Comparison of Spinal vs General Anesthesia via Laryngeal Mask Airway in Inguinal Hernia Repair

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Hypothesis: The use of laryngeal mask airway and propofol in inguinal hernia repair results in shorter operative and recovery room times.

Design: Randomized control trial.

Setting: University hospital.

Patients: From May 2000 to March 2002, a convenience sample of 79 patients was invited to participate; 34 entered the study. Fifteen patients were randomized to subarachnoid block, and 18 patients were randomized to laryngeal mask airway. No patients withdrew from the study because of adverse effects. All study subjects were followed up for 6 months.

Intervention: General anesthesia via laryngeal mask airway or lidocaine subarachnoid block anesthesia for inguinal hernia repair.

Main Outcome Measures: Operative and recovery room times; surgeon evaluation of the adequacy of the anesthetic technique; 36-Item Short-Form Health Survey scores before and after operation.

Results: Total time from entry into the operating room to discharge home was slightly longer in the subarachnoid block group (285 vs 262 minutes; 95% confidence interval, 251-317 minutes) but this difference was not statistically or clinically significant. Patient satisfaction was high with both techniques; patient-reported outcomes were the same. Surgeons rated muscle relaxation and exposure better with the subarachnoid block.

Conclusions: We found no differences between short-acting spinal anesthesia and general anesthesia via laryngeal mask airway with intravenous propofol in efficiency or in early or late outcomes after elective inguinal hernia repair. Surgeon and patient preferences appear to be the most important reasons for selecting an anesthetic technique for individual patients undergoing inguinal hernia repair.


Inguinal hernia repair is a common surgical procedure almost always performed in the outpatient setting. Patients who are otherwise healthy expect to undergo this operation with little or no anesthetic risk, minimal discomfort, rapid recovery from anesthesia, and early discharge home. The choice of anesthetic techniques ranges from local infiltration to regional or subarachnoid block to general endotracheal. For a patient with no coexisting morbidities, this choice may be made on the basis of the complexity of the procedure and its expected duration, the preferences of the surgeon and the anesthesiologist, the wishes of the patient, or any combination of these. Cost and efficiency are additional considerations.

Although many inguinal hernia repairs are done using local anesthesia and sedation, most repairs in the United States, including those at our hospital, are done under general or regional anesthesia. There are many reasons for this. Not all surgeons are skilled in local anesthetic techniques, local or regional block may not be adequate to provide the exposure or relaxation needed for repair, substantial intravenous (IV) sedation is often required, and not all patients are good candidates for operation under local anesthesia for both anatomical and psychological reasons.

The most commonly used regional anesthesia technique is subarachnoid block (SAB) with either hyperbaric lidocaine or isobaric bupivacaine, depending on the expected duration of the operation. Subarachnoid block has the advantage of avoiding paralytic agents and endotracheal intubation, but has the disadvantage, particularly when bupivacaine is used, of being associated with slow recov-
ery of sensory and motor function, long recovery room times, and urinary retention.

Until recently, general anesthetic techniques have required the use of endotracheal intubation. When this technique is used, slow recovery from the anesthetic agent and nausea can delay discharge home from the hospital or ambulatory surgery center. The introduction of the laryngeal mask airway (LMA) and IV propofol as a general anesthesia technique has revolutionized the practice of outpatient anesthesia. Patients recover from propofol anesthesia rapidly, muscle paralysis is not required since patients breathe spontaneously, and there is a rapid transition to discharge from the postanesthesia care unit (PACU).

In this randomized study, we compared the use of 2 anesthetic techniques for inguinal hernia repair, both of which promise low risk and rapid recovery time: SAB with lidocaine and LMA with IV propofol. The purpose of this study was to compare the recovery time profile, incidence of complications, patient and surgeon satisfaction, and costs between these 2 anesthetic techniques. We hypothesized that general anesthesia using IV propofol and LMA would result in shorter recovery time, better postoperative control of pain, less nausea and vomiting, and higher patient satisfaction than SAB when used for inguinal hernia repair. The null hypothesis was that there would be no difference in outcomes between patients receiving SAB and those receiving LMA with propofol.

Five primary outcomes were evaluated: (1) total time in the operating room and the PACU; (2) incidence of adverse effects during the recovery period, including postoperative pain, coughing, and readmission; (3) surgeon satisfaction with the adequacy of anesthesia (subjective measure); (4) cost of the 2 anesthetic techniques from the perspective of the institution; and (5) patient satisfaction with the anesthesia experience. We also evaluated changes in overall health status and recorded times to return to normal activities of daily living and to work.

ANESTHETIC TECHNIQUES

Group 1 patients underwent neuraxial block using a 27-gauge Whitacre spinal needle in either a sitting or lateral decubitus position. Five percent lidocaine with 7.5% dextrose was injected into the subarachnoid space, after which the patient was placed in the supine position. Group 2 patients were preoxygenated with 100% oxygen via face mask. Two milligrams per kilogram of propofol premixed with 2% lidocaine to prevent pain on infusion was administered intravenously. At loss of eyelid reflex, an appropriate LMA (size 3 for females and size 4 for males) was positioned in the back of the throat, and the cuff was inflated with 20 mL of air. Accurate LMA positioning was confirmed by auscultation and the appearance of end-tidal carbon dioxide on the capnograph. Anesthesia was maintained in most patients, with nitrous oxide–oxygen in the ratio of 70%:30%, and isoflurane in the ratio of 1:1.5 minimum alveolar concentration. Fentanyl was intravenously titrated to a respiratory rate of 18 to 20/min. The surgeon placed an ilioinguinal nerve block in all patients, using 8 to 10 mL of 0.5% bupivacaine after the skin incision but before any fascial incision to diminish postoperative pain, regardless of group.

 METHODS

A convenience sample of American Society of Anesthesiology (ASA) class I or II patients scheduled to undergo elective, unilateral standard inguinal hernia repair in the Section of General Surgery at University of Michigan Medical Center (Ann Arbor) were invited to participate in the study. Patients were enrolled in the study at the time of preoperative history and physical examination, which usually took place separately from the patient’s initial surgical consultation and evaluation. All men or women in classes I or II and aged 18 years or older were eligible to be included. Patients undergoing operation for recurrent hernia or bilateral hernia were excluded, as were pregnant patients, those in prison, patients with mental impairments; patients with allergy to lidocaine and those at increased risk of aspiration or anticipated airway problems, severe arthritis, serious heart disease, or history of substance abuse were also excluded.

Eligible patients were randomly assigned to 1 of 2 groups. Group 1 patients were randomized to receive SAB with lidocaine at operation. Group 2 patients received a general anesthetic via LMA and IV propofol. Randomization was carried out using a blocked and balanced random number table. A sealed opaque envelope with the randomization assignment was opened only after the patient had given informed consent for the study. No investigative or experimental treatments, anesthetic agents, or protocols were used. The institutional review board of the University of Michigan medical center reviewed and approved the study protocol.

At the time of enrollment, each patient was asked to complete the 36-Item Short-Form Health Survey (SF-36) as well as a preoperative condition-specific inguinal hernia questionnaire. Two weeks after operation, patients were given a postanesthesia satisfaction questionnaire to complete, usually during their first postoperative clinic visit. Two months after operation, patients were once again asked to complete the SF-36 and a condition-specific health status survey. Six months after operation, patients were once again asked to complete the study.

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 PACU RECOVERY PERIOD

There were 2 PACU phases of care. In phase 1, all patients were monitored for heart rate, blood pressure, respiratory rate, electrocardiogram assessment, alertness, wakefulness, pain level, nausea/vomiting, itching, urine output, headache, backache, sore throat, and medications required. A research assistant, who met the patient in the PACU, recorded this information. When patients were alert and anesthetic effects were wearing off, they were transferred to phase 2 PACU, where they were prepared for discharge. All patients were required to urinate satisfactorily prior to discharge. The research assistant recorded specific outcomes measures, including time in the operating room, time in phase 1 recovery, time ready for transfer to phase 2 recovery, time in phase 2 recovery, time ready for discharge, and time actually discharged home. Cost data were obtained for all patients from the hospital data warehouse, which contains data obtained with the Transition Systems Inc (Boston, Mass) system.

STATISTICAL ANALYSIS

The main outcome measure was time required for full patient recovery and discharge after inguinal hernia repair. We recorded the time required for the recovery process in both phase 1 and phase 2 PACU as well as the total length of time the patient was physically located in the recovery rooms before discharge.

Computations were done with the SAS statistical computing package (SAS Institute, Cary, NC). Data were analyzed with...
regard to the following variables: body habitus, comorbidity, type of anesthesia, type of surgical repair, surgeon, satisfaction with adequacy of anesthesia and muscle relaxation, postoperative nausea or vomiting, pain, urinary retention, satisfaction with pain control, nausea and vomiting control, and postoperative complications. Simple descriptive statistics were used to verify the balance of the randomization, using such variables as age, sex, and ASA classification. Univariate statistics were used to summarize the outcomes of interest described above. Bivariate statistics were used to determine differences between the 2 anesthetic groups using the t test. Nonparametric statistics were used if the distributions in either group were nonnormal. Comparisons between groups of discrete data were done using the Fisher exact test for expected cell values in 2 tables less than 5. P values of .05 or less were considered statistically significant. We estimated that at this level, and with a power of .80 and a difference of 23.6 minutes. A detailed breakdown of operating room and recovery room times is presented in Table 2. The total time in the operating room for group 1 patients was 79 minutes; for group 2 patients, it was 90 minutes. Phase 2 PACU times were longer for group 1 patients, who were slower to void satisfactorily.

At the time of discharge, 3 (20%) of 15 patients in group 1 had a pain score of 4 (of 10) or higher. In group 2, 6 (38%) of 16 patients had a pain score of 4 or higher. Twelve (80%) of 15 patients in group 1 and 17 (94%) of 18 in group 2 received pain medication in the PACU. Nonnarcotic medication was used to detect a 45-minute difference from the time in the PACU to discharge readiness from the PACU between the 2 anesthetic groups. This was felt to be a clinically significant difference.

### RESULTS

Between May 2000 and March 2002, a total of 132 patients were screened; 79 patients met protocol inclusion criteria and were invited to participate in the study. Of the 79, 34 (43%) agreed to participate and 45 declined. One patient dropped out of the study after randomization but before the operation, leaving 33 patients who completed the study protocol. Fifteen (45%) of the 33 patients were randomized to SAB with lidocaine (group 1), and 18 were randomized to LMA with IV propofol (group 2). One patient assigned to group 2 inadvertently underwent SAB. This patient was left in group 2 for analysis, which was done on the basis of intention to treat. Isoflurane per protocol was used in 10 patients to supplement the propofol. Comparison of the groups receiving LMA with propofol vs LMA with propofol and isoflurane revealed no significant differences. They are therefore reported as a single group for all analyses. No patient had general endotracheal anesthesia.

The main results are summarized in Table 1. The total time from the beginning of the operation until discharge from the PACU was 285.4 minutes (95% confidence interval [CI], 251-317 minutes) for group 1 and 261.7 minutes (95% CI, 223-293 minutes) for group 2, a difference of 23.6 minutes. A detailed breakdown of operating room and recovery room times is presented in Table 2. The total time in the operating room for group 1 patients was 79 minutes; for group 2 patients, it was 90 minutes. Phase 2 PACU times were longer for group 1 patients, who were slower to void satisfactorily.

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### Table 1. Results of Randomized Comparison of SAB and LMA With Propofol for Inguinal Hernia Repair

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Time to Discharge (95% CI), min</th>
<th>Pain Score &gt;4 at Discharge, %</th>
<th>Nonnarcotic Medication in PACU, %</th>
<th>Narcotic Medication in PACU, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAB with lidocaine (n = 15)</td>
<td>285.4 (251-317)</td>
<td>20</td>
<td>40</td>
<td>67</td>
</tr>
<tr>
<td>General anesthesia via LMA with IV propofol (n = 18)</td>
<td>261.7 (223-293)</td>
<td>38</td>
<td>39</td>
<td>94</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; IV, intravenous; LMA, laryngeal mask airway; PACU, postanesthesia care unit; SAB, subarachnoid block.

*P = .07.

### Table 2. Detailed Operating Room and Recovery Room Times for Patients Undergoing Inguinal Hernia Repair

<table>
<thead>
<tr>
<th>Group</th>
<th>Operating Room, min</th>
<th>Phase 1 PACU Ready for Discharge to Phase 2, min†</th>
<th>Phase 1 PACU Actual Discharge to Phase 2, min</th>
<th>Phase 2 PACU Actual Discharge to Home, min‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAB with lidocaine (n = 15)</td>
<td>79</td>
<td>53</td>
<td>80</td>
<td>129</td>
</tr>
<tr>
<td>General anesthesia via LMA with IV propofol (n = 18)</td>
<td>90</td>
<td>83</td>
<td>98</td>
<td>78</td>
</tr>
</tbody>
</table>

Abbreviations: IV, intravenous; LMA, laryngeal mask airway; PACU, postanesthesia care unit; SAB, subarachnoid block.

*P<.006.

†P=.02.
analgesia as good or excellent in all 15 patients in group 1 and in 14 (78%) of 18 patients in group 2 (Table 3). They rated muscle relaxation and exposure as good or excellent in 14 (93%) of 15 patients in group 1 and in 13 (72%) of 18 patients in group 2. Surgeons rated overall satisfaction for the anesthetic technique as good or excellent in all 15 group 1 patients and in 13 (72%) of 18 group 2 patients ($P = .05$). Patient satisfaction with anesthetic technique was high in both groups (Table 3). All 15 patients in group 1 agreed or strongly agreed that they were satisfied; the 14 patients in group 2 who answered the question responded similarly (2 patients in group 2 failed to answer the question).

Cost data from the Transition Systems Inc system was available on 31 of 33 patients. The total average cost per patient in group 1 was $1663. The total average cost in group 2 was $1748. The difference of $75 was not statistically significant. Preoperative and postoperative patient-reported health status by the SF-36 is shown in the Figure. Patients were in good general health compared with the national norms for men and had better than average scores in social and emotional function. Preoperative physical role limitations and bodily pain were corrected by operation.

Most published studies of anesthetic techniques for inguinal hernia repair have compared local anesthesia with other anesthetic techniques to promote the safety and efficacy of operation under local anesthesia at a time when general endotracheal anesthesia was the norm. Recovery time and time to discharge are significantly reduced when local anesthesia is used compared with general or regional techniques, but patient satisfaction is lower when local anesthesia is used without sedation and monitoring. A very recent randomized study compared the effects of general anesthesia via LMA and local anesthesia on postoperative cognitive function and found no difference in that or in patient satisfaction.

In our randomized trial comparing short-acting spinal anesthesia using lidocaine and general anesthesia using LMA with IV propofol for inguinal hernia repair, we found no significant differences in recovery times or in early or late patient outcomes. The total time from entry into the operating room until the time of discharge readiness was 24 minutes longer (8.4%) in the SAB group than in the LMA group. This difference was the result of longer time spent in phase 2 PACU and, while measurable, is relatively small. It is not of sufficient magnitude to influence clinical decision making regarding anesthetic preference, other things being equal. The results of this study, therefore, support the contention that individualization of anesthetic techniques to best meet surgeon and patient preferences can be carried out without concern for differences that may result in postoperative recovery, such as time in the recovery room, if either a short-acting SAB or LMA and propofol technique is chosen.

In a study similar to ours, Song et al also compared recovery times after ambulatory inguinal hernia repair under regional nerve block with sedation (including propofol), general anesthesia with LMA and propofol, and SAB with 0.75% bupivacaine in a total of 81 patients. They found that recovery room times measured from the end of operation to discharge were much longer with the long-acting bupivacaine SAB than with LMA and propofol (280 vs 171 minutes). Total (anesthesia, operative, and recovery) times in this study were also a good deal longer than in our study, for LMA and propofol (327 vs 258 minutes) and for SAB (425 vs 284 minutes). Using the short-acting agent, lidocaine, for SAB dramatically reduces recovery time and virtually eliminates problems with urinary retention that occur with longer-acting SAB agents.

At the beginning of the study, we empirically chose 45 minutes as the magnitude of difference likely to be clinically relevant, believing that it would take a difference of that magnitude to justify a change in clinical practice. We closed the study after examining the data at the 2-year interval, when it became apparent that a huge number of patients would have to be enrolled to find a statistically significant difference. Based on the data at hand, we believed...

Table 3. Patient and Surgeon Satisfaction (Agree/Strongly Agree) With Anesthetic Technique

<table>
<thead>
<tr>
<th>Anesthetic Technique</th>
<th>Patient Satisfaction Overall, %</th>
<th>Surgeon Satisfaction With Relaxation, %</th>
<th>Surgeon Satisfaction With Analgesia, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAB with lidocaine (n = 15)</td>
<td>100</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td>General anesthesia via LMA</td>
<td>88</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>General anesthesia with IV propofol (n = 18)</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
</tbody>
</table>

Abbreviations: IV, intravenous; LMA, laryngeal mask airway; SAB, subarachnoid block.

* $P = .05$.
that given a sufficient time and a much larger number of patients enrolled, we could have proven a statistically significant difference, but the difference found would not have been clinically or operationally significant.

One unanticipated aspect of the study was the surprisingly low rate of recruitment. During a 2-year period, we were able to enroll only 34 of 79 eligible patients scheduled for elective inguinal hernia repair. This was a very low rate compared with our experience in recruiting patients into other clinical studies. One explanation for the low rate of recruitment may be that many patients come with preconceived ideas or concerns regarding the type of anesthesia they would like to have or are willing to accept. An alternative and perhaps better explanation is that patients may have a hard time participating in a randomized study that compares 2 obviously quite different anesthesia techniques, even though neither technique is experimental and each technique is equally efficacious and safe as far as we know. Further investigation of this phenomenon would be of interest.

Other parameters of interest were surgeon and patient satisfaction. Surgeon satisfaction was higher with SAB than with LMA and propofol, related primarily to the degree of muscle relaxation that was present. Most of these patients had primary open Cooper ligament repairs without mesh. In strong, muscular patients, exposure for this type of repair was easier to obtain with SAB. It is possible that there might have been less need for relaxation had mesh repairs been done on all patients, but this is speculative, and a separate study would be required to test this hypothesis. There was no difference in patient satisfaction with the anesthetic experience between SAB and LMA with propofol. This is good evidence that the 2 techniques studied are equivalent from the patient point of view among patients with no strong preconceived preferences.

The chief limitation of this study was our inability, despite best efforts, to recruit as many patients as we had expected to. While we are comfortable with the results and conclusions we have described, we obviously cannot be as confident about them as we could have been had we been able to recruit 60 to 70 patients as originally planned.

Another weakness of the study is that most of the patients who declined to participate did so because of pre-existing anesthesia preferences or concerns about randomization to what were quite different anesthesia techniques. Thus, we cannot comment on whether patients with preconceived preferences would have been just as happy with an alternate technique. The patients that did enroll in the study had higher than average social and emotional function. We do not have SF-36 data from those who declined to participate.

We found no major differences in early or late patient outcomes between short-acting spinal anesthesia and general anesthesia with LMA and propofol for outpatient inguinal hernia repair. Both techniques were highly satisfactory to surgeons and patients, and were associated with acceptable postoperative recovery times. Surgeon and patient preferences, therefore, remain the most important factors for selecting an anesthesia technique for individual patients.

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REFERENCES