr>
<td>Urethral Wall</td>
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<td>0.50</td>
<td>239</td>
<td>0.9</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Figure 1. Energy absorbed versus tissue depth for (a) transvaginal and (b) transurethral approaches. The laser beam is incident from the left in each figure.
COMPARISON OF PROXIMAL FIBER TIP DAMAGE DURING HOLMIUM:YAG AND THULIUM FIBER LASER LITHOTRIPSY

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Introduction: Optical fibers used in Holmium:YAG laser lithotripsy are commonly manufactured, sterilized, and marketed as “single use,” to be disposed of after every lithotripsy procedure. However, these fibers sometimes fail during operation and must be replaced before the procedure can continue. Sources of fiber failure include extreme bending, distal fiber tip degradation and burnback, and proximal fiber tip failure. If excessive energy is reflected at the connectorized proximal fiber end, this may lead to decreased energy transmission and stone ablation efficiency in a best-case scenario, and proximal fiber destruction and laser or endoscope damage in a worst-case scenario. The experimental Thulium fiber laser (TFL) is being studied as an alternative to the Holmium laser for lithotripsy. The TFL beam originates within an 18-μm-core thulium doped silica fiber, and its near-single mode, Gaussian beam profile allows higher laser power to couple into smaller fibers (e.g., 50 and 100 μm core) than currently used during Holmium laser lithotripsy. This study examines whether the near-single mode, TFL spatial beam profile reduces proximal fiber tip damage compared to Holmium laser’s multimodal beam profile.

Methods: A 100-Watt, TFL with 1908 nm wavelength was used. The laser beam was focused to a spot diameter of ~25 μm for coupling into 105-μm-core, low-OH, silica fibers, with pulse energy of 35 mJ, pulse duration of 500 μs, and variable pulse rates of 50, 100, 200, 300, 400, and 500 Hz. For each study, 500,000 pulses were delivered, and average power output was recorded every 10,000 pulses. Magnified images of the proximal fiber tip were taken before and after each trial. For comparison, 270-μm-core fibers were collected after single Holmium laser lithotripsy procedures in the clinic (with typical settings of 600 mJ, 350 μs, and 6 Hz) and total energy (J), total # pulses, and total irradiation time (s) recorded.

Results: For TFL studies, initial output pulse energy and average power were stable. No proximal fiber damage was observed after TFL delivery of 500,000 pulses at settings up to 35 mJ, 500 Hz, and 17.5 W of average power. Images of fiber tips after Holmium lithotripsy revealed significant proximal fiber tip degradation, as observed by the presence of numerous ablation craters (Figure 1), and damage increased with procedure time. Proximal tip damage may originate from hotspots in multimodal Holmium laser beam profile.

Conclusion: The proximal fiber tip of a 105-μm-core, silica fiber transmitted an average TFL power up to 17.5 W without degradation, compared to 270-μm-core fibers that degraded when delivering an average Holmium power of only 3.6 W.

Figure 1. (a) Damaged 270-μm-core proximal fiber tip after Holmium laser delivery of 117 pulses, showing numerous ablation craters caused by hotspots from multimodal Holmium laser beam. (b) Undamaged, 105-μm-core proximal fiber tip after TFL delivery of 500,000 pulses at 35 mJ, 500 Hz, and 17.5 W.
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“ONE-STOP-SHOPPING”: BIOPSY, DIAGNOSIS & FOCAL THERAPY IN ONE SESSION

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Introduction: Our purpose was to maximize efficiency and accuracy and minimize patient discomfort by combining prostate biopsy, pathology examination and, if necessary and indicated, (focal) CA-therapy in only one session. The whole procedure takes place under general anesthesia and lasts less than 2 hours. By means of mpMRI we pre-select low-risk, single lesion patients as candidates for such treatment. We then first perform prostate biopsy, then pathology, and last focal therapy of prostate CA location(s) using irreversible electroporation (IRE) without intermediate patient movement.

Methods: After mpMRI we first performed MRI-US fusion for transperineal biopsy using the BiopSee® system of MedCom. We took MRI-targeted & systematic samples from ~20-30 locations, depending on the prostate size and imaging. Two samples were taken from each location: one was used for immediate intraoperative frozen section analysis (FSA) and the second for standard histopathology. FSA pathology of the first cores starts already in parallel to the on-going biopsy process and finishes ~20 min after the last core has been sampled. Using the results from the FSA and while the patient was still under general anesthesia, we performed electrophoresis of CA-suspicious areas using NanoKnife® of Angiodynamics. Planning and placement of electrophoresis needles was performed again by the BiopSee® system (Figure 1) and electrodes were placed in the corresponding holes around the CA location using the same template and setup as previously for acquiring the transperineal biopsy samples (Figure 2). Treatment was completed in approximately 40 minutes. Due to general anesthesia and patient immobilization, the method benefits from a robust & reliable registration between biopsy and therapy for the exact localization of CA areas.

Results: This method was performed so far to 9 patients with the latest procedures being completed in less than 2 hours. In our cohort the results from histopathology have confirmed the results from FSA. Using the same setup for biopsy and for treatment under general anesthesia and patient immobilization we ensured that we performed electroporation to the exact position(s) of the confirmed lesion(s). We found that incorporation of the two techniques into our surgical practice simplified the process and improved the accuracy of the focal treatment.

Conclusion: We believe that our approach has the potential to increase the accuracy and provide more comfort and fewer complications to the patient. However, the reliability of FSA depends heavily on the availability of accordingly experienced pathologist in-situ, a fact practically limiting the availability of the approach on specialized centers offering the corresponding level of care.

Figure 1: Planning of Nanoknife electrodes
Figure 2: Positioning of Nanoknife electrodes
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LAPAROSCOPIC CRYOABLATION FOR RENAL CELL CARCINOMA: 100-MONTH ONCOLOGIC OUTCOMES, A SINGLE INSTITUTION’S EXPERIENCE

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Introduction: With incidence of renal cell carcinoma (RCC) on the rise, treatment options for the small renal mass have broadened. Cryoablation is increasingly used as a therapeutic option for the treatment of renal tumors in selected cases. However, studies with long-term oncologic outcomes are sparse. The purpose of this study is to evaluate the long-term oncologic outcomes of laparoscopic renal mass cryoablation.

Methods: We reviewed our laparoscopic cryoablation (LCA) database for patients who had LCA from October 1997 to February 2005. Patients with less than 3 months follow up were excluded. Patient and tumor characteristics and perioperative outcomes, including complications, were recorded. Recurrence free survival, cancer specific survival and overall survival were analyzed using Kaplan-Meier curves.

Results: 142 tumors in 138 consecutive patients were treated by LCA. The mean age of the cohort was 66.35 years, 99 (71.7%) males and 39 (28.3%) females. The mean BMI was 29.15 Kg/m² and median ASA score was 3. Solitary kidney was present in 23 (16.2%) patients. The mean tumor size on cross-sectional imaging was 2.4 cm. Mean pre and post-operative eGFR was 66.72 and 61.00 mL/min respectively, post-operative eGFR was gathered at a mean (SD) of 15.17 (10.99) months follow up. The median R.E.N.A.L. nephrometry score was 5. Of the total 142 tumors, 100 were diagnosed as RCC after histopathologic examination of the biopsy specimen. Of those diagnosed with RCC, the estimated 3, 5, and 10 year RFS was 91.4%, 86.5% and 86.5%, respectively. The estimated 3, 5, and 10 year CSS was 96.8%, 96.8% and 92.6%, respectively. The estimated 3, 5, and 10 year OS was 88.7%, 79.1% and 53.8% respectively. The mean (SD) follow-up time was 98.8 (54.2) months for those diagnosed RCC. The mean time to recurrence was 2.3 years. The latest experienced recurrence was 4.4 years after LCA. There was a post-operative complication rate of 10.6%, with a total of 15 complications.

Conclusions: LCA achieves good long-term oncologic outcomes for localized small renal masses. It can safely be used for patients who cannot or are unwilling to accept the risks partial nephrectomy. Mean time to recurrence was 2.3 years and all recurrences occurred within 4.4 years of initial treatment.
MAINTENANCE COSTS OF FLEXIBLE URETEROSCOPY: A MULTI-SITE SURVEY

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Introduction: Flexible ureteroscopy allows nonsurgical treatment of both common and complex upper urinary tract pathologies. While durability of ureteroscopes has been implicated as a driving force for scope costs, maintenance costs have not been closely examined as a source of ureteroscopic expense. We established the WEstern STone consortium (WEST) to examine cost of scope maintenance across institutions in the Western United States. The purpose of this study was to characterize flexible ureteroscope utilization at seven high volume endourology institutions and costs associated with flexible ureteroscope purchase and maintenance.

Methods: The WEST consortium is comprised of seven academic urology departments - University of California, San Francisco; University of California, San Diego; and Oregon Health Sciences University, San Francisco General Hospital, University of Washington Medical Center, and the Puget Sound Veterans Administration Hospital. A site survey was administered at each institution in a prospective fashion. Site profile data points collected included flexible ureteroscope caseload, model type and quantity, associated purchase price, repair costs, warranty costs, processing and sterilization techniques, and repair and servicing information.

Results: The number of ureteroscopic cases performed in 2012 ranged from 79 to 260 at each institution. The number of ureteroscopes owned by each ranged from seven to twelve, and the most common models were the Olympus URF-P6, URF-V, and Storz Flex X². Purchase price per ureteroscope averaged $18,508. Institutional cost of repairs ranged from $44,722 to $65,428 with at least one repair required per month per institution. Those with the lowest institutional scope maintenance costs utilized a service warrantee contract.

Conclusion: Maintenance costs and frequent damage of flexible ureteroscopes are significant concerns that should be considered when evaluating long-term value. Repair costs were significant compared to equipment cost, and institutions utilizing a service contract for maintenance appeared to benefit from cost savings. The cost of scope maintenance should play an important role in making institutional decisions regarding the utilization of flexible ureteroscopes.
FEASIBILITY OF 3D CONTRAST ULTRASOUND DISPERSION IMAGING FOR PROSTATE CANCER LOCALIZATION

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² Urology Dept, Academic Medical Center, University of Amsterdam, Amsterdam, the Netherlands

Introduction: In Western countries, prostate cancer (PCa) is the type of cancer with the highest incidence in men. To date, reliable tools for PCa localization are lacking. Recently, contrast-ultrasound dispersion imaging (CUDI) by spatiotemporal analysis performed on transrectal dynamic contrast-enhanced ultrasound (DCE-US) loops has been proposed as a promising option for PCa localization. This method evaluates the spatial similarity between indicator dilution curves in each pixel compared to its ring-shaped surrounding. Until now, CUDI has been performed in 2D only, with each plane requiring a separate bolus injection of the contrast agent. 3D DCE-US can potentially solve this limitation, enabling the analysis of the entire prostate with a single bolus injection. Therefore, this work proposes CUDI by spatiotemporal similarity analysis in 3D.

Methods: The method is based on the assessment of the similarity between indicator dilution curves in each pixel and its 3D shell-shaped surrounding. Similarity is estimated in terms of linear correlation between curves either in time or in frequency domain. The feasibility to localize PCa was evaluated in two patients by qualitatively comparing similarity maps obtained by 3D CUDI with those obtained by 2D CUDI in the corresponding planes and with histopathologic results from 12-core systematic biopsies. The data were acquired with a Logiq E9 ultrasound scanner (GE Healthcare) after an intravenous injection of 2.4-mL SonoVue™ (Bracco) contrast agent.

Results: Both the spatial and temporal resolution of the acquired data were sufficient for 3D CUDI. All the results showed good agreement, confirming the feasibility of 3D CUDI for PCa localization. Figure 1 shows two dispersion maps for one matching plane (2D and 3D) in the two patients.

Conclusion: PCa localization by 3D CUDI is feasible, permitting the investigation of the entire prostate by a single intravenous injection of ultrasound contrast agents. Extended validation with a larger dataset is however mandatory to assess the classification performance of the method.

Figure 1: Dispersion maps along a matching plane by 2D and 3D CUDI compared to the biopsy results.
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INTRACORPOREAL RENAL HYPOTHERMIA WITH ICE SLUSH VERSUS WARM ISCHEMIA DURING ROBOTIC PARTIAL NEPHRECTOMY: COMPARATIVE MATCHED ANALYSIS TO ASSESS FUNCTIONAL OUTCOMES

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Objective: To describe our technique for intracorporeal renal cooling with ice slush during robotic partial nephrectomy (RPN) and compare renal functional outcomes to traditional warm ischemia.

Methods: From September 2013 to November 2014, a total of 24 patients underwent RPN with use of intracorporeal ice slush for renal hypothermia by a single surgeon. Inclusion criteria were ischemia time estimated to take longer than 30 minutes based on nephrometry score, hilar location, and tumor complexity. Ice slush was administered via an accessory 12 mm port placed in the mid-axillary line beneath the coastal margin prior to hilar clamping. Renal temperature was monitored with a thermocoupler device while patient core body temperature was concurrently recorded. Perioperative patient characteristics and post-operative data were prospectively reviewed. Intracorporeal renal hypothermia cases were matched 2:1 with patients who underwent robotic partial nephrectomy with traditional warm ischemia for comparison of postoperative and 6-month renal function. Six-month functional data were only available on 16 patients who underwent intracorporeal renal cooling. Matching was done based on preoperative estimated GFR (eGFR), ischemia time, and RENAL nephrometry score.

Results: The mean age of our cohort was 58.2 years with a mean tumor size of 4.1 cm and a mean RENAL nephrometry score of 9. Mean ischemia time was 31.1 minutes in the cold ischemia group and 28.4 minutes in the warm ischemia group. Lowest mean renal temperature with intracorporeal ice slush was 15.4 degrees C at a mean of 10.3 minutes after placement of slush. Mean change in patient temperature was 0.3 degrees C. There was no difference in age, tumor size, renal score, or preoperative eGFR between the two groups. On multivariable, linear regression analysis, cold ischemia was associated with a 12.9% greater preservation in eGFR on POD 3 compared to warm ischemia (CI 1.6-24.3; p = 0.026). No differences were seen in renal function at 6-month follow-up between the cold or warm ischemia groups.

Conclusion: The use of intracorporeal ice slush during robotic partial nephrectomy improves preservation of eGFR in the immediate post-operative period and should be considered in patients with solitary kidneys, complex renal tumors, or chronic kidney disease. No difference was seen at 6-month follow up, which is likely due to short cold ischemia times.
DECELLULARIZATION OF TISSUE USING ULTRASOUND FOR REGENERATIVE MEDICINE

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Introduction: The field of tissue engineering aims to develop tissue and organ substitutes to replace diseased or injured tissue and organs. While replacement of whole organs has been elusive, there have been major technological advances in this field. One example is the process of decellularization in order to create 3-dimensional scaffolds to facilitate creation of bioartificial organs. To increase the efficiency of decellularization, ultrasound has been used to augment chemical or enzymatic agents, however, as a sole technique only thin regions of tissue have been successfully decellularized with negligible temporal improvement. Here we introduce the possibility of decellularizing large tissue volumes in short time frames by using the non-thermal focused ultrasound technique termed boiling histotripsy (BH).

Methods: Freshly excised cubes of bovine liver and whole porcine kidneys were placed in custom holders for treatment using a clinical MR-guided High Intensity Focused Ultrasound (HIFU) system or a bench top HIFU system. Volumetric lesions (1 cm diameter in cross-section) were created with single lesions spaced 1-5 mm apart using BH treatment regimens tailored towards decellularization. Each lesion was created with ten to thirty 10 ms long pulses with duty factor of 1%. The in situ peak positive and negative pressures ranged within 78-88 and 12-17.5 MPa, respectively. After treatment, lesions were cut in cross section, photographed, and then rinsed to visualize the remaining structure. Separate samples were prepared for histological evaluation.

Results: Volumetric lesions (1 cm in diameter) were produced within 5 - 40 minutes. Macroscopic evaluation showed that lesions contained homogenized tissue. After washing out the liquefied contents, a residual three-dimensional tissue matrix could be seen (Figure 1). This tissue structure appeared to be pliable and easily manipulated without damage. Histological evaluation of the remaining tissue matrix revealed intact fibrous-stroma, patent vessels and/or biliary vessels surrounded by liquefied cells in the liver tissue. There were some small caliber vessels that contained intact cells, although this was not evident in all samples. In the kidney, patent vessels and stroma surrounding tubules and glomeruli were present whilst most of the cellular contents were liquefied (Figure 1).

Conclusion: This study demonstrates that large volumes of tissue can be decellularized by boiling histotripsy in a short period of time. The treatment left a 3-dimensional structure that could be used as a scaffold on which to seed cells. With further tailoring of the pulsing scheme, this treatment modality could potentially be utilized for the decellularization of organs for tissue engineering applications.

![Figure 1: Volumetric lesion in kidney with homogenized cells washed out to reveal remaining structures (left). Scale bar represents 5mm. Masson's trichrome stained kidney cortex from a treated region (middle) and control tissue (right). Scale bar represents 100 μm.](image)

Acknowledgements: This research was funded by NIH EB007643, K01 EB015745, T32 DK007779, NSBRI through NASA NCC 9-58, RFBR 13-02-00183
ABSTRACTS

ABSTRACT 49

EARLY RESULTS OF THE SAFETY AND INITIAL EFFICACY STUDY OF THE
VORTX RX® FOR TREATMENT OF BENIGN PROSTATIC HYPERPLASIA

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Introduction: Histotripsy is a non-thermal, non-invasive acoustic energy modality that induces controlled cavitation to homogenize targeted tissue. Feasibility of prostate tissue debulking has been previously demonstrated in a canine model with the VORTX RX system. The objectives of this first-in-human study were primarily to assess safety of the VORTX RX system for treatment of benign prostatic hyperplasia (BPH) and secondarily to gather initial efficacy data.

Methods: Twenty-five male subjects with moderate to severe lower urinary tract symptoms (LUTS), prostate size between 30 and 80 grams on transrectal ultrasound (TRUS) and no evidence of prostate cancer were enrolled at two sites in a prospective, first-in-human safety study. Treatment using the VORTX RX consisted of delivery of acoustic energy through the perineum to the prostatic adenoma with real-time TRUS monitoring under anesthesia or sedation. Follow-up evaluations were performed on post-op day one and 1, 3, and 6 months and included a physical exam, uroflowmetry, International Prostate Symptom Score (IPSS), quality of life, and sexual health questionnaires.

Results: Delivery of acoustic energy resulted in intraprostatic bubble cloud formation (cavitation) in all subjects. Device-related adverse events (definitely or probably related, as adjudicated by a DSMB) were limited to 3 cases with transient retention (<3 days), 1 case of retention (8 days), a minor anal abrasion, and 1 case with microscopic hematuria. To date, all subjects have completed three month follow-up. Average IPSS improvement at one month was 12.5 (52.4%) (95 percent confidence interval, 9.9 to 15.1) (n=25), at three months was 12.0 (51.0%) (95 percent confidence interval, 8.9 to 15.0) (n=24), and at six months was 10.8 (43.3%) (95 percent confidence interval, 7.1 to 14.5) (n=19). Uroflow and post-void residual improvements were marginal to minimal. Inconsistent homogenization of the targeted prostate volume was apparent on TRUS, suggesting that optimal acoustic pressures were not achieved at the target focal point. Urinary symptoms, quality of life and sexual health questionnaires however demonstrated overall post-procedure improvement.

Conclusions: Prostate histotripsy was well tolerated and safe in this first-in-human trial. Optimal tissue effects have not yet been achieved and system modifications are underway to optimize dose and better replicate the tissue homogenization seen in pre-clinical canine studies. Despite this, pronounced LUTS improvement was noted. These results provide a basis for technology safety, system modification, and future study design.

Funding: HistoSonics, Inc. Disclosure: WWR has equity, royalty, and consulting interests with HistoSonics, Inc.
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ENDOPHYTIC STATUS OF RENAL TUMORS IS ASSOCIATED WITH POST-OPERATIVE IPSILATERAL RENAL FUNCTIONAL LOSS AFTER RAPN

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Introduction: Robot assisted partial nephrectomy (RAPN) has become an increasingly standard procedure in treatment of neoplasms of the kidney. Multiple studies have attempted to categorize what factors lead to optimal outcomes in terms of maximizing postoperative renal function. This study examines the effects of endophytic status of masses and warm ischemia time (WIT) during the procedure to predict ipsilateral renal function (IRF) preservation.

Methods: Our prospectively maintained, IRB-approved RAPN database was queried to identify patients receiving a pre- and 2-6 month post-op MAG3 nuclear renal scan. Included patients were those with masses less than or equal to 5 cm. IRF was measured by multiplying a calculated eGFR by percent contribution from the kidney of interest, determined from renal scan.

Results: 94 patients were included in the analysis and of those, average age, BMI, and R.E.N.A.L nephrometry score were 60 ± 11 years, 31 ± 7 Kg/m2, and 7 ± 2 respectively. Mean operative time, estimated blood loss (EBL), and WIT were 190 minutes, 225mL, and 19 minutes. Mean pre-operative eGFR was 82.7 mL/min/1.73m2 while mean ipsilateral pre-operative eGFR was 41.8 mL/min/1.73m2. Post-operative eGFR and ipsilateral eGFR were 74.0 and 31.0 mL/min/1.73m2 respectively. Multivariable analysis demonstrated that WIT and EBL were not significant in predicting a substantial drop in ipsilateral eGFR (p-values of 0.08 and 0.84) but a tumor being more than 50% endophytic was indicative of an ipsilateral eGFR loss of more than 10% (p=0.04).

Conclusion: Endophytic status is a predictor of post-operative IRF preservation while WIT showed no association. This finding suggests the importance of anatomic characteristics of the tumor being perhaps more significant than the intraoperative parameters of the surgery when predicting functional outcomes following RAPN.
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TOP 10 ABSTRACT

BODY WALL FORCES APPLIED DURING PELVIC TASKS USING Da Vinci Xi AND LAPAROSCOPY

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Introduction: Minimally invasive surgical (MIS) techniques provide numerous patient benefits. However, a common perception is that the lack of touch sensation, especially in robotic surgery, could potentially lead to excessive force application on tissues, including the port sites. We previously reported forces measured at the body wall with a sensorized cannula during surgical tasks performed with the da Vinci® Si™ Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA) and laparoscopic platforms. Our objective in this study was to develop an improved sensorized cannula for body wall force measurement, and then measure and compare forces at port sites during simple surgical tasks using the new da Vinci® Xi™ Surgical System and traditional laparoscopic instruments.

Methods: We first redesigned our sensorized cannula, which was constructed to directly measure in vivo body wall forces during MIS procedures. The new sensor addressed challenges from the previous one; specifically it has a smaller diameter, simpler waterproofing, improved robustness, and increased sensitivity. A standard long length robotic cannula was modified with an overtube designed to contact the body wall and deflect like a cantilever beam. Standard strain gauges (force sensors) were then fixed the proximal end of the overtube. The new sensorized cannula was calibrated and validated using standard force gauges. The cannula was then used in in vivo porcine experiments to perform simple surgical tasks using robotic (da Vinci® Xi™ Surgical System) and laparoscopic platforms. Six surgeon test subjects performed various pelvic tasks twice including: dissection of the ureter, bowel manipulation, instrument tip collisions, and pelvic organ retraction. We continuously recorded the force applied at the body wall and then compared the change in resultant force magnitude (delta force) for each task.

Results: The overall range of the mean delta force measured during these tasks was 3.3-14.5N with the laparoscopic platform and 3.9-12.8N with the surgical robot. A statistically significant lower mean delta force was demonstrated with the surgical robot for instrument tip collisions (7.6N vs. 3.4N, p<0.05). Porcine uterine retraction resulted in a lower mean delta force with laparoscopy (3.9N vs. 7.4N, p<0.05). There was no statistically significant difference in mean delta force between platforms for the remaining 5 tasks.

Conclusion: The absence of force feedback in robotic surgery is often viewed as a risk factor for inadvertent tissue injury. Results of this preliminary study indicate that forces applied at the body wall by the new da Vinci® Xi™ Surgical System and traditional laparoscopic instruments during simple surgical tasks are within a similar range, are task independent, and induce a maximum mean delta force of 14.5N (< 3.5 lbs). Future studies in this area may help understand forces in other platforms such as single site surgery and potential relationships between body wall forces and port site complications (e.g., hernias and infections).

Figure: A) Redesigned sensorized cannula with obturator. B) Cannula used with laparoscopic tools. C) Cannula mounted to da Vinci® Xi™
3D BLADDER PHANTOM FOR EVALUATION OF CYSTOSCOPIC TECHNOLOGIES

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Introduction: New imaging modalities, such as optical coherence tomography (OCT) and fluorescence cystoscopy (FC), can serve as complementary techniques to white light cystoscopy (WLC). Three-dimensional (3D) organ-mimicking phantoms provide realistic imaging environments for testing new technology designs, the diagnostic potential of systems, and novel image processing algorithms prior to validation in real tissue. The ideal phantom should mimic features of healthy and diseased tissue as they appear to several modalities: OCT is sensitive to variations in thickness and scattering of the bladder’s subsurface layers; WLC can detect tissue color, surface morphology and vasculature appearance; FC provides fluorescent contrast of lesions that are difficult to visualize under WLC.

Methods: To fabricate a hollow bladder-shaped phantom, we spray-coated several layers of Dragon Skin (DS) (Smooth-On Inc.), a highly elastic polymer, onto a 3D-printed mold. The optical scattering of DS was tuned by adding titanium dioxide (TiO₂); due to the minimal contribution of absorption to attenuation in bladder tissue, absorption properties were not controlled. The mucosal vasculature, tissue coloration, and urethral orifice were mimicked using elastic cord, red dye, and a paint pen (hand-drawn), respectively. A small hole excised from the base of the phantom enabled removal from the mold and access for the urethra. Inclusions having properties similar to diseased tissue as visible with OCT, WLC and FC were inserted: blurred layer boundaries (OCT), altered tissue color (WLC), and fluorescence emission (FC). We assessed the phantom and the underlying material and fabrication process on the basis of elasticity, optical tunability, achievable layer thicknesses, and qualitative image appearance.

Results: The TiO₂ concentrations tested yielded scattering coefficients ranging from 0.5 to 8 mm⁻¹, which is sufficient to cover the relevant range of bladder (0.49 to 2.0 mm⁻¹). The scattering coefficient was linear with TiO₂ concentration (R² = 0.99). We observed a clear tradeoff between the viscosity and elasticity of DS when adding a thinner to enable spray-coating. Using 100% thinner sufficiently reduced viscosity to enable spray-coating without significantly compromising elasticity; native DS (0% thinner) has a Young’s modulus of 151 kPa compared to 212 kPa after thinning. With spray-coating we fabricated uniform layers as thin as 25 μm (the urothelium is ~50 μm). OCT, WLC, and FC images of our phantom qualitatively matched healthy bladder tissue and cancerous lesions of various stages.

Conclusion: We fabricated the first 3D bladder phantom with illustrative features to enable detection using WLC, OCT and FC. The realistic appearance of the phantom under several modalities and its long shelf life (years) make it both a useful training tool for doctors and a useful research tool for engineers.

Figure: a) Vasculature network incorporated underneath the urothelium (prior to adding muscularis). b) External view of the final 3D bladder phantom. Simulated flat cancer lesion within the phantom viewed using WLC (c) and FC (d). OCT images of phantom: healthy tissue (e) with urothelium (U), lamina propria (LP), and muscularis propria (MP) marked; carcinoma in-situ (f) with characteristic fusion of U+LP layers.
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A STUDY ON THE EFFECTIVENESS AND FEASABILITY OF HIGH INTENSITY FOCUSED ULTRASOUND (HIFU) ABLATION ON MALIGNANT RENAL TUMORS

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Introduction: In the United States, 65,000 new cases of renal cell carcinoma (RCC) are diagnosed annually. The majority of tumors are organ confined and amenable to local treatment. However, many cases are diagnosed in the elderly with medical comorbidities that may preclude them from surgical resection. Small incidental renal tumors found often carry indolent courses. There is increasing interest in minimally invasive ablative options with relatively low comorbidities. Kidney cancer treatment with HIFU has not been clinically utilized and studied in the US. The purpose of this study was to evaluate the technical feasibility of HIFU ablation on malignant human renal tumors and the histologic effect from HIFU.

Methods: Patients with renal masses ≤ 3 cm undergoing laparoscopic partial nephrectomy were selected for concurrent HIFU ablation. Prior to ablation, the tumor was identified laparoscopically and biopsied using standard spring-loaded needle core intraoperatively for histologic diagnosis. HIFU ablation using the Sonatherm® system (SonaCare Medical; Charlotte, NC) was then performed using an 11mm 4-MHz HIFU Sonatherm probe with time of ablation adjusted for tumor volume (11-16 minutes) with real-time sonographic monitoring. Post ablation, the tumor was immediately resected during the same setting by laparoscopic partial nephrectomy and analyzed histologically for successful ablation using NADH staining.

Results: No bleeding or immediate complications were noted in the patients who underwent HIFU ablation of masses proven to be clear cell RCC at time of surgery. No post-op complications were noted following a mean follow up of 9.3 months. Histologically, HIFU ablation resulted in extensive hemorrhage within the tumor and disruption of the acinar patterns typical in clear cell RCC (Fig 1). A clear line of demarcation between nonviable and viable tissue was confirmed by NADH staining differentiating ablated vs. nonablated tissue respectively indicating preservation of normal kidney parenchyma.

Conclusion: In this first ongoing study performed in the United States, HIFU ablation is an effective and feasible means to destroy malignant human renal tumors without increased morbidity. Histologically, there is good evidence of tissue destruction and non-viability of tumor cells following localized treatment. Further studies are needed to evaluate the long-term effects with HIFU and the effectiveness in oncologic control.

Figure: Renal tumor post HIFU ablation Negative for NADH staining
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SECOND HARMONIC GENERATION OPTICAL MICROSCOPY IDENTIFIES AGGRESSIVE RCC VARIANTS

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Introduction: Matrix-based data using a new optical technology called Second Harmonic Generation (SHG) microscopy have been linked to prognoses in ovarian and breast cancer, but few studies have evaluated extracellular matrix based markers for renal cell carcinoma (RCC). We sought to characterize renal cell carcinoma using SHG and identify optical biomarkers in the extracellular matrix.

Methods: A tissue microarray (TMA) was constructed from renal tissue specimens, including RCCs grades 1–4 and benign tissue. A 5μm section was cut from the TMA and SHG images were captured with an excitation wavelength of 890 nm and an emission filter centered at 445 nm with a 20 nm bandwidth. SHG images were analyzed using Curvelet transform-based software, which automatically extracts collagen fibers in an image and quantifies the alignment of fibers with respect to each other. Alignment coefficients and several measures of fiber density were compared with ANOVA.

Results: Both benign and malignant renal specimens generated excellent SHG signals despite the small samples used in the microarray. Curvelet transform-based image analysis software accurately quantified RCC collagen fiber alignment and density. Both collagen fiber density and alignment of fibers differ significantly among benign tissue, high, and low-grade RCC. Collagen fiber density was greatest in benign tissue, followed by grade 4, with grade 1 RCC being the least collagen-dense (p<0.0001 for benign vs grades 1 and 4 and grade 1 vs 4). Collagen fibers appeared more linearly aligned in high grade RCC compared to low grade RCC or benign (p=0.04 and 0.0003).

Conclusions: SHG biomarkers of collagen fiber density and alignment distinguished between benign renal parenchyma, high, and low-grade RCC. SHG imaging provides a flexible platform with which to analyze renal tumors and may provide additional information to characterize both whole specimens and biopsy cores. In other malignancies, aligned collagen fibers have been shown to act as a “scaffold” along which cancer cells migrate.

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PILOT STUDY: 9.4 T MAGNETIC RESONANCE ELASTOGRAPHY OF EX VIVO PROSTATE CANCER

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Introduction: Prostate cancer is the most common non-cutaneous cancer in men in the US. Initial screening includes a digital rectal examination and a blood test for prostate specific antigens. An abnormality in these tests is an indication for transrectal ultrasound assisted prostate biopsy. Biopsy has the advantage of being able to grade the cancer against healthy tissue but it is invasive, poses an increased infection risk and can only provide information on a fraction of tissue from the prostate gland. The use of magnetic resonance imaging (MRI) can provide valuable information for clinicians, however the limited sensitivity and specificity of routine MRI protocols in detection and grade stratification of prostate cancer leaves room for innovation. Magnetic resonance elastography (MRE) has the potential to provide quantitative data and images showing the size, location, stage, and viscoelastic properties of tumors, which may be linked to their malignancy. In this study we assessed the efficacy of ex vivo MRE imaging of prostates to identify cancerous lesions.

Methods: Using an ultra-high field, 9.4 T, scanner high resolution stiffness images of ex vivo prostate were obtained with high frequency shear waves not detectable in clinical scanners. The specimen studied immediately after surgical removal via robotic assisted radical prostatectomy. The quality of the stiffness images were improved using a recently developed simultaneous 3D wave field MRE pulse sequence. Imaging was performed in a 9.4 T preclinical MRI scanner (310/ASR, Agilent Technologies, Santa Clara CA) using a 72 mm volume RF coil and maximum gradient amplifiers of 400 mT/m. A modified spin echo pulse sequence was used to simultaneously encode wave displacement in all three Cartesian directions. The MRI and MRE imaging parameters were as follows: 40 mm2 field of view, 0.3125 mm2 voxel size, 2 mm slice thickness, 25.1/750 ms TE/TR, 500 Hz actuation frequency, 80 mT/m motion encoding gradient (MEG) strength, 8 MEGs, and 8 time steps. Shear waves were induced into the prostate using a cylindrical tube, in which the prostate was snugly fit, attached to a piezo actuator (P-840.1, Physik Instrumente GmbH & Co., Karlsruhe Germany) and driven axially creating radially converging shear waves in the prostate. The acquired wave images were spatially filtered using a Gaussian lowpass filter. Shear modulus values were then derived using a 3D inversion of the Navier equation of motion after the application of a curl operation to remove the compression wave.

Results: Correlation with pathology analysis is currently in progress. The real part of the shear modulus (G) maps, in Fig. 1B, and 1C, visually delineate regions of high stiffness from the background tissue, which was determined to have an average G of 1.7 + i1.4 kPa. Regions of interest (ROI) 1 and 2 define a suspect lesion of 4 mm in diameter and the collapsed wall of the urethra respectively; their corresponding average G’s are 3.9 + i2.5 kPa and 2.9 + i2.2 kPa.

Conclusion: Comparison with pathology results is in progress and additional specimens will be available prior to presentation. This technique also has the potential to transfer to clinical use.

Figure 1: Box A) Wave images of 3D vector field. Box B) Left side, shear modulus (G) overlaid onto magnitude image showing only G > 50% of the mean G, right side shows the entire G map and ROI 1. Box C) different slice showing urethra, ROI 2.
IN-FIELD TEMPERATURE MEASUREMENTS USING A 902-928 MHZ MICROWAVE ABLATION SYSTEM

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Introduction: The microwave penetration depth achieved during microwave ablation (MWA) of solid tumors depends on the relative permittivity of the tissue, which can vary with the frequency, temperature, and water content. It is theorized that 915MHz has a larger penetration depth than 2450MHz. A larger energy field may result in more controllable heating environment for larger sized ablations. At 915 MHz, wave penetration is expected to be 2-4cm. A MWA system that offers frequency variability between 902-928MHz to minimize reflectivity loss and enhance energy output is currently available. The objective of this study was to measure the temperature changes near the emitting region of the MW antenna in order to investigate equations describing the heating of tissue within a MW energy field.

Methods: Two ablations per kidney were performed in ex-vivo porcine kidneys using the Medwaves AveCure 915 MHz System (San Diego, CA) in power mode at 24W, 96°C set temperature, 3 minutes irradiation time, and a 16G microwave needle, for a total of 8 trials. The needle was inserted 4.5 cm into the kidney at the upper or lower pole, between the surface and the collecting system boundary. Temperatures were measured using a fiber optic thermal sensor with a sampling rate of 1 Hz placed directly above the emitting region of the antenna. Maximum temperatures were determined and curve fitting was completed for the initial 10 seconds of ablation using Origin 8 (Northampton, MA).

Results: The maximum temperatures ranged from 66.64°C to 129.76°C with an average of 82.69±24.02 °C. The temperature curves were best fit to an equation having the form $T=at^b$, where “T” is the change in temperature [°C] measured in the tissue, “t” is the time into ablation [s], and “a” and “b” are equation parameters. The average values of “a” and “b” were determined to be 0.103±0.216 and 2.451±1.187, respectively. The “a” values showed an increasing trend with increasing temperature changes, whereas “b” showed a decreasing trend. The mean R-squared value of the fitted curves was 0.989±0.019. The large standard deviations in temperatures and equation parameters may be attributed to the variability in tissue structure and in placement of the thermal sensor of up to 5mm away from the antenna.

Conclusion: The temperature increase within a MW energy field during the initial 10 seconds of irradiation can be described by a nonlinear power equation of the form $T=at^b$. It is hypothesized that this equation is proportional to the specific absorption rate (SAR) of the tissue. The equation can be used to develop a theoretical model of the heating of tissue due to microwave energy absorption within the zone of direct heating. Further investigations using precise placement of temperature sensors with increased sampling frequency are warranted to refine and confirm equation parameters.

Figure: Sample curve fit of $T=at^b$.
(a=0.022, b=2.068, R-squared=0.997)
EVENT DETECTION ALGORITHM IN SINGLE CHANNEL BLADDER PRESSURE RECORDING

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Introduction: Currently catheter based urodynamic studies require a bladder pressure sensor along with an abdominal sensor in order to distinguish detrusor activity from increasing abdominal pressure. Wireless implantable pressure sensors are under development to allow for non-catheter based measurements of bladder pressures, making long-term at-home urodynamic studies feasible. However, the use of such devices is limited by the ability to process recorded pressure data for diagnosis in real time and to distinguish abdominal pressure and physiological noise from true detrusor activity. This study presents a novel, parameterized, user-tunable algorithmic framework, which facilitates rapid processing of bladder pressure data from a single pressure sensor.

Methods: An algorithm was developed which included an exponential moving average low pass filter to remove artifact and noise and a wavelet transformation to extract features of interest prior to adaptive thresholding and classification of voiding events. To evaluate the efficacy of the proposed framework, we implemented this algorithm in Matlab and tested it with recorded UDS data from 26 patients (6 patients with neurogenic bladder and 20 patients with urge urinary incontinence). Finally, results were compared with other state-of-the-art methods for thresholding data for event detection.

Results: Using patient-specific, or tuned, parameters, accuracy of the algorithm with adaptive threshold was 100% for detecting voiding contraction events within 1 second of contraction onset as compared to 98-100% accuracy for static threshold using single sensor data. The adaptive algorithms, however, had higher false positive rates ranging from 2.3 to 9.2 vs. 0.3 – 2.0 false positives per contraction for static threshold. Operating in the wavelet domain was found to reduce the false positive rate for adaptive thresholds by an average of 48% while maintaining accuracy. The algorithm could not detect events that are purely sensory, in which urgency is felt but not accompanied by a discernible rise in pressure.

Conclusions: We have developed a real-time, highly accurate bladder voiding contraction event detection system that does not require an abdominal reference sensor. The algorithm was able to successfully distinguish voiding events from changes in posture, coughs, and other non-voiding events using only bladder pressure data. Further work is needed to detect non-voiding urgency related contraction events. This system may be used to augment existing diagnostic and treatment techniques for urinary incontinence.
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WST-11 VASCULAR TARGETED PHOTODYNAMIC THERAPY (VTP) IN PORCINE RENAL PELVIS VIA RETROGRADE URETEROSCOPY CAN BE PERFORMED SAFELY WITH REPRODUCIBLE TREATMENT EFFECTS

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Introduction: WST-11 is a novel photosensitive therapeutic agent for cancer treatment that remains intravascular and allows titratable degrees of tissue necrosis making it uniquely suited for endoluminal organs such as the upper urinary tract. The purpose of this study was to develop a retrograde endoscopic approach to treatment with WST-11 VTP and evaluate the feasibility, safety and long-term effects in the renal pelvis.

Methods: Unilateral retrograde ureteroscopy was performed on 6 healthy female swine. A laser fiber with a 2 cm cylindrical-diffusing tip was placed through the ureteroscope into the renal pelvis. Photosensitizing WST11-VTP was administered intravenously. Following WST-11 infusion illumination of the renal pelvis was provided at a light fluence of 200 mW/cm for 10 minutes by a 753 nm medical diode laser. Three animals were sacrificed at 24 hours and 3 animals at 4 weeks after WST11-VTP. Animals surviving to 4 weeks had triple phase CT imaging with focus on delayed images performed on a weekly basis along with serum chemistries and complete blood counts. At the time of sacrifice, histopathological evaluation for necrosis was performed on the treated renal pelvis and surrounding renal parenchyma.

Results: Weekly CT imaging was normal and no evidence of hydronephrosis or dysfunction was clinically evident at any time point post WST11-VTP. Early histologic findings at 24 hours shows completely sloughed surface urothelium with necrosis and hyperemia through the lamina propria. At 4 weeks, there is evidence of minimal surrounding parenchymal changes upon gross examination. Mild elevation in serum creatine was seen at 24 hours (n=6) and 4 weeks (n=3) after unilateral WST11-VTP treatment although these were not statistically significant and no control animal data was available for comparison.

Conclusion: WST11-VTP with retrograde ureteroscopy can be performed safely in the renal pelvis allowing direct visual observation of fiber positioning and treatment providing reproducible localized ablation effects. This novel technique may be adaptable for upper tract urothelium as a form of laser-based treatment for soft tissue ablation.

A: Laser fiber placement through ureteroscope with visual positioning (arrow demonstrates 2 cm diffusing tip fiber) B: Representative CT scan at 3 weeks without evidence of hydronephrosis or extravasation. C: Micrograph of H&E histology at urothelial treatment site 24 hours post-treatment demonstrating absent surface urothelium and D: TUNEL staining depicting depth of treatment effect (dotted line delineating normal versus necrotic in C and D) E: Gross findings at 4 weeks post treatment, circle indicates small region of parenchymal treatment effect adjacent to treated area identified in 1 of 3 treated kidneys and F: confirmation on histology of normal and regenerated renal tubules with intervening fibrous tissue.

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Mapping the Autonomic Nerve Distribution of the Bladder Using Three-Dimensional Image Reconstruction

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Introduction and Objective: Combining high quality standard histopathology techniques and modern advances in computer-aided design (CAD) software, we have created three-dimensional (3D) reconstructions of microscopic tissue in human organs. A virtual 3D map of the autonomic nerve distribution to the bladder could redefine our understanding of the relationship between neural tissue and bladder urothelium, and could have important ramifications for common diseases such as bladder overactivity and interstitial cystitis. Furthermore, it may help improve nerve-modulating therapies and prevent unwarranted nerve damage during invasive procedures. Thus, we developed a 3D image reconstruction of autonomic nerve tissue innervating the urinary bladder using male and female cadaver histopathology.

Methods: We obtained bladder specimens from a male and female cadaver. Axial cross sections of the bladder neck were generated at 3-5mm intervals and stained for S100 protein. Nerves were manually demarcated using ImageScope software (Aperior, Vista, CA). Distances between autonomic nerves and bladder mucosa were recorded using AutoCAD software (Autodesk, Venice, CA). Blender computer graphics software (Amsterdam, Netherlands) was used to generate 3D reconstructions of autonomic nerve anatomy and nerve density.

Results: Axial cross-sections and 3D image reconstructions showed that autonomic innervation was highly concentrated in the posterior aspect of the bladder neck in both male and female bladder specimens (Figures 1 and 2). Mean distances between autonomic nerve tissue and the bladder mucosa was 1.15mm posteriorly versus 4.0mm anteriorly in the male bladder (0.27-2.87 vs. 2.03-6.20, p<0.001) and 1.51mm posteriorly versus 1.83mm anteriorly in the female bladder (0.50-2.91 vs. 0.55-3.07, p=0.027).

Conclusions: Novel 3D reconstruction of the bladder is feasible and may help redefine our understanding of human bladder innervation. Autonomic innervation of the bladder is highly focused in the posterior aspect of the bladder neck in both male and female bladders.
EVALUATION OF QUALITY OF UPPER URINARY TRACT BIOPSY USING BIGOPSY FORCEPS: PRELIMINARY REPORT AND PROPOSAL FOR MULTI-INSTITUTIONAL STUDY

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Introduction and Objective: The use of ureteroscopic biopsy devices is critical to providing an accurate diagnosis for patients with upper tract urothelial carcinoma (UTUC). The fBIGopsy biopsy device (Cook Medical, Bloomington, IN, USA) is a novel instrument developed to extract deeper and larger biopsy samples. To date, there remains limited data comparing the BIGopsy device to other contemporary instruments. Herein we performed a single-center retrospective comparison of endoscopic biopsy quality using the BIGopsy device and other contemporary biopsy devices.

Methods: Between 2011 and 2014, 22 endoscopic biopsies were performed for suspected UTUC in 16 patients. Biopsies were performed with BIGopsy forceps, Piranha biopsy forceps (Boston Scientific, Newport Beach, CA, USA), or a standard 2.4F nitinol basket (Boston Scientific, Newport Beach, CA, USA). Lesion location, specimen size, and the presence of crush artifacts and intact urothelium were recorded. Histopathology was retrospectively reviewed by one pathologist, blinded to the type of biopsy device used, who graded the quality of each biopsy specimen on a scale from 1-10. Finally, tumor grade of the endoscopic biopsy specimen was compared to the grade of nephroureterectomy specimen for patients who underwent nephroureterectomy within 3 months of the endoscopic biopsy.

Results: Sixteen endoscopic biopsies (72.7%) were obtained using BIGopsy forceps and 6 (27.3%) using other biopsy devices. The mean specimen size was 3.10mm (SD 2.22) for the BIGopsy forceps and 2.08mm (SD 1.20) (p=0.186) for other biopsy devices. Biopsy specimens obtained using BIGopsy forceps contained significantly more intact urothelium (p=0.031) and less crush artifacts (p=0.007). BIGopsy specimens received the highest scores in biopsy quality and ease of biopsy interpretation as graded by a pathologist. A definite diagnosis was made in 75% of biopsies using the BIGopsy device compared to 67% using other devices (p > 0.05). A higher rate of concordance between biopsy grade and surgical pathology grade was found in tumors biopsied using the BIGopsy device when compared to standard devices (80% vs 50%; p > 0.05).

Conclusions: Upper tract biopsies obtained using BIGopsy forceps are of higher quality and contain significantly more intact urothelium and less crush artifacts than biopsies obtained using other devices. When compared to other devices, BIGopsy enables pathologists to more easily reach definitive and accurate diagnoses. A larger multicenter study comparing different biopsy devices is proposed to validate these findings.
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A CORDLESS CYSTOSCOPE PRODUCING DIGITAL IMAGES WHICH ARE STITCHED TOGETHER CREATING A BLADDER MAP

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Introduction: Current cystoscopes require large, bulky towers to display images. They have a thick cord from the scope to the tower that requires an assistant for hookup and necessarily must be both in and out of the sterile field, making it a potential source for contamination. Furthermore, the images they produce are analog and therefore are usually limited to being printed onto photo paper, with little opportunity for post-processing manipulation. This creates a barrier to finding and following lesions over time. Our group has developed a device that anchors a wireless digital camera to the back of a cystoscope and can transmit these images to any computer, tablet or phone. This is coupled with our post-processing software that aims to stitch these images together to create a map of the bladder urologists can then use as a reference and for patient education.

Methods: We utilized a high definition wireless digital camera [Sony DSC-QX10] for video acquisition. A custom docking system with self-locking mechanism was designed [SolidWorks] and printed with a 3D printer using ABS plastic (Figure 1A and B). The developed docking mechanism implements an automatic snap-on system with a cystoscope and only requires one hand to manipulate. The custom image processing software was developed utilizing OpenCV image processing tool box. In this software, homology between images are calculated by SIFT (Scale Invariant Feature Transform) algorithm and matching points in images are overlapped to create a smooth stitched image. Acquired videos of porcine bladder were used to test effectiveness of created software.

Results: Our cage design and digital camera is able to produce images comparable to the current analog models without a long cord. We are optimizing the software to stitch these images together to create a bladder map and have found that the largely monotonous surface of the bladder and complex shape makes this challenging but incorporating that the images are sequential has produced promising results (Figure 2).

Conclusion: A cordless digital cystoscope is possible and may allow for post-processing of the images to create a complete map of the bladder.

Figure 1: Design (A) and 3D Printed Dock (B) to Hold Digital Camera to Cystoscope

Figure 2: Several Bladder Images Stiched Together
RESULTS OF PHASE I STUDY OF LOCAL APPLICATION OF DEHYDRATED HUMAN AMNION/CHORION MEMBRANE ALLOGRAFT NERVE AROUND THE PROSTATIC NEUROVASCULAR BUNDLE DURING ROBOT-ASSISTED RADICAL PROSTATECTOMY

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Purpose: We present a phase I study of patients undergoing placement of dehydrated human amnion/chorion membrane (dHACM) around the neurovascular bundle (NVB) during nerve-sparing (NS) robot-assisted laparoscopic prostatectomy (RARP) in order to evaluate a possible faster sexual and continence recovery in postoperative period.

Materials and methods: From March 2013 to October 2014 76 patients who were preoperatively potent (Sexual Health Inventory for Men [SHIM] score >19) and continent (no pads) underwent full NS RARP.

Results: Mean age of patients was 56.5 ±6.5. Postoperative outcomes were analyzed in terms of safety and time to return to continence, potency. dHACM use was not associated with any side-effects or toxicity in regard to intra-,peri- and postoperative period. The minimum 8-wk follow-up was complete for all patients in both groups, with an average follow-up of 6 months. Continence and potency at 8 weeks returned in 89.5% and 67.1% of patients, respectively. Graft placement enhanced time to continence and potency that has been established in multiple studies reported in the literature.

Conclusions: dHACM allograft use appears to facilitate the early return of continence and potency in patients following RARP. A prospective, randomized, propensity score–matched clinical trial is underway to further prove an efficacy cell tissue therapy in local application as a potential efficient treatment modality to reduce postoperative inflammation and accelerate regenerative healing abilities of vital structures responsible for maintenance of potency and continence.
PercSac: A NOVEL DEVICE TO PREVENT STONE FRAGMENT MIGRATION DURING PERCUTANEOUS LITHOTRIPSY

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Introduction: Up to 50% of patients with residual fragments after percutaneous nephrolithotomy (PCNL) experience a stone-related event. We developed a polyethylene sack (the PercSac) that fits over the shaft of a rigid nephroscope and is deployed in the collecting system to capture a stone and contain fragments generated during PCNL, allowing for efficient and complete removal. We previously reported our results with the PercSac in a percutaneous cystolithopaxy model. Herein we compare the efficiency of stone fragmentation with and without the PercSac in a PCNL model.

Methods: The in-vitro PCNL model consisted of a human kidney model created on a 3-D printer with an open upper pole calyx, renal pelvis, and ureter. A 30F Amplatz working sheath was placed in the upper pole calyx. Ten Bego® stones made in spherical molds of 2.0cm diameter, matched for weight, were fragmented using a 24F rigid nephroscope and a CyberWand®, five with and five without the PercSac. The time for stone fragmentation with the CyberWand®, total time for stone clearance from the kidney, a gross assessment of the stone-free status, and need for flexible nephroscope to achieve stone-free status were recorded.

Results: The mean stone weight for both groups was 4.76 g (PercSac SD= 0.12, no PercSac SD= 0.16). The median time for stone fragmentation with the CyberWand® was significantly shorter in the PercSac group compared with the control group [217 sec (IQR= 169-255) vs 340 sec (IQR= 310-356), (p= 0.028)]. Likewise, the total time from insertion of the nephroscope into the kidney to completion of stone clearance from the kidney was significantly shorter for the PercSac group [293 sec (IQR= 244-347) vs 376 sec (IQR= 375-480), (p= 0.047)]. One trial with the PercSac had residual dust remaining in the kidney while all 5 trials without the PercSac had small residual fragments remaining. All trials without the PercSac and none of the trials with the PercSac required flexible nephroscopy and basket extraction to achieve a stone-free state.

Conclusions: Ultrasonic lithotripsy using the PercSac device is more efficient and efficacious than traditional ultrasonic lithotripsy in a PCNL model. This advantage may be even more pronounced during clinical PCNL where residual fragments migrate into difficult-to-access calyces. Further in vitro and in vivo testing is underway.

Figure: Stone fragmented within the enclosed PercSac.
FOCAL LASER ABLATION: A PATH TOWARD OUT-OF-BORE THERAPY

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2 David Geffen School of Medicine, Department of Urology
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Introduction: Focal laser ablation (FLA) has to date only been performed during MRI by interventional radiologists. Herein we describe studies that suggest FLA can be performed safely out of an MRI bore.

Methods: Eight men ages 58-73 y.o., who were found upon MRI/US fusion biopsy to have Gleason ≤3+4 cancer (CaP) isolated to within an MRI target (Figure 1A), were subjects of this prospective IRB-approved trial. FLA was performed in-bore as previously described (Oto, Radiol., 2013); additionally, 2-3 MRI-compatible thermal probes (STB, Lumasense) were placed into the prostate trans-perineally under US guidance to determine treatment temperatures at various intra-prostatic sites, independent of MR thermometry (MRT) (Figure 1B,C). A 980-nm, 15 W laser system (Visualase, Medtronic) was used to treat each target with a 5-10 mm margin (4-9 laser applications per patient). A multi-parametric MRI was obtained immediately following treatment to determine ablation effect (Figure 1D).

Results: FLA was well-tolerated under local anesthesia with conscious sedation. All patients were discharged within 4 hours of study completion and have now been followed > 3 months without decline in sexual function or urinary control. During FLA, temperatures in the treatment zone reached a max of 73-95°C by MRT, but temperatures in adjacent tissue, as measured by thermal probes, were 36-50°C in the 6 of 8 men (Table I). Treated volumes (non-perfused) were on average 10 times as large as the target volume (Table I). The ablation zone, was confined and limited to the intended part (Figure 1). Critical structures (rectum, sphincter, capsule) were unaffected.

Conclusion: FLA of the prostate can be performed safely even when wide margins are applied to the target. Interstitial thermal probes were consistent with MRT and confirmed the limited extent of laser heat within the prostate. These findings may provide a safety basis for FLA without need for MR thermometry. Follow-up biopsy data are pending.

<table>
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<th>Patient</th>
<th>Prostate Volume, PV (CC)</th>
<th>Target Volume (CC)</th>
<th>Treated Volume, cc (% of PV)</th>
<th>Max Temp at ROI center (°C)</th>
<th>Max Temp of Probe in adjacent tissue (°C)</th>
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<td>3</td>
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<td>1.9 (2.9%)</td>
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<td>4</td>
<td>37</td>
<td>0.66</td>
<td>2.6 (7.0%)</td>
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<td>5</td>
<td>45</td>
<td>0.97</td>
<td>3.4 (7.6%)</td>
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<td>6</td>
<td>30</td>
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<td>4.1 (13.7%)</td>
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<td>7</td>
<td>29</td>
<td>0.08</td>
<td>2.3 (7.9%)</td>
<td>86</td>
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<tr>
<td>8</td>
<td>34</td>
<td>0.36</td>
<td>8.9 (26.2%)</td>
<td>95</td>
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Table I . Summary of eight patients who underwent FLA.

Figure 1. Example of 59 yr-old man with (A) biopsy-confirmed GS7 CaP within the MRI target. (B) During FLA, MRI-independent thermal probes record real-time temperatures in prostate. (C) Temperature near laser (probe 1) rises to 55 C, but probes away from laser show little change. (D) Post-treatment MRI shows non-perfused area from 5 laser applications.
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AWARDS:

Best Paper Awards:

SCANNING FIBER TECHNOLOGY FOR RAPID VOLUMETRIC OPTICAL COHERENCE TOMOGRAPHY CYSTOSCOPY. Kristen L. Lurie, Abhijit A. Gurjarpadhaye, Eric J. Seibel, and Audrey K. Ellerbee. E.L. Ginzton Laboratory and Department of Electrical Engineering, Stanford University. Department of Mechanical Engineering, University of Washington

MR-GUIDED BOILING HISTOTRIPSY OF THE KIDNEY USING A CLINICAL HIGH INTENSITY FOCUSED ULTRASOUND SYSTEM. George R. Schade, Navid Farr, Yak-Nam Wang, Tatiana D. Khokhlova, Ari Partanen, Adam D. Maxwell, Wayne Kreider, Michael R. Bailey, Vera Khokhlova. Department of Urology, Center for Industrial and Medical Ultrasound, Department of Gastroenterology, University of Washington, Seattle, WA. Clinical Science MR Therapy, Philips Healthcare, Andover, MA

Top 10 Abstracts:

PILOT STUDY EVALUATING 99mTc-SESTAMIBI SPECT/CT FOR THE DIFFERENTIATION OF ONCOCYTOMA FROM RENAL CELL CARCINOMA. Michael A. Gorin, Steven P. Rowe, Jennifer Gordetsky, Mark W. Ball, Phillip M. Pierozsio, Jonathan I. Epstein, Mehrbod S. Javadi, Mohamad E. Allaf. Departments of Urology, Radiology and Pathology, Johns Hopkins University School of Medicine, Baltimore, MD, USA

WST-11 VASCULAR TARGETED PHOTODYNAMIC THERAPY (VTP) IN PORCINE RENAL PELVIS VIA RETROGRADE URETEROSCOPY CAN BE PERFORMED SAFELY WITH REPRODUCIBLE TREATMENT EFFECTS. Katie Murray, Renato Beluco Corradi, Stephen LaRosa, Sylvia Jebiwott, Alex Somma, Govindarajan Srimathveeravalli, Kwanghee Kim, Sebastien Monette, Avigdor Scherz, Jonathan Coleman. Department of Surgery, Memorial Sloan Kettering Cancer Center, Department of Surgery Sloan Kettering Institute, Department of Radiology, Laboratory of Comparative Pathology, Memorial Sloan Kettering Cancer Center, Department of Plant Sciences, Weizmann Institute of Science

CT-ULTRASOUND FUSION USING AN IMAGE-FRAME-IMAGE REGISTRATION METHOD. Doyoung Chang, Changhan Jun, Chunwoo Kim, Sunghwan Lim, Doru Petrisor, Dan Stoianovici. Robotics Laboratory, Department of Urology, Johns Hopkins University

BODY WALL FORCES APPLIED DURING PELVIC TASKS USING Da Vinci Xi AND LAPAROSCOPY. Smita De, M.D., Ph.D., Brett Page, B.S., Samana Ghimire, M.S., Amy Kerdok, Ph.D.; Department of Urology, Stanford University Hospital, Stanford, CA, USA. Intuitive Surgical Operations, Sunnyvale, CA, USA

A CORDLESS CYSTOSCOPE PRODUCING DIGITAL IMAGES WHICH ARE STITCHED TOGETHER CREATING A BLADDER MAP. M. Glamore, C. Li, M. Golman, P. Kharel, J. Song. Washington University School of Medicine Urological Surgery Residency Program, Washington University, Biomedical Engineering, Department of Computer Science

SAFETY AND FEASIBILITY OF ROBOT-ASSISTED DIRECT MRI-GUIDED TRANSPERINEAL PROSTATE BIOPSY. Mark W. Ball, Ashley Ross, Chunwoo Kim, Changhan Jun, Doru Petrisor, Doyoung Chang, Katarzyna J. Macura, Dan Stoianovici, Mohamad Allaf. Robotics Laboratory, Urology and Radiology Departments Johns Hopkins University, Baltimore, MD

TANDEM-ROBOT ASSISTED LAPAROSCOPIC RADICAL PROSTATECTOMY (T-RALP) IN 49 MEN. Misop Han, Chunwoo Kim, Doru Petrisor, Haixin Chen, Doyoung Chang, Hyung-Joo Kim, Bruce J Trock, Dan Stoianovici. Robotics Laboratory, Urology Department, Johns Hopkins University, Baltimore, MD

3D BLADDER PHANTOM FOR EVALUATION OF CYSTOSCOPIC TECHNOLOGIES. Gennifer T. Smith, Kristen L. Lurie, Monica Agrawal, Joseph C. Liao and Audrey K. Ellerbee. E.L. Ginzton Laboratory and Department of Electrical Engineering, Stanford University. Department of Urology, Stanford University School of Medicine, Veterans Affairs Palo Alto Health Care System
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THANKS:

Dr. George Nagamatsu, Engineering and Urology Society Founder (1985)

Dr. Jack Vitenson, Society Treasurer since formation and then Society Secretary

Special thanks to Dr. Thomas Lawson for his help formatting this program.

We thank Michelle Paoli and Debra Caridi for organizing the Annual Meeting.