Impact of Laparoscopic Lens Contamination in Operating Theaters: A Study on the Frequency and Duration of Lens Contamination and Commonly Utilized Techniques to Maintain Clear Vision

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Introduction: In laparoscopy, contamination of the distal lens is problematic. Not only a cause of frustration, repeatedly cleaning the laparoscope takes up significant time and disrupts the operative flow. Our study aims to explore and describe quantitatively this particular issue within the operating theaters of a major teaching hospital.

Materials and Methods: We recorded data assessing the occurrence of impaired vision on the screen display and quantified the occurrence, duration, and modality of cleaning events. Data were recorded on a time-line sheet and collected for basic quantitative analysis as reported below. A brief interview with the surgeons was carried out at the end of each procedure.

Results: A total of 64 hours of laparoscopy covering 25 procedures in 4 surgical disciplines were observed. The study found that 56% of the operation was performed with a clear display, while 37% of the time was spent impaired vision. Seven percent of the operation was spent cleaning the distal lens. The interviews recorded a unison sense of frustration and safety concerns regarding lens contamination.

Conclusions: Our observational study demonstrates that one third of the duration of a laparoscopic procedure is performed without perfectly clear display. The suboptimal display during an operation is similar to that of driving with a dirty windshield and having to step out of the car to clean it before continuing with the journey. The disruption to operative flow is transcribed as frustration felt by surgeons when display is compromised and having to clean the lens. However, the economical impact of cleaning the lens during the operation remains to be demonstrated.

Key Words: laparoscopy, lens contamination, lens fogging, lens cleaning, laparoscopic lens

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The advantages of laparoscopy have encouraged its adoption into an ever larger number of specialties. This has coincided with dramatic technological advancements, contributing to the improvement in operative time and precision; ultimately improving surgical care.[1] However, one domain which has not seen a great deal of progress is the fogging and contamination of laparoscopic lens. As a result, cleaning the lens leads to temporary halts to reestablish clear intracorporeal view. Typically, vision is impaired when clarity is needed the most. For instance when a hemorrhage contaminates the scope, or when a narrow operating space collapses after sudden loss of pneumoperitoneum.[2,3] Furthermore dealing with a soiled lens is a frustrating affair.[4]

In this study, we aim to record the frequency of the occurrence of distal lens contamination, the amount of time spent cleaning the lens, and surgeons' views on the matter.

MATERIALS and METHODS

All the procedures were observed at King's College Hospital, London. The observational study covered a variety of operations within several departments including urology, general surgery, gynecology, and general pediatric surgery. Three observers were recruited for the data collection phase of the study. Consent was obtained from the lead surgeons before attending their operation lists. The surgical teams observed were blinded from the aims of our study. The observers assessed the display of the laparoscope monitor while recording all relevant data.

During the study phase we recorded several variables:

- The number of lens contamination events.
- The number of cleaning events.
- Length of time spent cleaning the distal laparoscopic lens.
- Length of time spent operating with suboptimal laparoscopic vision.
- The cleaning modality used to prevent and/or remove lens contamination.
- The surgical members involved during the cleaning process.

Postoperatively, we tape recorded a semistructured interview with the surgeons on their opinions regarding the cleaning of a soiled lens intraoperatively.

Definitions and Classification

Assessment of the laparoscopic display is quantified into 3 categories:

(a) Clean: image reproduced on the monitor is clear, and without any lens fogging or contamination.
(b) Minor: visualization is obscured:
  (i) Less than 25% of the monitor.
  (ii) Not in the center of the monitor.

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(c) Major: visualization is obscured:

(i) Greater than 25% of the monitor; and/or
(ii) at the center of the monitor.

The time spent cleaning the lens was defined and recorded as:

(a) The removal of the laparoscope from its port, up to the point of reinsertion and resumption of the procedure; or
(b) the touching of the tip of the laparoscope against visceral tissue with the intention of removing lens contamination.

Validity

The observers were recruited and assessed to ensure quality and consistency of the recording of variables. A pilot run was held during which each observer recorded data while under direct supervision. The observers logged data onto a standardized pro-forma containing all relevant variables. This also included a time-line sheet which permits for easy recording. The pro-forma allowed for a valid conduction of analysis.

RESULTS

Overall, 25 laparoscopic procedures were observed, equating to 63 hours and 50 minutes of data recorded. We logged a total of 382 lens contamination events spanning across the 25 operations observed, averaging into 15.3 lens contamination events recorded per operation. A total of 64.7% of lens contamination events were classified as minor compared with 35.3% of which were major. All 25 operations observed showed at least one episode of lens contamination. Only 1 procedure proceeded without a cleaning event taking place. One laparoscopic procedure was abandoned midway in preference for an open laparotomy due to adhesions.

The study found that on average, 6.9% of the operational time was spent cleaning the laparoscope. In total, 312 cleaning events were logged; equating to 2 hours and 41 minutes spent removing contamination on the distal lens. Only 56.3% of the operational time was the done with a clean image, while 36.9% of the time was spent with a suboptimal screen.

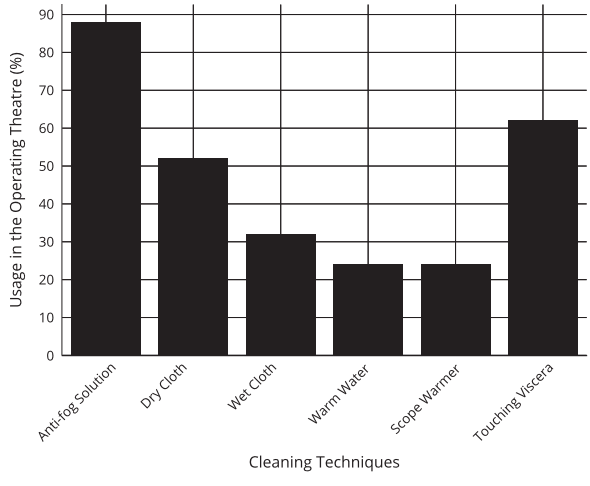

FIGURE 1. Cleaning techniques applied in the operating theater.

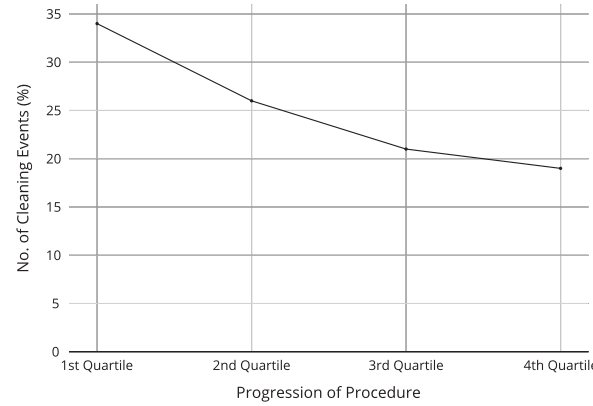

FIGURE 2. Number of cleaning events during a laparoscopic procedure.

Of the materials available, the most common method used during a laparoscopic procedure was the antifog solution (22/25 operations; 88%). Another prevalent practice was by means of touching a visceral organ (16/25 operations; 62%). The least frequently used methods were both the warm water and scope warmer (6/25 operations; 24% each). Other types of cleaning the laparoscope included the use of a sterile cloth which was either dry or applied with saline (Fig. 1).

The data also revealed that while cleaning activities happen throughout the operation, the initial quarter of a laparoscopic procedure logged the most amount of cleaning events (34% of all cleaning activities). There was a downward trend on the frequency of cleaning activities with only 19% of cleaning events occurring at the final quarter of the operation (Fig. 2).

Our study showed that among the surgical staff members, 56% of lead surgeons were involved during cleaning events intraoperatively. In total, 48% and 20% of the first assisting surgeons and scrub nurses, respectively, were implicated in cleaning the laparoscope intraoperatively.

The responses of the interviews showed a collective acceptance that cleaning the laparoscope was a necessary task. However, many of them felt frustrated having to complete this task repeatedly during a procedure, particularly those with a longer duration. A pediatric surgeon highlights the fact that the lens often used within his field is smaller; therefore becoming more prone to lens contamination than his adult counterparts. Some of the surgeons have also mentioned that not only is the task of removing and re-insertion of the scope longwinded, it also breaks the fluidity while performing a procedure. Although it is agreed that safety cannot be compromised, 1 surgeon said that sometimes if there is a small amount of contamination or it is a particularly difficult phase of the operation, then it is acceptable to proceed.

DISCUSSION

Lens contamination can be categorized into the following:

- Tissue products: adipose tissue, connective tissue.
- Bodily fluids: blood, bile, urine.
- Iatrogenic products: eschar, smoke, condensation of water vapor.[3,5]

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Intraoperatively, lens contamination is an issue and more effort is being placed to reduce its implications within laparoscopic surgery. Lawrentschuk et al[3] have categorized these methods into 4 broad mechanisms:

(a) Mechanisms to warm the laparoscope.
(b) Antifogging solutions.
(c) Equipment modifications to the laparoscope.
(d) Miscellaneous.

Many methods included within (a) are applied with the knowledge that humidity and temperature levels affect the condensation process, although these techniques are now frequently applied within the operating theater they prove to be of limited success in preventing fogging.[6] Novel modifications to the laparoscope such as titanium dioxide glass have been promising although not properly commercialized due to the lack of evidence and also the potential cost implications.[7] Alternatively, surgeons have also opted for low tech materials which are claimed to be better than conventional equipments in preventing fogging and contamination.[8–10]

Patient safety is of the highest priority when proceeding with a surgical procedure. Our study demonstrates significant amount of time spent with a compromised visualization of the viscera during a laparoscopic procedure. This is a factor which can increase procedural time and affect surgeons' operational performance; ultimately it compromises patient's safety.[2] Furthermore, operating with a suboptimal view increases the risk of surgical complications, prolongs operational delays, and potentially increases the financial costs.[3]

We were concerned that a great amount of lens contamination removal was achieved by touching the visceral organ. Yavuz et al[11] have conducted a study which showed that the light source attached onto the laparoscope can reach dangerously high temperature. Therefore any contact between the laparoscope and visceral tissue risks iatrogenic burning and damage, paradoxically leading to smoke and further fogging and contamination.[11–13] However, current guidelines recommend cleaning against visceral organs as being a recognized technique to regain clear intracorporeal view during surgery.[14]

Our study supports previous research which suggests cleaning the laparoscope can cause delays to a laparoscopic operation.[15] One of the reasons for this may be due to the need to remove and reinsert the laparoscope during a clean; as well as the time consumed when maneuvering the laparoscope after reinsertion to regain optimum view of the primary operation site.

Although a significant amount of time was spent with a contaminated lens, it is unclear from the results whether the contamination was sufficiently grave to impair the surgeon's view of the primary site. Retrospectively, collecting data on the length of time spent with minor as well as major contaminations would have aided our understanding of the circumstances.

Although literature has often noted the economic implications of lens contamination and cleaning, our study quantifies that the delays due to this issue is unlikely to be sufficiently significant to have an impact on the economic burden of laparoscopic surgery. Nonetheless, secondary issues led by suboptimal view such as intraoperative complications may potentially increase costs of procedures.

The responses of the interviews showed a collective acceptance that cleaning the laparoscope was a necessary task in laparoscopic surgery. However, most of them voiced their frustration of having to complete this task regularly. Some of the surgeons showed insight that the removal of the laparoscope during procedure compromises with the fluidity of movement. This was interesting as it reflected the falling trend in cleaning events as the operation progressed. It suggests that surgeons were often making conscious decisions either to delay the procedure by cleaning the lens or to press on with the procedure while visualization of the viscera is impaired.

Conventional ways of cleaning contaminations require the removal and reinsertion of the laparoscope which leads to surgical flow disruptions and time consumption; ultimately resulting in surgical errors.[16,17] This may be further implicated with the use of robotic surgical systems which are gaining popularity within the operating theater. Furthermore, the removal of the laparoscope causes the distal lens to equilibrate suddenly to room temperature. Hence upon reinsertion condensation occurs rapidly leading to vapors to form onto the lens shortly after a clean.[18]

In conclusion, our study demonstrates that lens contamination and fogging is an irritating and common occurrence during laparoscopic procedures. Many techniques have been developed to reduce its incidence; however they are often time consuming and lead to disruption of surgical flow. Hence, operations are often conducted with an impaired visualization of the viscera. We question the financial implications caused by operative delays due to lens contamination. Nonetheless, the data suggests there is still an unmet need within the device market. More effort should be focussed on ergonomically designed devices; ideally an automated ancillary device or one which is built into the laparoscope. This would aid to reduce the surgical disruptions, yet maintain a clear laparoscopic view throughout an operation.

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