Assessing Visualization in Robotic-Assisted Surgery: Demystifying a Misty Lens

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Introduction

Robotic-assisted laparoscopic surgery (RAS) is an exciting and rapidly growing surgical field. Despite major technological advancements within the field, there are still shortcomings to explore and address. This study assesses the prevalence of suboptimal vision in minimally invasive robotic surgery and corresponding factors regarding the related surgical conditions, specifically:

- Occurrence of occlusion events
- Cleaning duration and frequency
- Active instrumentation during occlusion events

Methods

- 45 minimally invasive surgeries performed using the Da Vinci XI were observed
  - Three surgical subspecialties: General Surgery, Urology, OB/GYN
- Lens occlusion and cleaning events were recorded with their time of occurrence
  - Occlusion: the presence of a visual distortion caused by debris deposition on the scope lens; active instrumentation was noted
  - Cleaning: removal of the scope from the body cavity to be cleaned by cloth or Clearify; cleaning duration and method was noted
  - Suboptimal vision: any moment in which the screen was obscured by a visual occlusion
- Descriptive statistics were used to summarize duration-based variables
- One-factor ANOVA test with Tukey-Kramer post-hoc analysis compared active instrumentation categories and surgical subspecialties

Conclusions

- Surgeons exhibited reluctance to interrupt surgery to clean, preferring to operate with sub-optimal vision
- Surgeons most likely to clean instruments after occlusions with Insert/Remove Instrument, Camera Movement or Irrigation active
  - Less likely to clean after occlusions when Cautery active
    - May indicate certain areas where cleaning is more desirable during surgery
- Several factors may have contributed to the high degree of variability including patient body composition and anatomy, location of the operative site, complexity of surgery, and the surgical team

Results

Table 1. Occlusion and cleaning statistics by surgical specialty

Specialty	Cases Observed	Average Length [minutes]	Occlusions per Case	Cleaning per Case	Suboptimal Vision [% surgery]
Urology	17	181.1 ± 64.2	10.5 ± 1.2	5.0 ± 0.9	47.6 ± 20.4
General Surgery	19	89.4 ± 67.6	4.4 ± 1.1	2.3 ± 0.8	42.9 ± 33.8
OB/GYN	9	102.1 ± 51.5	5.1 ± 1.7	3.1 ± 1.2	28.4 ± 25.5
Total	45	126.6 ± 75.6	6.8 ± 5.6	3.5 ± 3.7	41.4 ± 28.1

- High variability for all metrics across cases and subspecialties
- 41.4 ± 28.1% operative time spent occluded versus 1.2 ± 1.0% spent cleaning
- Surgeons operated with occluded vision ~35x the time used to clean the lens
- Cautery significantly (Table 3) more active during occlusion events than other instrument categories
- Pareto Analysis (Figure 1) affirmed top 4 most active instrumentation categories accounted for 82% of all occlusions
- No significant difference in subspecialties for occlusion rate per case (Table 4)
- Urology had significantly (Table 2) more total occlusions than other specialties observed
  - No significant difference between OB/GYN and General Surgery in occlusion counts (Table 2)
- Figure 2 illustrates Irrigation, Insert/Remove Instrument, and Camera Movement were the categories with the highest percentage of occlusions which preceded a cleaning
  - Notably, Cautery had a lower rate

Table 2. Significance of occlusion counts between surgical specialties (p-values)

	General Surgery	Urology
General Surgery		
Urology	0.002	
OB/GYN	0.937	0.033

Table 3. Significance of cautery presence against other instrument categories

Instrument Category	p-values
Suction	<.0001
Irrigation	<.0001
Scissors	<.0001
Insert/Remove Instrument	<.0001
Instrument Movement	<.0001
Camera Movement	0.0373
Other	<.0001

Table 4. No significance of occlusion rate per minute between surgical specialties (p-values)

	General Surgery	Urology
General Surgery		
Urology	0.986	
OB/GYN	0.905	0.955

Figure 1. Pareto analysis with relative proportion line

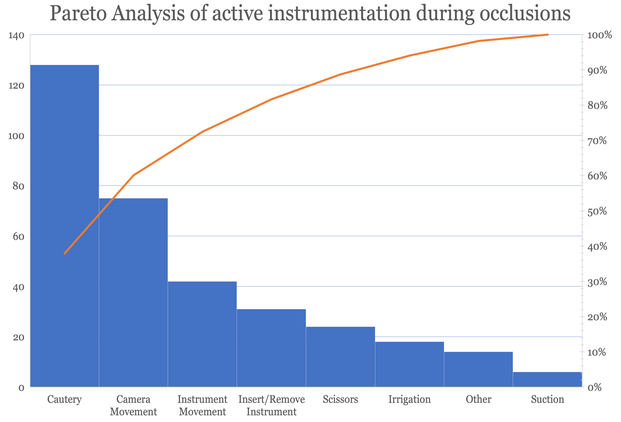


Figure 2. Histogram of percentage of each instrument category which preceded a cleaning

