

12-1-2011

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### Recommended Citation

Healy, Kelly A; Pak, Raymond W; Cleary, Ryan C; Colon-Herdman, Arturo; and Bagley, Demetrius H, "Hand problems among endourologists." (2011). *Department of Urology Faculty Papers*. Paper 14. <http://jdc.jefferson.edu/urologyfp/14>

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# Hand Problems Among Endourologists

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## Abstract

**Background and Purpose:** Endourology has evolved rapidly for the management of both benign and malignant disease of the upper urinary tract. Limited data exist, however, on the occupational hazards posed by complex endourologic procedures. The aim of this study was to determine the prevalence and possible causes of hand problems among endourologists who routinely perform flexible ureteroscopy compared with controls.

**Materials and Methods:** An online computer survey targeted members of the Endourological Society and psychiatrists in academic and community settings. A total of 600 endourologists and 578 psychiatrists were contacted by e-mail. Invited physicians were queried regarding their practice settings and symptoms of hand pain, neuropathy, and/or discomfort.

**Results:** Survey responses were obtained from 122 (20.3%) endourologists and 74 (12.8%) psychiatrists. Of endourologists, 61% were in an academic setting and 70% devoted their practice to endourology. Endourologists were in practice for a mean 13 years, performing 4.5 ureteroscopic cases per week with a mean operative time of 50 minutes. Hand/wrist problems were reported by 39 (32%) endourologists compared with 14 (19%) psychiatrists ( $P=0.0486$ , relative risk [RR]=1.69). Surgeons who preferred counterintuitive ureteroscope deflection were significantly more likely to have problems (56%) compared with intuitive users (27%) (RR 2.07,  $P=0.0139$ ) or those with no preference (26%) (RR 2.15,  $P=0.0451$ ). Overall, most respondents (85%) with hand/wrist problems needed either medical or surgical intervention.

**Conclusions:** Hand and wrist problems are very common among endourologists. Future studies are needed to develop more ergonomic platforms and thereby reduce the endourologist's exposure to these occupational hazards.

## Introduction

ADVANCES IN URETEROSCOPE DESIGN and instrumentation allow urologists to perform complex endoscopic procedures to treat patients with benign and malignant disease of the upper urinary tract.<sup>1</sup> Endourologic procedures that involve prolonged operative times, sustained awkward postures, and repetitive hand movements may cause upper extremity fatigue. Previous studies have well examined ergonomics and musculoskeletal problems in other professions and surgical fields, particularly laparoscopy. Minimal data exist, however, on the occupational hazards that are posed to endourologists.

The purpose of this study was to determine the prevalence and possible causes of hand problems among endourologists who routinely perform flexible ureteroscopy compared with controls (psychiatrists). In doing so, we sought to identify modifiable risk factors and to offer possible solutions for future designs.

## Materials and Methods

All members of the Endourological Society were contacted by e-mail and asked to complete an online survey. A control group consisted of academic and community psychiatrists, who do not routinely perform complex manual procedures. A total of 600 endourologists and 578 psychiatrists were invited by e-mail. Study participants were asked to respond to a series of multiple choice and free text questions related to their practice settings and symptoms of hand pain, neuropathy, and/or discomfort (Appendix 1). All responses were blinded and collected by a commercially available Internet-based survey host ([www.surveymonkey.com](http://www.surveymonkey.com)). The survey was circulated for 60 days, and a reminder was sent at 30 days to encourage survey completion. No compensation was offered to participants. Statistical analyses were then performed for categorical data using the Fischer exact test and two-tailed  $P$  values. A  $P$  value of  $\leq 0.05$  was considered statistically significant.

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**Results**

Survey responses were obtained from 122 (20.3%) endourologists and 74 (12.8%) psychiatrists. None of the psychiatrists included any form of endoscopy in their practice. Endourology respondent characteristics are reported in Table 1. Most urologists (70%) devoted their practice to endourology. Hand or wrist problems were reported by 40 (32.8%) endourologists compared with 14 (18.9%) psychiatrists (relative risk [RR] 1.69,  $P=0.0486$ ). Table 2 summarizes the types of reported problems based on study group, with some patients reporting multiple problems. The most frequently affected upper extremity areas were, in descending order, the hand, wrist, and elbow.

Overall, the majority of respondents with hand problems needed either medical or surgical intervention: 33/39 (84.6%) endourologists and 12/14 (85.7%) psychiatrists. Among endourologists, treatment included medications (25), physical therapy (6), surgery (1), and unknown (1).

Intuitive ureteroscope deflection (up is up, down is down) was preferred by the majority (74/122, 61%) of endourologists, while 20% (25/122) preferred counterintuitive deflection (up is down, down is up) and 19% (23/122) had no preference. Subgroup analysis revealed that counterintuitive ureteroscope users were significantly more likely to experience problems (14/25, 56%) compared with surgeons with no preference (6/23, 26%) (RR 2.15,  $P=0.0451$ ) or intuitive users (20/74, 27%) (RR 2.07,  $P=0.0139$ ) (Fig. 1).

**Discussion**

The first clinical use of an actively deflectable fiberoptic ureteroscope was reported in 1971 by Takaysu and colleagues.<sup>2</sup> However, the first flexible ureteroscopes did not become commercially available until the mid- to late 1980s. Since then, the diagnostic and therapeutic capabilities of flexible ureteroscopy have remarkably expanded<sup>1</sup> for a multitude of upper urinary tract diseases, including tumors, large complex stones, and intrarenal obstruction. This evolution has been driven by significant advancements in fiberoptics, ureteroscope design, accessory instrumentation, and laser technologies.<sup>3</sup>

With new applications come increased operative times and subsequent increased workload to the surgeon. Despite the

TABLE 2. UPPER EXTREMITY PROBLEMS REPORTED BY SURVEY RESPONDENTS

Upper extremity problem	Endourologists (n=122)	Psychiatrists (n=74)
Paresthesias	16 (13%)	2 (2.7%)
Musculoskeletal pain	11 (9%)	1 (1.4%)
Joint pain	8 (6.6%)	3 (4.1%)
Lateral epicondylitis (tennis elbow)	5 (4.1%)	-
Carpal tunnel syndrome	5 (4.1%)	5 (6.8%)
Ganglion cysts	4 (3.3%)	-
Joint stiffness	3 (2.5%)	-
Neuropathic pain	2 (1.6%)	-
Hand arthritis	1 (0.8%)	3 (4.1%)
Wrist tendonitis (de Quervain tenosynovitis)	1 (0.8%)	-
Dupuytren contracture	1 (0.8%)	-
Trigger finger	1 (0.8%)	-

widespread application of flexible ureteroscopy, few studies have examined the occupational hazards to endourologists. In addition to the classic risks of infection, radiation, latex, and gas exposures, the actual performance of surgery may pose underestimated ergonomic risks to the endourologist.

Occupational workplace hazards and ergonomic design have been more extensively examined in other professions and surgical fields. The U.S. Department of Labor defines work-related musculoskeletal disorders (WMSDs) as injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and spinal disks associated with exposure to risk factors in the workplace.<sup>4</sup> In general, risk factors for musculoskeletal injury include awkward body postures, repetitive upper extremity movements, and prolonged static back and head postures.

Epidemiologic studies indicate that WMSDs are common and are associated with the performance of repetitive hand-intensive tasks.<sup>4,5</sup> Among manual workers, hand complaints had a self-reported prevalence of 30% to 45%.<sup>5</sup> WMSDs account for one-third of all lost workday illnesses, and those of the hand and wrist are associated with the longest absences from work. Hand and wrist WMSDs represent a substantial burden on the U.S. workplace and are associated with high medical costs and lost productivity. Because of the

TABLE 1. ENDOUROLOGY RESPONDENT CHARACTERISTICS (N=122)

Mean years in practice (range)	13.0 (1-35)
Practice setting	
Academic (n)	60.7% (74)
Community (n)	39.3% (48)
Mean operative time	50.4 min
Mean number of ureteroscopic cases per week	4.5
Right hand dominance	87%
Preferred flexible ureteroscope	
Storz Flex-X	1
ACMI DUR-8	2
Olympus URF-P3	3
Deflection preference	
Intuitive (positive)	61% (74/122)
Counter-intuitive (contrapositive)	20% (25/122)
No preference	19% (23/122)

HAND PROBLEMS BY DEFLECTION PREFERENCE

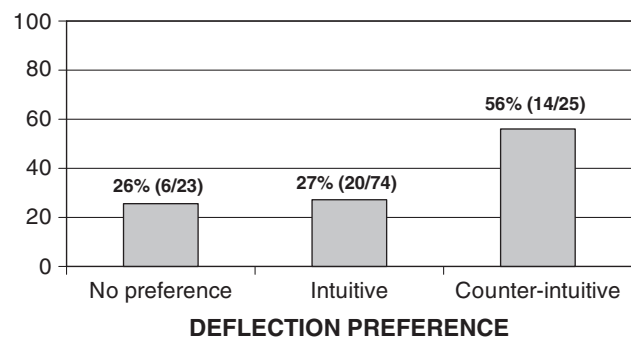


FIG. 1. Hand problems by flexible ureteroscope deflection preference.

performance of highly repetitive hand-intensive tasks, musicians<sup>6,7</sup> and service/manufacturing industry workers (ie, assemblers, construction laborers, cashiers, carpenters, and clerical workers) are particularly prone to the development of upper extremity WMSDs.<sup>4,8</sup>

In a prospective Danish study of 3123 workers from 19 different industrial settings, repetition and force were significantly associated with hand/wrist pain and clinical signs of tendonitis.<sup>5</sup> Similarly, another study of more than 500 industrial and clerical workers found that highly repetitive hand activities and preexisting conditions of the upper extremity predict eventual chronic upper extremity discomfort.<sup>9</sup>

Minimally invasive surgical techniques expose surgeons to occupational hazards that may promote musculoskeletal disorders. In the field of surgical laparoscopy, an abundance of studies have demonstrated an increased risk of work-related physical injuries.<sup>10-15</sup> Compared with traditional open surgery, laparoscopy is associated with increased physical and mental strains. Contributing ergonomic factors include inappropriate operating room setup, suboptimal instrument design, two-dimensional visualization, limited degrees of freedom, and decreased tactile feedback. Furthermore, static back and neck postures during prolonged laparoscopic procedures may lead to increased postural fatigue.<sup>12</sup> Awkward positions of the arms, hands, and fingers have also been implicated. Taken together, these may result in upper extremity fatigue, pressure point injury, eyestrain, carpal tunnel syndrome, thenar neuropathy, and even cervical spondylosis.

Both subjective and objective assessments have well documented the physical impact of laparoscopy on the surgeon. In a large study (n=149) conducted by the Society of American Gastrointestinal Endoscopic Surgeons Task Force on Ergonomics, Bergeur and associates<sup>13</sup> evaluated electromyographic signals during simulated surgical tasks and found that peak and total effort of thumb and forearm muscles were significantly greater using laparoscopic instruments *vs* standard hemostats. They reported an 8% to 12% incidence of frequent neck or upper extremity pain after laparoscopic operations among experienced laparoscopic surgeons.

Sari and colleagues<sup>14</sup> found an even higher incidence, with 73% of respondents reporting physical complaints during or after laparoscopy. Recently, in the largest North American survey to date, Park and coworkers<sup>15</sup> reported that 87% of surgeons who routinely perform minimally invasive surgery suffer from physical discomfort or injuries, primarily related to high case volume. The exact incidence of musculoskeletal complaints varies widely based on the cohort studied. It is clear, however, that laparoscopic surgery is ergonomically unfavorable and poses occupational risks to the surgeon.

Urologists are not immune to the ergonomic challenges and associated physical demands of minimally invasive surgery. Among surveyed urologists, Hemal and colleagues<sup>16</sup> found that laparoscopic surgeons (n=131) reported significantly more finger numbness and eyestrain compared with open surgeons (n=73).<sup>16</sup> Johnston and associates<sup>17</sup> documented that hand-assisted laparoscopy (HAL) is associated with significantly more neuromuscular strain to the upper extremity than standard laparoscopy (SL) in urology. The high incidence of hand/wrist injuries with HAL may be from biomechanical and ischemic etiologies related to the fixed arm position while manipulating the hand and fingers.<sup>17,18</sup>

In a multi-institutional survey, Wolf and coworkers<sup>19</sup> reported significant shoulder and neck pain among 17% and 28% of urologists, respectively. More recently, Gofrit and colleagues<sup>20</sup> evaluated urologists' injuries during and after laparoscopic surgery, including SL, HAL, and robot-assisted laparoscopy (RAL). Nearly one-third of respondents noted neuromuscular or arthritic injuries during surgery. Post-operative injuries were even more common, with 45% of surgeons performing HAL having persistent hand/wrist numbness after surgery. Risk factors included the total number of laparoscopic procedures performed, length of procedure, and approach (HAL > SL > RAL). Based on these findings, the authors concluded that "the laparoscopic operating theater is a hostile ergonomic environment." As the number of minimally invasive urologic surgeries continues to increase, ergonomic challenges may have even more debilitating effects on the surgeon.

The importance of ergonomics to minimize injury and maximize efficacy has been well recognized in the field of gastrointestinal endoscopy, including both esophagogastroduodenoscopy and colonoscopy.<sup>21</sup> Survey-based studies highlighting overuse injuries in gastrointestinal endoscopists have estimated a prevalence of musculoskeletal symptoms between 37% and 89%, mostly in the hand-wrist area. To our knowledge, however, limited data exist on the ergonomics of endourologic procedures, specifically flexible ureteroscopy. The need for ergonomic evaluation is paramount because endourologists are tackling more complicated upper tract pathology.

Few studies have examined the risks of occupational hazards among endourologists, which are likely an under-recognized problem. We found that nearly one-third of endourology respondents reported hand problems. Endourologists were significantly more likely to report hand problems than nonendoscopists (psychiatrists) (32% *vs* 19%, RR 1.69). A control group of psychiatrists was selected because of the paucity of procedures in this medical field with similar handwriting and typing demands. Among endourologists and psychiatrists with hand problems, the combined medical and surgical intervention rates were high at approximately 85% for both groups. This suggests a real concern and debilitation.

Given the high prevalence of hand problems, strategies aimed at prevention and early intervention are necessary. Endourologists with even minor complaints of hand/wrist discomfort may experience the development of significant discomfort over time. In fact, more severe impairment may take years to manifest after the initial occupational exposure, as documented in industrial studies. Among workers with highly repetitive hand activities, hand/wrist tendonitis demonstrated a mean latency time of approximately 5 years.<sup>22</sup> Therefore, increased awareness of WMSDs is needed in the urologic community to halt the subsequent development of more major, long-term disabilities.

Our finding of a significant difference in the prevalence of hand problems between users of intuitive *vs* counterintuitive deflection warrants a closer look. The deflection mechanism of the flexible ureteroscope is essential for maneuvering within the intrarenal collecting system. The mechanism includes wires running from the tip along the entire length of the ureteroscope to a manually operated lever in the handle of the ureteroscope. Manipulation of this lever, typically with the



thumb, then deflects the ureteroscope tip. Deflection is described as either intuitive or counterintuitive. If the tip moves down as the lever is moved down or away from the operator (up is up, down is down), then the deflection is intuitive, or positive. If, however, the tip moves in the opposite direction of the lever or up when the lever is moved down or away from the operator (up is down, down is up), then the deflection is counterintuitive and contrapositive.

In this study, counterintuitive ureteroscope users were twice as likely to report hand problems. We hypothesize that difficulty in accessing lower pole calices may explain this difference. The majority of movement for access within the kidney involves deflection of the tip in one direction, most commonly down. For example, to access the lower pole or the mid portion of the kidney, the tip is deflected in one direction. The intuitive ureteroscope necessitates some deflection to reach the lower pole calices while counterintuitive instruments need extreme thumb extension that is ergonomically disadvantageous.

Motion studies of the human hand show that the thumb naturally flexes rather than hyperextends.<sup>23,24</sup> Thumb flexion uses the interphalangeal joint, which has only one motion vector. In contrast, thumb extension uses the metacarpophalangeal joint, which has two motion vectors and, therefore, increases joint stress.

As demonstrated among industrial workers performing hand-intensive tasks, hand position may be as important as repetition in risk of injuries.<sup>5</sup> Larger, more controlled studies of this effect or careful study of the hand during instrument deflection are needed to elucidate the association between ureteroscope deflection and hand problems.

All major manufacturers of flexible ureteroscopes now offer flexible ureteroscopes with deflection of either design. At the time of this study, Olympus was the only manufacturer using counterintuitive deflection exclusively. Intuitive deflection is offered as the standard in the United States, while counterintuitive deflection is available as an option.

This study is not without limitations. The retrospective study design is prone to recall bias by respondents. The response rate was 20.3% and 12.8% for endourologists and psychiatrists, respectively. This is consistent with mean response rates of approximately 20% reported in the literature for e-mail-only surveys.<sup>25</sup> The final sample sizes ( $n=122$  endourologists,  $n=74$  psychiatrists) also compare favorably with most laparoscopy series reported in the literature.

A potential confounder includes the fact that endourologists commonly perform both laparoscopy and ureteroscopy. We chose to focus on hand problems specifically to highlight the injuries associated with ureteroscope deflection and manipulation. We did not want the variable of laparoscopic surgeries performed by endourologists to affect our analysis and therefore excluded upper extremity problems of the neck and shoulders. Furthermore, we focused on flexible ureteroscopy, which comprises a major portion of endourologic procedures.

Finally, our questionnaire included open-ended, subjective reports of hand problems from respondents. Future studies may incorporate more objective measures to quantify outcomes more specifically. For example, Lee and coworkers<sup>26</sup> used the Job Strain Index and Rapid Upper Limb Assessment to quantify upper extremity exposure to postural and force risk factors in manual and telerobotic endoscopic surgery.

More objective outcomes will likely yield even more convincing evidence that endourology is detrimental to the surgeon.

## Conclusions

Flexible ureteroscopy is being increasingly used for the diagnosis and management of a broad range of upper urinary tract pathologies. Hand and wrist problems are particularly common among endourologists and may be attributed to several factors, including repetitive movements, prolonged operative times, and uncomfortable hand positions during endourologic procedures, including flexible ureteroscopy. Advances in ureteroscope design have focused on scope size, tip deflection, and image clarity with minimal focus on ergonomics. Development of more ergonomic platforms for endourology is needed to reduce the surgeon's exposure to these occupational hazards.

## Disclosure Statement

Dr. Bagley is a consultant for Bard, Cook, and Boston Scientific. For the remaining authors, no competing financial interests exist.

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#### Abbreviations Used

HAL = hand-assisted laparoscopy  
 RAL = robot-assisted laparoscopy  
 RR = relative risk  
 SL = standard laparoscopy  
 WMSDs = work-related musculoskeletal disorders

APPENDIX 1.

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*Endourologic Society Questionnaire*

1. How many years have you been in practice?
2. What is your practice setting? (i.e., academic, private practice, government)
3. Approximately what portion of your practice is devoted to endourologic procedures?
4. How many ureteroscopy cases do you perform during a typical week of practice?
5. What is the average operative time (minutes) for flexible ureteroscopy cases in your setting?
6. What is your preferred flexible ureteroscope in order of preference? (Manufacturer & Model)
7. What is your hand dominance? Right or Left
8. What is your preferred direction of ureteroscope deflection? Intuitive/positive (up is up, down is down), Counter-intuitive/contra-positive (up is down, down is up), or No preference
9. What is your preferred hand for deflection of ureteroscope? Right or Left
10. What is your preferred digit (finger) for ureteroscope deflection? Thumb, index, middle, or other
11. Do you have any hand and/or wrist problems in your dominant hand? If yes, please specify.
12. Do you have any hand and/or wrist problems in your non-dominant hand? If yes, please specify.
13. Do you have any pre-existing conditions that would predispose you to hand/wrist problems?
14. If you have experienced hand/wrist problems, what did you do to alleviate your symptoms?

*Psychiatry Questionnaire*

1. How many years have you been in practice?
  2. What is your practice setting? (i.e., academic, private practice, government)
  3. Do you perform endoscopic procedures? Yes/No
  4. What is your hand dominance? Right or Left
  5. Do you have any hand and/or wrist problems in your dominant hand? If yes, please specify.
  6. Do you have any hand and/or wrist problems in your non-dominant hand? If yes, please specify.
  7. Do you have any pre-existing conditions that would predispose you to hand/wrist problems?
  8. If you have experienced hand/wrist problems, what did you do to alleviate your symptoms?
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