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Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery ☆

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ABSTRACT

Objectives. There is limited data regarding physical strain and minimally invasive gynecologic surgery (MIS). We sought to evaluate ergonomic strain among gynecologic oncologists.

Methods. An online survey was sent to all physician members of the Society of Gynecologic Oncology in North America in 2010. The survey contained 42 questions and data was analyzed using univariate and bivariate analyses with summary statistics, *t*-tests, and chi-squared test.

Results. There were 260 respondents (31.2%) to the survey. Case mix was 26% benign and 64% oncologic surgery. Over 52% of respondents had been in practice for greater than 11 years and 52% practice in an academic setting. Physical discomfort related to MIS was reported in 88% (216/244) of surgeons with 52% reporting persistent pain. Increased pain symptoms were associated with surgeon's height, glove size, age and female gender. Patient body mass index (BMI) was associated with pain symptoms in surgeons performing conventional laparoscopic surgery, but not robotic surgery. To decrease pain, surgeons changed positions (78%), limited the number of cases per day (14%), spread cases throughout the week (6%), or limited the total number of cases (3%). Only 29% had received treatment at any time for pain symptoms. Treatment included physical therapy (59%), medical management (28%), surgery (13%), and time off (1%). Only 16% of those with pain symptoms had received formal ergonomic training.

Conclusion. Physical strain rates of 88% are far greater than previously reported. Such prevalent occupational strain presents a growing problem in the face of increasing demand for MIS.

1. Introduction

Minimally invasive surgery (MIS) has revolutionized patient care across many medical specialties including gynecology, general surgery, oncology, and thoracic surgery. Historically, surgeon strain related to MIS has been quoted at 12–18% [1,2]. A recent study, which surveyed members of the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) challenged this rate, with 87% of responding surgeons reporting physical symptoms or discomfort [3]. In the SAGES survey, 272 surgeons (86.9%) reported physical symptoms or discomfort. The strongest predictor of symptoms was case volume. Neck, hand, and lower extremity strain was correlated temporally with fellowship training, a time of concentrated case volume. The exceptions to case volume and strain were eye and back symptoms, which were present even for those with low case volumes. The overall surgeon awareness of ergonomic techniques was low with most being slightly to somewhat aware [3]. Despite these findings, the impact of physical strain on gynecologic surgeons has not been adequately evaluated.

According to the United States Department of Labor statistics, the incidence of work related injury in healthcare and social assistance was 4.8 per 100 full-time workers in 2010, the highest of all industry categories. At present it is difficult to distinguish disability rates of surgeons specifically as most reviews reporting on diseases and disorders are based on all health care workers and do not specify physicians [4]. There are a number of reports in specific subspecialties. Most notably, interventional cardiologists report a 42% rate of spinal injuries, a third of those injuries requiring them to miss work [5]. However, there is no specific literature from the Department of Labor available for gynecologic oncologists.

Despite the potential for surgeon strain, the demand for MIS from patients and providers is increasing. From a patient perspective, MIS techniques hold the promise of shorter recovery period, less postoperative

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pain, and potentially fewer operative complications [6,7]. These improvements allow patients and their caregivers to return to their preoperative level of functioning in a shorter period of time [8]. Prospective data from the Gynecologic Oncology Group (GOG) LAP-2 trial showed that there are benefits from MIS in the immediate post-operative period [7]. Additionally, in the face of the obesity epidemic, there is a perception that MIS techniques may be particularly beneficial in this medically compromised patient population, which will only serve to further increase demand.

Given this trend of increasing MIS volume in gynecologic oncology, with some reports showing a four-fold increase in case volume, and reports in other surgical disciplines of significant physical discomfort, there is a need for information related to strain and work related injuries in gynecologic oncologists [9]. While there is widely held belief that MIS causes greater strain on surgeons than open surgery, there is no data specific to gynecologic surgery, which encompasses a large volume of MIS operative cases in the United States. For this reason we sought to provide information about occupational injury incurred while performing minimally invasive gynecologic surgery in hopes of providing a forum to decrease the incidence of ergonomic strain in the future.

2. Methods

The Institutional Review Board at the University of North Carolina approved the study protocol. An invitation to participate in an online survey was sent by e-mail to 833 physician members of the Society of Gynecologic Oncologists (SGO) in May to June of 2011. Included within the invitation was an explanation of the study and a statement that completion of the survey was voluntary, responses would be used for research purposes, and there was no link between the responses and personal identifiers. The study participants accessed the online survey via a link included in the invitation e-mail. Two reminder e-mails were sent over the course of the study and the survey was closed 2 weeks after the final reminder e-mail was sent.

The survey contained 42 questions which focus on demographics, physical characteristics of surgeons related to ergonomic strain, laparoscopic and robotic surgery volume, ergonomic set-up and characteristics of the operative setting, and operative strain and impact on practices. Answers were yes/no, multiple choice, or numeric response. The questions and answer structure are included in Table 1.

The results from the survey were imported from the online platform into Microsoft Excel and then analyzed using STATA 11® (College Station, TX) software. Univariate and bivariate analyses were performed using summary statistics, student *t*-tests, and chi-square tests, with p-value <0.05 considered statistically significant.

Table 1
Survey questions.

Question	Answer
Demographics	
What year did you finish your residency?	NR
What year did you finish your Gynecologic Oncology Fellowship?	NR
How many years have you been in practice?	MC
Where do you practice?	MC
What environment do you practice in?	MC
What is your height?	NR
What is your age?	MC
What is your gender?	SA
What is your surgical glove size?	NR
How many years has minimally invasive surgery been a part of your practice?	MC
What percentage of each type of cases (benign or oncology) do you do? (Total needs to be 100%)	NR
If you had a preference, how would you choose to post a case?	SA
Robotic surgery	
Do you perform robotic surgeries?	SA
How many robotic cases do you perform a year?	MC
How many robotic cases do you perform in a week?	MC
How many robotic cases do you perform in an average day?	MC
How long is your average robotic case?	MC
What is the average BMI of your robotics cases?	MC
Which type of robot do you have at your institution (if applicable)? Check all that apply.	MC
How many robots are available?	MC
Is the robotic system easily accessed?	SA
How is access to the robotic system determined?	SA
Laparoscopic surgery	
How many laparoscopic cases do you perform a year?	MC
How many laparoscopic cases do you perform in a week?	MC
How many laparoscopic cases do you perform in an average day?	MC
How long is your average laparoscopic case?	MC
What is the average BMI of your laparoscopic patients?	MC
Do you have multiple monitors available during laparoscopic surgery?	SA
Who typically assists you?	MC
Describe the fit of the laparoscopic surgical instrument in your hand: Bipolar, monopolar, needle driver, and grasper.	MC
Ergonomic strain	
Have you experienced physical discomfort directly related to MIS?	SA
How would you describe this discomfort	MC
Where to you experience symptoms? Check all that apply	MC
How do you attempt to minimize these symptoms?	MC
Are your symptoms limited only to time spent operating or do they persist?	SA
Did you receive specific training in ergonomically sound techniques?	SA
Have you seen a professional (PT, orthopedist, primary care) for your symptoms?	SA
Have you had treatment for physical strain?	SA
What treatment have you had? Check all that apply.	MC
Has this injury caused you to limit your practice?	SA
If yes, how has it limited your practice? Check all that apply.	MC
Have you reported your symptoms to your institutions' employee health resources?	SA

NR = Numeric response, MC = Multiple choice, SA = Single answer.

3. Results

3.1. Demographics

Two hundred and sixty (response rate of 31.2%) gynecologic oncology surgeons responded to the survey. Surgeon demographics are summarized in Table 2. The majority (52%) of participants had been in practice for greater than 11 years. Sixty-four percent of surgeons practiced in a university hospital or affiliated setting. Surgeons reported that approximately 65% of surgical cases in any given practice were performed for oncologic indications, and 26% for benign disease. Regarding preferred operative modality, 62% of surgeons preferred to post cases robotically, 25% laparoscopically, and 13% via laparotomy.

Several questions addressed robotic and laparoscopic surgery factors. These responses are summarized in Table 3. Nearly 89% of responding surgeons participated in robotic surgery. Forty-six percent of patients who underwent robotic surgery had a reported BMI of 31–35 kg/m^2 and 46% had an average BMI of 36–40+ kg/m^2. Meanwhile, 55% of patients who underwent laparoscopy had a reported BMI of 31–35 kg/m^2 and 12% had an average BMI of 36–40+ kg/m^2.

3.2. Equipment and operative set-up

A total of 96.4% of responders reported the availability of multiple monitors for MIS. Typical assistants were residents in 41.4%, fellows in 35.5%, surgical technicians in 17.9%, and another attending in 5.2% of cases. Participants were asked to describe the fit of several commonly used laparoscopic instruments. The majority found the instrument fit to be “just right”: 70.8% in relation to bipolar devices, 77.8% for graspers, 74.4% for needle drivers, and 84.8% for monopolar devices (Table 4). There was no association between physical strain and type of assistant or perceived fit of the laparoscopic instrument.

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Table 2
Surgeon demographics.

Demographic factor	All	Reported strain, n (%)	No reported strain, n (%)	p-value[a]
Average year of residency completion, mean (SD)	1995 (8.2)			
Average year of fellowship completion, mean (SD)	1999 (8.4)			
Average type of cases, mean % (SD)				
Benign	26.3	213 (26.0)	29 (27.9)	0.73
Oncology	64.7	215 (65.3)	29 (65.8)	0.55
Number of years in practice, n (%)				0.012
0–5	75 (28.8)	63 (29.3)	6 (20.7)	
6–10	50 (19.2)	34 (15.8)	11 (37.9)	
11–15	55 (21.2)	51 (23.7)	2 (6.9)	
16–20+	80 (30.8)	67 (31.2)	10 (34.5)	
Practice location, n (%)				0.44
North East	77 (29.6)	61 (28.4)	12 (41.4)	
South East	83 (31.9)	70 (32.6)	8 (27.6)	
Midwest	60 (23.1)	50 (23.3)	4 (13.8)	
West Coast	40 (15.4)	34 (15.8)	5 (17.2)	
Practice environment, n (%)				0.60
University hospital	136 (52.3)	107 (49.8)	18 (62.1)	
University hospital affiliate	30 (11.5)	24 (11.2)	3 (10.3)	
Health system owned practice	43 (16.5)	40 (18.6)	3 (10.3)	
Private practice	51 (19.6)	44 (20.5)	5 (17.2)	
Height, cm, mean (SD)	173.9 (10.0)	173.3 (10.1)	177.5 (8.30)	0.04
Age, n (%)				0.03
25–30	2 (0.8)	0 (0)	1 (3.45)	
31–39	64 (24.6)	56 (26.1)	4 (13.8)	
40–49	118 (45.4)	96 (44.7)	14 (48.3)	
50+	76 (29.2)	63 (29.3)	10 (34.5)	
Gender, n (%)				0.001
Female	106 (40.8)	98 (45.6)	4 (13.8)	
Male	154 (59.2)	117 (54.4)	25 (86.2)	
Years of MIS in practice, n (%)				0.48
0–5	64 (24.6)	52 (24.2)	7 (24.1)	
6–10	94 (36.2)	76 (35.4)	14 (48.3)	
11–15	60 (23.1)	52 (24.2)	4 (13.8)	
16–20+	42 (16.2)	35 (16.3)	4 (13.8)	
Surgeon preference for case posting, n (%)				0.55
Laparotomy	33 (12.7)	24 (11.2)	4 (13.8)	
Laparoscopically	65 (25.0)	57 (26.5)	5 (17.2)	
Robotically	162 (62.3)	134 (62.3)	20 (69.0)	

[a] Chi-square test was used for all of the above variables to report percent frequencies, except for height and average type of cases, for which a student *t*-test was used to report means and standard deviations.

3.3. Physical strain

Two-hundred and forty-four surgeons responded to questions regarding physical strain. Two-hundred and fifteen (88.1%) reported physical discomfort directly related to MIS. When asked if those symptoms were limited to operative time or if they persisted, 117 (51.8%) of those responding (n = 226) reported persistence of symptoms. The locations of strain symptoms are summarized in Fig. 1. When asked about other pain symptoms, injuries reported included forehead/face pain (n = 3), joints (n = 2), and eyes (n = 1).

The strain symptoms were associated with each of the survey's demographic questions. The study revealed that strain symptoms were correlated with surgeon height and glove size. Shorter surgeons and surgeons with smaller glove size were more likely to experience strain ($p = 0.03$). Strain was also associated with surgeon age, with younger surgeons experiencing more strain ($p = 0.03$). Surgeon gender was also associated with strain with 82.4% of male surgeons reporting and 96.1% of female surgeons reporting pain ($p < 0.05$). Female surgeons had 5.2 times the odds of having pain compared with male surgeons (OR 5.2, CI 1.76–15.6). When controlling for height, glove size and age, females had 7.3 times the odds of having pain (OR 7.3, 95% CI 1.4–37.3) compared to males in a multivariate model. Finally, in surgeons performing robotic surgery, strain was associated with number of cases per day ($p = 0.02$) and length of surgical cases ($p = 0.01$). However, this association was not seen when surgeons reported on their laparoscopic experience.

Patient body mass index (BMI) was correlated with increasing pain symptoms in surgeons performing laparoscopic surgery ($p = 0.04$), but not robotic surgery. This was despite surgeons reporting higher patient BMIs in the robotic surgery group. Finally, pain symptoms related to MIS were associated with years in practice with symptoms being more common in physicians who had been in practice for a shorter period of time ($p = 0.01$).

3.4. Symptom alleviation and treatment

When asked how they attempted to minimize symptoms 79% (158/201) of surgeons reported that they did so by changing positions, 14% (27/201) limited the number of cases in a week, and 2.5% (5/201) of surgeons decreased their case load altogether. When asked about other methods of decreasing strain, responses included using the robotic operating system (n = 8), adjusting monitors (n = 3), and exercise regimens (n = 1). Of surgeons reporting strain, 28.9% had received treatment for their physical strain. Treatments included physical therapy (58.5%), medical management (28.3%), surgery (13.2%), and time off (0.9%) (Fig. 2). Other treatments for pain symptoms included massage therapy (n = 8), joint injections (n = 4), and utilizing a chiropractor (n = 2). Nine percent of surgeons stated that physical strain limited their practice. The types of limitations included a change in surgical approach (56%) and a decrease in number of cases (31%). Only 1% of respondents had reported the

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Table 3
Robotic and laparoscopic surgery characteristics.

Robotic surgery factor	All, n (%)	Reported strain, n (%)	No reported strain, n (%)	p-value[a]
Use of robotic surgery, n (%)	218 (89.3)	193 (89.8)	25 (86.2)	0.56
Robotic cases per year, n (%)				0.12
0–50	85 (37.4)	73 (37.8)	9 (37.5)	
51–100	76 (33.5)	70 (36.3)	4 (16.7)	
101–150	43 (18.9)	31 (16.1)	8 (33.3)	
151–200+	23 (10.1)	19 (9.8)	3 (12.5)	
Robotic cases per week, n (%)				0.33
0–5	198 (87.2)	170 (88.1)	19 (79.1)	
6–10	27 (11.9)	21 (10.4)	5 (20.8)	
11–15	2 (0.9)	2 (1.04)	0 (0)	
>15	0 (0)	0 (0)	0 (0)	
Robotic cases per day, n (%)				0.02
0–1	92 (40.5)	81 (42.0)	7 (29.2)	
2–3	127 (55.9)	108 (56.0)	14 (58.4)	
4–5	8 (3.5)	4 (2.1)	3 (12.5)	
>5	0 (0)	0 (0)	0 (0)	
Length of average robotic case, n (%)				0.01
30–60 min	1 (0.4)	0 (0)	1 (4.2)	
61–90 min	37 (16.3)	30 (15.5)	6 (25.0)	
91–120 min	97 (42.7)	82 (44.5)	11 (45.8)	
120 + min	92 (40.5)	81 (42.0)	6 (25.0)	
BMI of average robotic case, n (%)				0.66
20–25	0 (0)	0 (0)	0 (0)	
26–30	17 (7.5)	14 (7.23)	3 (12.5)	
31–35	105 (46.3)	87 (45.1)	10 (41.7)	
36–40+	105 (46.3)	92 (47.7)	11 (45.8)	
Number of robotic systems available, n (%)				0.60
1	99 (43.6)	86 (44.5)	10 (41.7)	
2	72 (31.7)	64 (33.2)	6 (25.0)	
3	27 (11.9)	20 (10.4)	3 (12.5)	
4+	29 (12.8)	23 (11.9)	5 (20.8)	
Access to robotic system is easy, n (%)				0.13
Yes	150 (66.1)	123 (63.7)	19 (79.2)	
No	77 (33.9)	70 (36.3)	5 (20.8)	
Laparoscopic surgery factor	**Data**			
Laparoscopic cases per year, n (%)				0.34
0–50	132 (51.6)	110 (51.2)	15 (51.7)	
51–100	56 (21.9)	47 (21.9)	8 (27.6)	
101–150	37 (14.5)	32 (14.9)	1 (3.5)	
151–200+	31 (12.1)	26 (12.1)	5 (17.2)	
Laparoscopic cases per week, n (%)				0.83
0–5	4 (1.8)	3 (1.7)	1 (3.9)	
6–10	185 (84.5)	155 (85.2)	21 (80.8)	
11–15	29 (13.2)	23 (12.6)	4 (15.4)	
>15	1 (0.5)	1 (0.6)	0 (0)	
Laparoscopic cases per day, n (%)				0.96
0–1	33 (14.7)	26 (14.3)	5 (20.0)	
2–3	91 (40.4)	73 (40.1)	9 (36.0)	
4–5	68 (30.3)	55 (30.2)	7 (28.0)	
>5	33 (14.6)	28 (15.4)	4 (16.0)	
Length of average laparoscopic case, n (%)				0.38
30–60 min	63 (24.6)	51 (23.7)	11 (37.9)	
61–90 min	88 (34.4)	77 (35.8)	8 (27.6)	
91–120 min	70 (27.3)	60 (27.9)	6 (20.7)	
120 + min	35 (13.7)	27 (12.6)	4 (13.8)	
BMI of average laparoscopic case, n (%)				0.04
20–25	7 (2.7)	2 (0.9)	2 (6.9)	
26–30	77 (30.1)	63 (29.3)	12 (41.4)	
31–35	143 (55.1)	124 (57.7)	11 (37.9)	
36–40+	31 (12.1)	26 (12.1)	4 (13.8)	

[a] Chi-square test was used for all of the above variables to report percent frequencies.

physical strain to their institution employee health and only 16.4% of those with pain symptoms had received formal ergonomic training.

4. Discussion

Our findings revealed that the observed physical strain rate of 88% is far greater than earlier reports and consistent with a recently published survey of general surgeons who perform MIS (3). Our survey is the first study of MIS related strain in surgeons whose practice is limited to gynecology. With a reported ergonomic training rate of only 16% and an increasing demand for MIS, there is an urgent need to evaluate and improve the quality ergonomic training among surgeons at high risk for occupational injury. These results highlight a growing problem of physician injury caused by MIS related strain [10,11] and growing demand for the service. As more gynecologic surgeons are performing MIS over the entirety of their career and performing increasingly difficult cases, ergonomic training and ways to prevent, recognize, and manage MIS related injury is urgently needed.

Our study showed strain symptoms are correlated with both physician and patient characteristics. Strain was increased in younger

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Table 4
Laparoscopic instrument fit.

Instrument and fit	Physician response, %	Reported strain, n (%)	No reported strain, n (%)	p-value[a]
Bipolar				0.10
Too small	11.4	24 (11.8)	2 (7.7)	
Just right	70.8	140 (69.0)	23 (88.5)	
Too big	17.4	39 (19.2)	1 (3.85)	
Monopolar				0.77
Too small	8.0	16 (2.8)	2 (7.7)	
Just right	84.8	173 (84.4)	23 (88.5)	
Too big	7.2	16 (7.8)	1 (3.9)	
Needle driver				0.06
Too small	11.7	22 (11.3)	5 (19.2)	
Just right	74.4	140 (72.2)	21 (80.8)	
Too big	13.9	32 (16.5)	0 (0)	
Grasper				0.75
Too small	9.9	21 (10.05)	3 (11.1)	
Just right	77.8	162 (77.5)	22 (81.5)	
Too big	11.9	26 (12.4)	2 (7.4)	

[a] Chi-square test was used for all of the above variables to report percent frequencies.

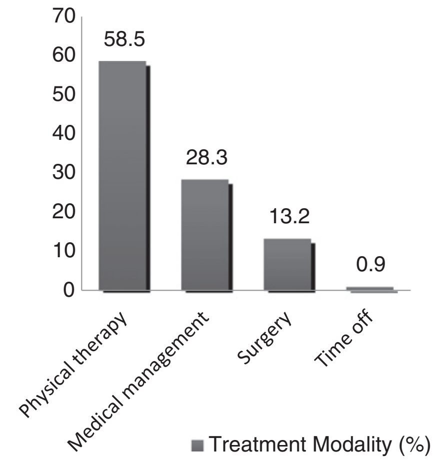

Fig. 2. Treatment of physical strain.

surgeons, those in practice for a shorter period of time, those with smaller glove size, and in shorter surgeons. Strain was also increased in female surgeons, which may be due to the association between strain and glove size and surgeon height as the female surgeons had a smaller glove size and were shorter than their male colleagues. This differs from the SAGES survey study in which symptoms were not related to age or height. However, consistent with the SAGES survey we did find an association between case volume and physician strain. Interestingly, this association was only seen in the robotic surgery category and was not seen in the laparoscopic surgery subset. When seeking an explanation for some of these associations, we can look to the change in the demographics of gynecologic oncologists and the increase in MIS in younger surgeons as reported in the State of the Subspecialty Survey of SGO from 2010. There may be a correlation between concentrated case volume, surgeon strain, surgeon age and length in practice, but we are unable to conclude that based on our data.

Patient attributes in the form of BMI were correlated with increasing strain symptoms in surgeons performing laparoscopic surgery, but not robotic surgery. Notably, this was despite higher reported patient BMIs in the robotic surgery group. Given the global obesity epidemic this data is significant, particularly in light of the recent National Health and Nutrition Examination Survey results. The study found that the age-adjusted prevalence of obesity was 35.5% in adult women aged 20 to 74 years in 2007 to 2008. Additionally,

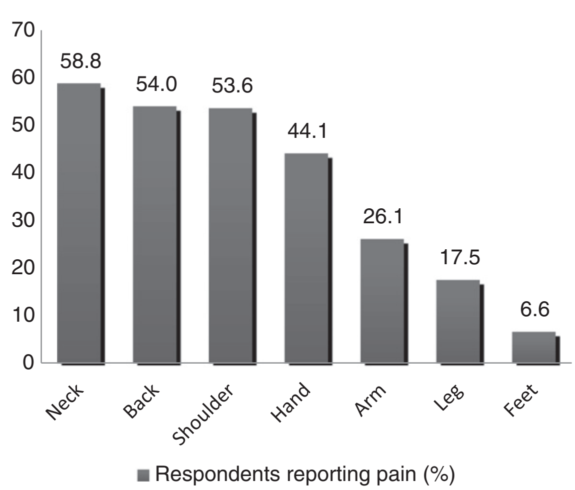

Fig. 1. Location of physical strain symptoms.

64.1% of all adult women are considered either overweight or obese [12]. With this growing epidemic and a potential link to MIS, extra attention must be paid to ergonomically sound technique to avoid strain.

Changing positions was the most commonly employed method of minimizing symptoms of physical strain. This finding is not surprising and is consistent with commonly reported methods of reducing MIS strain [3]. However, a significant percentage of surgeons ameliorated symptoms by spreading out or decreasing case loads. This suggests substantial morbidity and a potential problem as the demand for physician services increases. A number of surgeons specifically mentioned use of the robotic platform to minimize symptoms in the free response section. However, this was not an area specifically addressed in the survey. Although more information is needed, semiactive robotics in a solo-surgeon setting has been showsn to increase surgeon comfort by improving image stability and laparoscopic handling [13].

A large proportion of surgeons who suffered MIS-related injury required medical treatment. Twenty-nine percent of surgeons received treatment for physical strain, with more than half requiring physical therapy. Of those experiencing strain, 11% had symptoms that impacted their physical ability to the extent that surgery was required. MIS-related strain may severely impact a surgeon's longevity and underscores the need for more urgent attention. Currently, it is difficult to decipher from the available data, if any surgeons need to cease operating or subsequently become disabled due to strain related injuries.

Despite a large majority of surgeons reporting MIS related strain, only 16% of those endorsing strain reported receiving formal ergonomic training. Techniques that may reduce MIS related strain have been studied and include: proper alignment of the eye–hand–target axis to improve comfort, safety, effectiveness, and efficiency [14]. Additionally, van Veelen and colleagues described the issue of the non-neutral posture during MIS and five factors which influence this posture: instrument design, monitor position, use of foot pedal controls, operative table height, and static surgeon posture [15]. Educating MIS surgeons on what is known and more precise research regarding proper ergonomic technique must be priorities. Another important component of strain prevention was identified by Nguyen and colleagues who reported that MIS involves a more static posture of the neck and trunk and more frequent awkward movements of the upper extremities than open surgery [16]. The surgical instrument manufacturers need to be more cognizant of the ergonomic impact of instruments on the increasingly diverse surgeon work force and focus development resources on addressing surgeon heterogeneity.

We recognize the limitations of the data. Although our survey response rate is higher than previously published studies on the same

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topic [3], our response rate of 31.2% must be noted. Assuming that all surgeons not responding to the survey had no strain, we would have a 25.8% (215/833) rate of strain. Additionally, the small number of respondents could lead us to find statistical significance in areas that may not hold true with a larger number of participants. There is inherent selection bias in any survey study. For this study, those surgeons who experienced strain may be more likely to respond to a survey such as this and they may also be more likely to explore surgical platforms that they believe may decrease their risk for and incidence of strain. Additionally, 88.8% of respondents used robotic surgery as one of their MIS modalities, which may impact the reported strain rates.

The physicians who participated in this study were identified from a select pool of gynecologic oncologists who are members of SGO, comfortable with Web-based survey programs, and have e-mail. One concern is that our respondent pool may not represent the typical gynecologic oncologist practicing in the United States. Therefore, we compared our sample with the 2010 SGO State of the Subspecialty report to evaluate for similarities and differences between the respondents [17]. As for surgeon demographics, with regard to years in practice, case distribution (benign vs. oncologic), geographic practice location, and practice environment, our survey participants mirrored those who participated in SGO's most recent State of the Subspecialty survey. However, when comparing surgeon age and gender, our survey participants tended to be younger and more likely to be female. Finally, SGO's report further highlighted that MIS is a significant component of practice with 93% of surgeons reporting use of MIS in 2010.

Despite our study limitations the results highlight the significant incidence of physical strain experienced by gynecologic oncologic surgeons. Ultimately, more questions inevitably arise out of these studies. More research is needed to clearly define MIS strain in gynecologic surgery and better characterize what steps can be taken to minimize its impact on gynecologic surgeons.

Conflict of interest statement

Dr. John Boggess is a consultant for Intuitive Surgical. The remaining authors have not conflicts of interest.

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