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A Protocol to Recover Needles Lost During Minimally Invasive Surgery

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ABSTRACT

Background and Objectives: The loss of an instrument during a surgical procedure is a potentially dangerous medical event. Retained surgical needles are reported to cause chronic pain, chronic irritation, and organ injury. Surgical needles lost during minimally invasive surgery are particularly difficult to retrieve because of their diminutive size and the camera's limited visual field, often prompting protracted recovery attempts that can add to surgical costs. Few detailed recommendations exist for the recovery of a misplaced needle.

Methods: A survey was administered to minimally invasive surgeons across the United States to glean observations on the incidence of lost surgical needles and recovery techniques. Survey results were incorporated into an evidence-based protocol designed to expedite the recovery of lost surgical needles.

Results: Three hundred five minimally invasive surgeons from 11 surgical subspecialties completed the survey. Sixty-four percent of participants reported having experienced a lost surgical needle, with a minimum of 112 needles lost during the past 1 year alone. Urologists, pediatric surgeons, and bariatric surgeons reported higher rates of needle loss than surgeons practicing other subspecialties ($P = .001$). Removal of a needle through a minimally invasive port and laparoscopic suturing were the 2 most common situations resulting in lost needles. A systematic visual search, abdominal radiography, fluoroscopy, and the use of a magnetic retriever were reported as the most successful strategies for needle recovery.

Conclusions: On the basis of survey results and current literature, our protocol incorporates a camera survey of the abdomen, intraoperative fluoroscopic radiography, port inspection, and a quadrant-based systematic visual search for the recovery of needles lost during minimally invasive surgery.

Key Words: Surgical needle, Minimally invasive surgery, Retrieval, Protocol.

INTRODUCTION

The loss of an instrument during a surgical procedure is an infrequent yet potentially dangerous event.[1] Estimates of the incidence of retained surgical instruments and sponges range widely from 1 in every 1000 to 18 760 operations, corresponding to at least 1 case per year for a typical large hospital.[1,2] Retained surgical objects are associated with multiple negative outcomes, including prolonged operative time, patient injury, prolonged hospital stay, readmission, and reoperation.[3] In addition, medicolegal costs associated with retained instruments are high, with an average cost of $95 000 per incident.[4] Loss of surgical needles is challenging to surgeons because of small needle size and the tendency to shift locations during a search. During minimally invasive surgery, the challenge is enhanced because of the diminutive size of the needles used, the limited visual field of the camera, and difficulty manipulating structures within the body. Retained needles have been reported to cause chronic pain, chronic irritation, and organ injury.[5–7] Although the reports are scarce, the incidence of needles lost and subsequently recovered within the same surgical procedure may be quite high because needles are the most numerous objects used during surgery.[8] A 2007 study projected between 800 and 1000 cases that year after open abdominal and gynecologic surgeries alone,[9] and one institutional study found incorrect needle counts to account for 76% of all near-miss events.[10]

The danger of retained foreign bodies and the resulting costs have led to multiple efforts to prevent the loss of items during surgery. Common operating room (OR) practices now include surgical counts, barcode and radiofre-

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quency identification technology, and the implementation of routine postoperative radiographs. Societies such as the Association of Perioperative Registered Nurses have published several iterations of guidelines for sponge, sharp, and instrument counts. Although these protocols have proved useful in accounting for items used in the OR, there are few detailed recommendations regarding the recovery of a lost or misplaced needle. Most available protocols have greater applicability to OR ancillary staff than to the surgeon. A recent advisory statement by The Joint Commission stressed the high number of incidents of retained foreign objects after robotic surgery that were reported to its Sentinel Event database and advised that standardized processes must be implemented during robotic surgery to ascertain for these objects and facilitate their recovery.[11]

Most available guidelines for lost surgical items focus on preventing surgical items from being misplaced. Few, however, offer detailed instructions on the needle-recovery process. A directive published by the Veterans Health Administration of the US Department of Veterans Affairs states that in the case of an inaccurate surgical count, "the surgeon must stop closing the wound and proceed with a methodical wound examination while the OR staff continues to look for the missing surgical item." In addition, "It is imperative that a reasonable and appropriate search of the operative field and surrounding area be undertaken to recover the item." The directive also states that "[a] radiograph of the entire surgical field to rule out a retained surgical item must be performed . . . when the surgical count is 'incorrect' . . . and the surgical item in question is not recovered."[12]

Similarly, the Association of Surgical Technologists' *Recommended Standard of Practice for Counts* endorses "a visual search of the sterile field and nonsterile field" along with an "exploration of the abdomen or cavity" at the surgeon's discretion.[13] An intraoperative radiograph is also recommended if the item is still not found. The Association of Perioperative Registered Nurses' *Recommended Practices for Sponge, Sharp and Instrument Counts* offers some recovery recommendations, including the use of radiographic imaging for significantly sized needles, depending on the operative site.[14] No Thing Left Behind, a 10-year-old educational Web site dedicated to the prevention of retained surgical instruments, recommends an intraoperative radiograph for all lost needles >15 mm in size.[15]

To address these issues and further understand their scope, we administered a survey to a large group of minimally invasive surgeons across the United States to glean real-world observations on needle recovery. We then developed a protocol for the recovery of a lost needle with a focus on the surgeon. Our hope is that the implementation of these new guidelines will increase the likelihood of needle recovery and decrease the time needed to do so.

METHODS

A 15-question survey was developed for minimally invasive surgeons to assess the incidence of needle loss during minimally invasive surgery and to ascertain other factors germane to the subject. An anonymous electronic survey was selected as the method of distribution because some questions could potentially be construed as reflections on surgical skill. An invitation to participate in the anonymous survey was issued in January 2014 to 2027 members of the Society of Laparoendoscopic Surgeons representing various subspecialties; reminder E-mails were sent once per week over the course of 1 month. Each question had preformulated multiple-choice answers, as well as a free-response space if applicable. Completed surveys were automatically collected and collated by a single Web site dedicated to questionnaire-based research (Survey Monkey, Palo Alto, California). Free-response answers were coded into groups such that their frequency could be assessed in the same manner as the preset multiple-choice answers.

Participants were asked to select their primary surgical specialty, focus of practice (academic, private, government), and most minimally invasive surgery techniques used in their practice (eg, laparoscopy, robotic surgery, single-site laparoscopy). Experience was determined by number of years in practice. Participants were asked to record the number of times they had experienced a lost needle, the most common situations in which needles were lost, factors that they believed influence needle loss, the amount of time spent in needle recovery, the location in which needles were found, resulting complications, and strategies most successful for finding lost needles. Statistical analyses including frequency measurements and χ^2 analyses were performed with the SPSS software package (IBM, Armonk, New York).

When creating our protocol, we used information gathered from the questionnaire along with our own familiarity with needle recovery, including our experience with 174 needle recovery attempts from our previous investigation of a magnetic needle-retrieval device.[16]

RESULTS

The survey was completed by 305 minimally invasive surgeons, for a response rate of 15%. Respondents represented 11 different surgical subspecialties (general surgery, bariatric surgery, colorectal surgery, pediatric surgery, thoracic surgery, surgical oncology, trauma surgery, gynecologic surgery, orthopedic surgery, vascular surgery, and urology). Most respondents described their practice as private (73.3%), whereas 24.7% and 2% described their practice as academic and public/government/Veterans Affairs, respectively. General laparoscopy was performed by 97.6% of participants, 55% performed robotic surgery, and 27% performed single-site laparoscopy (single-port laparoscopy, laparoendoscopic single-site surgery, and so on). Surgical experience varied widely; 42.4% of participants had been in practice for >20 years, 39% for 10 to 20 years, 12.5% for 5 to 10 years, and 6.1% for <5 years. Participant characteristics are summarized in **Table 1**.

Most participants (63.8%) reported having experienced a lost needle during minimally invasive surgery, defined as a surgical needle that was misplaced or became obscured for any duration of time. The responses of the respondents who experienced needle losses are summarized in **Table 2**. Of these, nearly half had experienced a needle loss within the past 1 year (46%) with a minimum of 112 needles lost. Most respondents with needle loss experience reported 1 to 5 needle loss incidents during minimally invasive surgery over their careers (89.6%), 6% reported 6 to 10 incidents, 2.7% reported 11 to 20 incidents, and 1.7% reported >20 incidents.

The most common situation that resulted in needle loss was during the removal of a needle from a minimally invasive port, resulting in 80.23% of incidents. Other situations included laparoscopic suturing (18.64%), assistant error (17.51%), and the introduction of a needle through a port (13.56%). Needle size, obese patient body habitus, and equipment malfunction (eg, broken needle tip, detachment of intracorporeal knot-tying instrument parts) were most frequently selected as risk factors for needle loss by respondents. Of those who had experienced recent needle loss, 8.1% reported searching for <1 minute before recovering the needle, 42.2% searched for 1 to 5 minutes, 26.5% searched for 5 to 15 minutes, 7% searched for 15 to 30 minutes, and 13% searched for >30 minutes; 3% were unable to recover the needle after a prolonged search. Recovered needles were most frequently located in the operating field (eg, table, tray), in the loops of the bowel, in the pelvis, in the paracolic gutters, and within the trocar itself. Only 3% of respondents reported adverse

Table 1.
Participant Characteristics (N = 305)

	%
Surgical field	
Gynecology	38.7
General	33.5
Urology	12.3
Bariatric	6.7
Colorectal	2.8
Pediatric	2.8
Trauma	1.4
Oncology	0.7
Thoracic	0.3
Orthopedic	0.4
Vascular	0.4
Practice type	
Private	73.3
Academic	24.7
Public/government/Veterans Affairs	2.0
Time in practice	
<5 y	6.1
5–10 y	12.5
10–20 y	39
>20 y	42.4

Table 2.
Needle Loss Experience

	%
Needle loss during MIS[a] (N = 305)	
Yes	63.8
No	36.2
Needle loss during career (n = 195)	
1–5 times	89.6
6–10 times	6
11–20 times	2.7
>20 times	1.7
Needle loss during past 12 mo (n = 88)	
1 time	77.3
2–5 times	21.6
6–10 times	1.1

[a]MIS = minimally invasive surgery.

events due to needle loss; 2 respondents reported reoperating to recover the needle, and 2 reported lacerations, 1 each to the spleen and liver. Of the 185 respondents who indicated having experienced needle loss, only 14% reported the incidents as surgical errors to administrators.

Strategies used to successfully remove needles were a systematic visual search, abdominal radiography, a random visual search, and fluoroscopy. Only 5.4% of respondents who had experienced a lost needle recommended against recovery attempts if the needle size was small. Other methods proposed by respondents for recovery included the use of a magnetic device and withdrawing the camera to increase the breadth of the visual field.

In this cohort surgical specialty was statistically related to the likelihood of needle loss, with bariatric surgeons, pediatric surgeons, and urologists reporting the highest incidences of needle loss (91.7%, 75%, and 75%, respectively; $P = .001$). Surgeons with greater needle loss experience (defined as >5 career incidents) were not found to report faster needle recovery times than those who had experienced fewer lost needles ($P = .286$). Similarly, a greater number of years in surgical practice was not associated with faster recovery times ($P = .694$). Both robotic laparoscopy and single-site laparoscopy were associated with a higher likelihood of needle loss than general laparoscopy ($P < .001$ and $P = .006$, respectively).

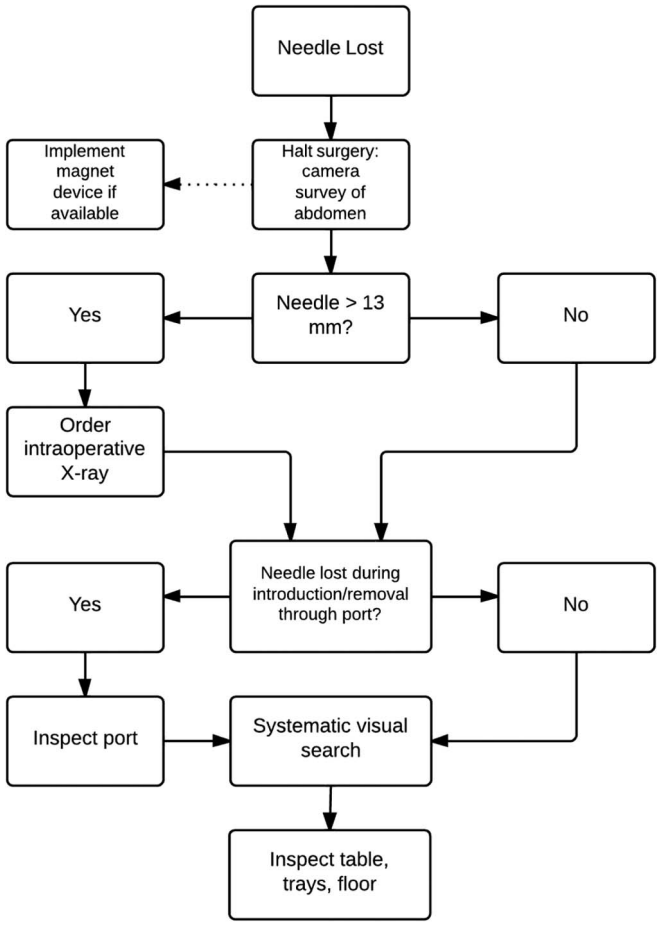

Figure 1. Protocol for recovery of surgical needle lost during minimally invasive surgery. Each step assumes failure to recover the needle during the prior step.

DISCUSSION

Needles lost during minimally invasive surgery present a unique challenge to surgeons. Difficulties in recovery arise from the small size of these needles and the camera's inability to view the entire operative field at one time. Current protocols for recovery involve a visual search and subsequent intraoperative imaging.[17] On the basis of the results of our survey, we propose a more detailed protocol for the recovery of needles lost during abdominal minimally invasive surgery (**Figure 1**):

1. Halt surgery: A survey of the entire abdomen should be performed via a slow pan of the camera. We recommend against using instrumentation in an immediate search because this was reported by participants to increase the chance of a needle shift into areas more visibly obscured. Every effort should be made to avoid moving the patient, instruments, or items on or near the surgical table. OR staff should be informed of the lost needle and of the need to refrain from moving or jostling equipment on or near the operating table.
2. Port inspection: If needle loss occurred during needle introduction or removal from a port, a careful visual inspection of the port should follow the first visual scan of the abdomen. Port inspection is relatively simple and was a technique that resulted in many recoveries by survey respondents. It should thus be carried out early in the recovery process.
3. Magnetic retrieval: Use of a magnetic needle retriever was a technique recommended by several survey respondents as a reliable and rapid method for recovery. An intracorporeal magnetic retrieval device should thus be implemented early in the recovery process if readily available.
4. Imaging: Intraoperative imaging should be ordered very early in the recovery process in anticipation of transport delays and given the ease of cancellation. We recommend ordering an intraoperative fluoroscopic ra-

diograph with a mobile image intensifier for needles sized 13 mm or larger, in accordance with studies on the ability to visualize small needles.[18] Imaging should be put to use immediately on arrival.

5. Systematic visual search: A systematic visual search of each quadrant should be carried out in a clockwise or counterclockwise fashion if intraoperative imaging fails to locate the needle. The use of a quadrant search system allows for a methodical exploration and takes into consideration the limited scope of most cameras. To shorten recovery time, we recommend taking into account patient positioning (eg, Trendelenburg position) and beginning the search in the quadrant in which the needle is most likely to shift because of gravity. Manipulation of structures is required to perform a thorough visual search of obscured areas, although any manipulation should be performed gently and to a minimal extent. If the patient is in a neutral position, we recommend beginning the search at the left upper quadrant because of the large area obscured by the liver:
   - The right lobe of the liver should be retracted anteriorly to expose the perihepatic space for visual inspection. Careful attention should be paid to areas in which the needle may have become lodged, such as the apposition between the inferior duodenal flexure and the transverse colon.
   - The left lobe of the liver should be retracted anteriorly to expose the superior aspect of the gastric fundus. Next, the body of the stomach should be gently retracted laterally to expose the spleen, and a visual search around the periphery of the posterior splenic attachments should be made.
   - Both right lateral and left lateral paracolic gutters should be thoroughly inspected.
   - A controlled run of the bowel should be conducted, beginning with the descending colon and running in reverse in the direction of the duodenum. We recommend applying gentle anterior traction to the bowel segments to properly visualize the needle if shaken loose.
   - Visual inspection of the inferior abdomen and superior pelvis should be made, with attention to areas adjacent to the bladder.
6. Operating table and floor: A systematic visual search of the OR table and drapes, along with the assistant's table and trays, should be conducted. If the search is still unfruitful, careful inspection of the floor near and around the table should be made.

Important aspects of this protocol are early intraoperative imaging based on needle size and a systematic, easily reproducible search of the abdominal cavity. We designed our protocol with the most "high-yield" techniques for needle recovery to be carried out earlier in the recovery process. More tedious techniques with lower yield per unit of time, such as running of the bowel, are carried out once other locations have been searched. The efficacy of magnetic retrieval devices has been shown recently in our own investigation and investigations at other institutions.[16,19] Our previous research indicates that an articulating magnetic needle retriever can increase the speed of recovery by >10-fold. Devices for the retrieval of ferrous metallic objects, such as the ConMed Magnetic Retriever (ConMed, Utica, New York), have recently become commercially available. We recommend the use of one of these magnetic devices, if readily available, early in the recovery process because of their speed, general ease of use, safety, and effectiveness.

Our protocol aims to offer a high likelihood of quick needle recovery. Although some surgeons have likened small needles (ie, <13 mm) to surgical clips in that their likelihood of causing injury is low, we still advocate a thorough search.[7] With recent malpractice suits awarding up to $2.6 million for patients with retained surgical needles, we believe that a methodical recovery attempt is warranted.

We also advocate the use of intraoperative imaging early in the recovery process for appropriately sized needles because its speed and accuracy of needle detection. A study of 100 US hospitals conducted in 2005 found that OR charges averaged $62 per minute, with a range of $22 to $133 per minute.[20] In this setting of exceedingly high operating costs, swift recovery of any misplaced surgical item is imperative.

The question of what to do when a needle has not been recovered remains controversial. A needle large enough to carry a high risk of injury if retained should also have a high likelihood of being identified on intraoperative radiography. If still unsuccessful, computed tomography may be helpful in precisely identifying the lost needle, especially if embedded in the viscera.[19] The disadvantages of computed tomography include the inability to be carried out at the time of the operation and exposure to higher doses of radiation. In the event that a smaller needle cannot be recovered, good ethical practice dictates informing the patient. The patient should be told of possible symptomatology and made aware that future magnetic

resonance imaging poses a negligible risk given that surgical needles are not ferromagnetic.[8]

Our study and this new protocol are not without limitations. Although we based our protocol on the experience of hundreds of surgeons and possibly thousands of needle loss incidents, our protocol has not yet been systematically tested in a trial setting. This type of study could be carried out in porcine or canine models, although anatomic differences may preclude a realistic investigation of each step in the proper sequence. Another drawback is the inability to examine individual cases or case logs to ascertain the precise reporting of incidences of events. There is currently not a standard code for a lost needle, making more exact population-level analysis of this issue difficult.

Although this study focuses on the recovery of lost surgical needles, prevention of needle loss is paramount. Simple tactics, such as a check of the tensile strength of the connection between suture and needle, as well as slow withdrawal of needles and instruments through a trocar, may help to reduce the number of lost needle incidents.

CONCLUSION

The loss of surgical needles is a relatively common occurrence during minimally invasive surgery that poses risks to both the patient and the surgeon. A standardized protocol for a lost needle may increase the likelihood of needle retrieval and decrease the amount of time spent during the recovery process.

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