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Comparison of the Costs and Recovery Profiles of Three Anesthetic Techniques for Ambulatory Anorectal Surgery

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Background: **Given the current practice environment, it is important to determine the anesthetic technique with the highest patient acceptance and lowest associated costs. The authors compared three commonly used anesthetic techniques for anorectal procedures in the ambulatory setting.**

Methods: **Ninety-three consenting adult outpatients undergoing anorectal surgery were randomly assigned to one of three anesthetic treatment groups: group 1 received local infiltration with a 30-ml mixture containing 15 ml lidocaine, 2%, and 15 ml bupivacaine, 0.5%, with epinephrine (1:200,000) in combination with intravenous sedation using a propofol infusion, 25–100 $\mu g \cdot kg^{-1} \cdot min^{-1}$; group 2 received a spinal subarachnoid block with a combination of 30 mg lidocaine and 20 μg fentanyl with midazolam, 1–2-mg intravenous bolus doses; and group 3 received general anesthesia with 2.5 mg/kg propofol administered intravenously and 0.5–2% sevoflurane in combination with 65% nitrous oxide. In groups 2 and 3, the surgeon also administered 10 ml of the previously described local anesthetic mixture at the surgical site before the skin incision.**

Results: **The mean costs were significantly decreased in group 1 ($69 ± 20 compared with $104 ± 18 and $145 ± 25 in groups 2 and 3, respectively) because both intraoperative and recovery costs were lowest ($P < 0.05$). Although the surgical time did not differ among the three groups, the anesthesia time and times to oral intake and home-readiness were significantly shorter in group 1 (*vs.* groups 2 and 3). There was no significant difference among the three groups with respect to the postoperative side effects or unanticipated hospitalizations. However, the need for pain medication was less in groups 1 and 2 (19% and 19% *vs.* 45% for group 3; $P < 0.05$). Patients in group 1 had no complaints of nausea (*vs.* 3% and 26% in groups 2 and 3, respectively). More patients in group 1 (68%) were highly satisfied with the care they received than in groups 2 (58%) and 3 (39%).**

Conclusions: **The use of local anesthesia with sedation is the most cost-effective technique for anorectal surgery in the ambulatory setting. (Key words: Cost–benefit; monitored anesthesia care; pharmacoeconomics; fast-track anesthesia.)**

HEMORRHOIDS and other anorectal disorders occur in 4 or 5% of the adult population in the United States. Symptoms related to perirectal disease lead to more than one million physician consultations per year.[1] Although the majority of these patients can be treated conservatively, many patients require anorectal surgery. Therefore, anorectal surgical procedures are among the most common surgical operations, with more than 90% of these procedures performed on an ambulatory basis.[2,3]

The optimal anesthetic technique would provide for excellent operating conditions, a rapid recovery, no postoperative side effects, and high patient satisfaction. In addition to increasing the quality and decreasing the costs of the anesthetic services, the ideal anesthetic technique would also improve operating room (OR) efficiency and provide for an early discharge. Local infiltration anesthesia, spinal anesthesia, and general anesthesia are all commonly used anesthetic techniques for anorectal surgery. However, opinions differ as to what is the best anesthetic technique for this surgical procedure.[4,5]

We designed this study to test the hypothesis that the use of local anesthesia combined with propofol sedation was superior to both general and spinal anesthesia with respect to recovery times, postoperative side effects, patient satisfaction, and total costs to the healthcare institution.

Materials and Methods

After obtaining institutional review board approval at the University of Texas Southwestern Medical Center in Dallas, 93 consenting outpatients with American Society of Anesthesiologists physical status I–III, aged 24–65 yr, who were scheduled for anorectal surgery procedures were enrolled in this study. A computer-generated random-number table was used to assign patients to one of the following three anesthetic treatment groups: local anesthesia with propofol sedation (group 1); spinal anesthesia with midazolam sedation (group 2); or general anesthesia with tracheal intubation (group 3). Patients with clinically significant cardiovascular, respiratory, renal–hepatic, or metabolic disease, as well as mental dysfunction or morbid obesity, were excluded. The study protocol permitted the use of general anesthesia if adequate surgical conditions were not obtained with the local anesthesia–sedation or spinal anesthetic techniques

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used for patients assigned to groups 1 and 2, respectively.

All patients were premedicated with 2 mg midazolam, administered intravenously. In group 1, patients received topical 2% lidocaine gel and sedation–analgesia with 75 $\mu g \cdot kg^{-1} \cdot min^{-1}$ propofol and 0.5 μg/kg fentanyl intravenously before the local anesthetic infiltration. The local anesthetic solution (30 ml) consisted of 15 ml lidocaine, 2%, and 15 ml bupivacaine, 0.5%, with epinephrine (1:200,000) and was infiltrated according to the technique of Nivatvongs.[6,7] The propofol infusion was titrated to maintain a stable level of sedation in which the patient was resting comfortably but was responsive to verbal or light tactile stimulation (Observer's Assessment of Alertness–Sedation score of 3, with 5 = awake/alert and 1 = asleep).[8] In group 2, patients received spinal anesthesia using a standard midline approach in the sitting position. A solution containing 30 mg lidocaine and 20 μg fentanyl was injected through a 25-gauge pencil-point needle into the subarachnoid space at the L2–L3 or L3–L4 interspace. Supplemental midazolam, 1–2-mg intravenous bolus doses, were administered for sedation. Fentanyl, 0.5-μg/kg intravenous bolus doses, were administered to treat patient discomfort during the surgical procedure in groups 1 and 2. In group 3, anesthesia was induced with 2.5 mg/kg propofol and 1–2 μg/kg fentanyl administered intravenously, and tracheal intubation was facilitated with 1 mg/kg succinylcholine administered intravenously. Anesthesia was maintained with 0.5–2% sevoflurane (end-tidal concentration) combined with 65% nitrous oxide in oxygen. In groups 2 and 3, the surgeon infiltrated the anorectal area before the skin incision with 10 ml of the previously described local anesthetic mixture.

Mean arterial pressure, heart rate, and hemoglobin oxygen saturation values were recorded at 5-min intervals throughout the operation. The duration of surgery (from incision to placement of the dressing) and anesthesia (from the first dose of intravenous propofol or spinal puncture to departure from the OR), the postanesthesia recovery score[9] on arrival in the phase 1 and 2 recovery units, and the time to achieve a modified Aldrete score of 10 were recorded. In addition, the times to sitting up, standing up, tolerating oral fluids, ambulating, discharge from the phase I unit (after achieving a modified Aldrete score of 10), and discharge home from the phase 2 unit were recorded by a blinded investigator (Dr. S. Li) who did not know which of the anesthetic techniques the patients had received. If the patient achieved a fast-tracking score[10] of 12 or greater before leaving the OR, they were admitted directly to the phase 2 recovery area.

Home-readiness was determined using a standardized postanesthetic discharge scoring system. The discharge criteria stipulated that the patients be awake and alert with stable vital signs, able to ambulate without assistance, void, and be free of intractable side effects. During the recovery period, ondansetron 4 mg administered intravenously, was given to patients who vomited or those who requested antinausea therapy. Patients who complained of pain received 25 mg meperidine, administered intravenously, if they rated their pain as severe, and 5 mg/500 mg hydrocodone–acetaminophen, administered orally, if their pain was mild to moderate. Side effects during the perioperative period (*e.g.*, nausea, vomiting, and pain), as well as the requirements for rescue medications were recorded. Patient interviews were conducted by phone 24 h after discharge home by the same blinded investigator to assess side effects, therapeutic interventions, and satisfaction with the anesthetic experience.

Cost Analysis

The perspective used in the cost analysis was that of the chief financial officer of an ambulatory surgery center. The marginal costs of drugs and resources used were calculated based on the actual acquisition costs to the center and not based on patient charges. These calculations included the costs of anesthetic drugs administered (and wasted) in the OR and analgesic and antiemetic drugs administered in the recovery area (table 1). Drugs and resources that were common to all three groups (*e.g.*, electrocardiogram leads, pulse oximeter probes, intravenous catheters and administration sets) were not included. The cost of sevoflurane was calculated using the formula:[11]

$$\text{COST} = \text{delivered concentration} \cdot \text{fresh gas flow} \cdot \text{time} \cdot \text{molecular weight} \cdot \text{cost of 1 ml})/(2{,}412 \cdot \text{density of sevoflurane})$$

Table 1. Basic Cost Assumptions for the Economic Analysis

	Cost (USD)
Anesthetic equipment costs	
Infusion pump tubing and disposables	1.68
Spinal tray, gloves, needle, lidocaine	10.54
Endotracheal tube, circuit, suction	9.10
Salter nasal cannulae	2.55
Anesthetic drug costs	
Midazolam, 2 mg	4.40
Propofol, 200 mg	15.00
Succinylcholine, 100 mg	4.26
Fentanyl, 100 μg	1.89
Sevoflurane, 250-ml bottle	189.00
Lidocaine, 2% (30 ml)	0.60
Bupivacaine, 0.5%, with epinephrine (1:200,000) (30 ml)	4.26
Recovery unit drug costs	
Ondansetron, 4 mg	16.35
Hydrocodone–acetaminophen, 5 mg/500 mg	0.50
Meperidine, 25 mg	0.66
Recovery unit resources costs	
Emesis management (per episode)	2.50
Oxygen delivery equipment	0.66
Nursing labor cost (hourly)	22.00

USD = United States dollars.

Table 2. Patient Demographics, Type of Surgery, Intraoperative Fluid Intake, and Supplemental Fentanyl Dosage in the Three Anesthetic Groups

	Local Anesthesia with Sedation	Spinal Anesthesia	General Anesthesia
Number	31	31	31
Gender (M/F) (n)	22/9	21/10	24/7
Age (yr)	40 ± 9	43 ± 10	41 ± 9
Weight (kg)	83 ± 18	82 ± 16	82 ± 22
Height (cm)	171 ± 11	169 ± 8	172 ± 10
ASA physical status (I/II/III) (n)	10/18/3	10/16/5	11/15/5
History of smoking (n)	15	17	16
HIV-positive (n)	7	5	8
Type of surgery (n)			
Hemorrhoidectomy	13	10	7
Fistulotomy	7	12	11
Excision of pilonidal cyst	2	4	5
Fulguration of condyloma	8	4	5
Sphincterotomy	1	1	3
Intraoperative intravenous fluid (ml)	476 ± 167	897 ± 356*	842 ± 374*
Fentanyl (μg)	90 ± 33	95 ± 78	159 ± 73*†
Propofol (mg)	203.2 ± 150.0	NA	169.7 ± 72.4
Sevoflurane (ml)	NA	NA	28.4 ± 7.6
Lidocaine–bupivacaine (ml)	29.7 ± 3.6	11.1 ± 2.1*	10.6 ± 2.2*
Midazolam (mg)	1.9 ± 0.2†	3.0 ± 0.6*	1.9 ± 0.2†

Values are mean ± SD and number.

* $P < 0.05$ *versus* local anesthesia with sedation. † $P < 0.05$ *versus* spinal anesthesia.

ASA = American Society of Anesthesiologists; HIV = human immunodeficiency virus; NA = not applicable.

The costs of resources used in the recovery area for managing and treating postoperative pain and nausea were included in the total costs. Nursing labor cost were based on the actual time spent by the nurse with a patient and prorated for the number of patients cared for at that time. For patients in the phase 1 unit, the nurse: patient ratio was 1:2, and in the phase 2 unit it was assumed to be 1:5, in keeping with the recommendations of the American Association of Postanesthesia Care Unit Nursing. The total cost of each anesthetic technique was calculated by summing the costs of anesthetic drugs and supplies, nursing labor, and resources used.

Statistical Analysis

An *a priori* power analysis based on previously published data[11–13] suggested that a minimum of 29 patients in each group would be required to detect a 30% reduction in total institutional costs, with a power of 90% at the $\alpha = 0.05$ level of significance. This group size would also be adequate to detect a 25% difference in time to home-readiness among the anesthetic groups with a power of 80% ($\alpha = 0.05$). It was also decided to analyze data on an intent-to-treat basis, where data from patients who required general anesthesia when the sedation–local anesthesia or spinal anesthesia technique failed, were included in the original assignment group. Continuous data were analyzed using one-way analysis of variance, and if significant differences were noted, a Newman-Keuls test was used for intergroup comparisons. Categoric data were analyzed using the chi-square test with Yates continuity correction or Fisher exact test, where appropriate. A P value less than 0.05 was considered statistically significant.

Results

There were no significant differences among the three groups with regard to demographic characteristics and types of operation performed (table 2). There were no anesthetic failures in groups 1 and 2 that required rescue with general anesthesia. The mean arterial pressure, heart rate, and hemoglobin oxygen saturation values did not significantly differ among the three groups preoperatively (data not presented). Compared with the baseline values, intraoperative mean arterial pressure values decreased an average of 10% in group 2, and heart rate values were increased by 12% and 10% in both groups 1 and 3 ($P < 0.05$).

The costs of drugs and supplies used in the OR were significantly lower in the group receiving spinal anesthesia and significantly higher in the general anesthesia group compared with the other two groups (table 3). However, the average time spent in the OR (per case) was significantly increased in the spinal and general anesthesia groups compared with the local sedation group because of the longer anesthesia times (table 4). When the time-related costs of labor in the OR were included in the total intraoperative costs, the use of local anesthesia with sedation was associated with the lowest mean costs, whereas the general anesthesia group had the highest mean costs. Although there were no significant differences in the costs of drugs used in the recov-

Table 3. Incremental Costs Associated with the Three Anesthetic Techniques*

	Local Anesthesia with Sedation	Spinal Anesthesia	General Anesthesia
Intraoperative costs			
Drugs	23.16 ± 9.29	3.92 ± 1.35†	48.22 ± 7.72†‡
Supplies	4.23 ± 0.27	13.29 ± 0.35†	9.1 ± 0.24†‡
Total OR drugs + supplies	27.39 ± 9.39	17.21 ± 1.55†	57.32 ± 7.89†‡
OR labor costs	36.34 ± 14.04	66.30 ± 15.17†	68.45 ± 14.04†
Total intraoperative costs	63.73 ± 20.69	83.50 ± 15.17†	125.78 ± 20.69†‡
Recovery costs			
Drugs	0.10 ± 0.20	0.63 ± 2.92	1.80 ± 4.94
Supplies	0	0.15 ± 0.47†	0.80 ± 0.82†‡
Nursing labor costs			
Phase 1	0	9.46 ± 3.22†	8.04 ± 4.94†
Phase 2	5.20 ± 1.23	9.94 ± 3.22†	8.79 ± 3.78†
Total	5.20 ± 1.23	19.40 ± 8.87†	16.83 ± 6.14†
Total recovery costs	5.29 ± 1.39	20.37 ± 9.15†	18.63 ± 9.96†
Perioperative costs			
Total drug costs	23.26 ± 9.25	4.55 ± 3.68†	50.03 ± 8.50†‡
Total supplies	4.23 ± 0.27	9.72 ± 0.46†	13.44 ± 0.47†‡
Total labor costs	41.54 ± 13.88	85.67 ± 17.83†	85.29 ± 18.79†
Total perioperative costs	69.02 ± 20.39	103.68 ± 18.13†	145.02 ± 25.31†‡

* Values are mean ± SD in United States dollars (USD). † $P < 0.05$ *versus* local anesthesia with sedation. ‡ $P < 0.05$ *versus* spinal anesthesia.
OR = operating room.

ery units (table 3), nursing labor cost was significantly lower in the local anesthesia–sedation group compared with the other two groups because all of these patients achieved fast-tracking criteria in the OR and were able to bypass the more labor-intensive phase 1 unit and were fast-tracked directly to the phase 2 unit where the nurse–patient ratio was 1:5.

The times to oral intake, to achieve a modified Aldrete score of 10, to home-readiness, and to actual discharge were significantly shorter in group 1 than in groups 2 and 3 (table 4). On arrival in the phase I or phase II recovery units, the Aldrete scores reached 10 for all patients in group 1, compared with 13% and 3% for groups 2 and 3 (with median scores of 10, 9, and 8 for groups 1, 2, and 3, respectively; $P < 0.05$). There was no significant difference in the incidences of hypotension, vomiting, headache, pruritus, dizziness, urinary retention, and unexpected hospitalizations after surgery (table 5). Only one patient in group 3 had to be hospitalized, and it was related to postsurgical hemorrhage. No patients required postdischarge readmission for the management of anesthetic-related complications. No patient was dissatisfied with the anesthetic care they received.

Discussion

Anorectal surgical procedures account for a large proportion of elective ambulatory surgical cases. A major goal of outpatient anesthesia is to provide for a rapid throughput and early discharge without side effects, thereby facilitating perioperative efficiency. Although the surgery times were identical in all three study groups, the anesthesia time was 44–47% shorter in the local anesthesia–sedation group (table 4). The cost benefit of more rapid turnover of cases and earlier discharge (*i.e.*, less disruption of lifestyle, less infection risk, and potential cost saving) can be realized only when institutional practices permit fast-tracking of the patients through the perioperative process.[10,14] Both general and spinal anesthesia are associated with well-known postoperative side effects (*e.g.*, headache, nausea, vomiting,

Table 4. Surgical, Anesthetic, and Recovery Times for the Three Anesthetic Groups

	Local Anesthesia with Sedation	Spinal Anesthesia	General Anesthesia
Duration of anesthesia (min)	40 ± 15	72 ± 17*	75 ± 19*
Duration of surgery (min)	26 ± 14	26 ± 13	26 ± 15
Phase 1 stay (min)	0	52 ± 18*	44 ± 27*
Phase 2 stay (min)	71 ± 17	135 ± 113*	120 ± 52*
Time to oral intake (min)	12 ± 5	59 ± 18*	60 ± 29*
Aldrete score on arrival in recovery unit (n)	10 ± 0	9.1 ± 0.4*	8.3 ± 0.7*†
Time to Aldrete score of 10 (min)	0	19 ± 7*	30 ± 19*†
Time to home-readiness (min)	76 ± 17	193 ± 112*	171 ± 58*
Duration of hospital stay (min)	116 ± 21	266 ± 112*	247 ± 65*

Values are mean ± SD.
* $P < 0.05$ *versus* local anesthesia with sedation. † $P < 0.05$ *versus* spinal anesthesia.

Table 5. Postoperative Adverse Events with the Three Anesthetic Groups*

	Local Anesthesia with Sedation	Spinal Anesthesia	General Anesthesia
Side effects			
Hypotension	0	2 (6)	2 (6)
Pain (medication requested)	6 (19)	6 (19)	14 (45)†
Nausea	0	1 (3)	8 (26)†
Vomiting	0	1 (3)	1 (3)
Headache	1 (3)	0	0
Pruritus	0	2 (6)	0
Dizziness	1 (3)	0	0
Urinary retention	0	2 (6)	1 (3)
Supplemental oxygen in recovery	0	4 (13)	27 (87)†
Overnight hospitalization	0	0	1 (3)
Acceptable surgical conditions (%)	100	100	100
Patient satisfaction			
Highly satisfied	21 (68)	18 (58)	12 (39)‡
Satisfied	10 (32)	13 (42)	19 (61)‡

* Value are numbers and percentages [n (%)]. † $P < 0.05$ *versus* local anesthesia with sedation and spinal anesthesia. ‡ $P < 0.05$ *versus* local anesthesia with sedation.

drowsiness, sore throat, backache, urinary retention) that delay patient discharge and decrease patient satisfaction.[14] However, the availability of pencil-point spinal needles and the newer short-acting anesthetics has reduced the incidence of complications associated with spinal and general anesthesia, respectively.[15]

In the early 1950s, Schneider[16] introduced a modified local anesthesia infiltration technique that has subsequently gained widespread acceptance for anorectal surgery.[6,7,17] In recent years, the availability of improved sedation techniques to complement local anesthetic infiltration has increased the popularity of surgery performed with so-called monitored anesthesia care (MAC).[18] This study has shown that the MAC technique is associated with highly acceptable surgical conditions, excellent patient satisfaction, short recovery times, and low costs that compared favorably with both spinal and general anesthetic techniques for outpatient anorectal surgery procedures.

The time required to achieve a state of home-readiness[14,18,19] is influenced by a wide variety of surgical and anesthetic factors. The major contributors to delays in discharge after anorectal surgery are nausea, vomiting, dizziness, pain, and prolonged motor blockade.[20] Although the incidence of postoperative nausea and vomiting can be decreased with the use of newer anesthetic and antiemetic drugs, it remains a common side effect after general anesthesia and prolongs discharge after ambulatory surgery.[21] In our study, there was a significantly higher incidence of nausea but not vomiting or retching after general anesthesia. The primary factor delaying discharge after spinal anesthesia was recovery from the residual motor blockade and sympatholytic effects of the subarachnoid block. Patients were considered "home-ready" based on institutional discharge criteria, which included urination and the ability to ambulate. These criteria were consistent with those published by Marshall and Chung[15] and Korttila.[22] All patients in the MAC group achieved fast-tracking criteria[10] before leaving the OR and were therefore able to bypass the phase 1 recovery unit.

The cost savings with the use of newer anesthetic techniques are lost if institutional nursing practices mandate minimum stays in the phase 1 unit and do not permit fast-tracking directly to the phase 2 unit. Claims of reduced total costs with earlier discharge are based on the assumption that there is a linear relationship between the costs of a service and the time spent providing it. However, personnel costs are semifixed, not variable, and an additional 15–30-min stay in the phase 1 unit may not be associated with increased costs to the institution unless it is working at capacity. In that situation, a longer stay is potentially associated with a "bottleneck" in the flow of patients through the OR suites and may require overtime payments to the nurses or the hiring of additional personnel. There is a much closer relation between lower costs and bypassing of the phase 1 unit as the major factor in recovery care costs relates to the peak number of patients admitted to the phase 1 unit at any time.[23] Fast-tracking may permit the use of fewer nurses and a mix of less highly trained, lower-wage nursing aides and fully qualified nurses.

This study may be criticized for not examining changes in recovery unit hiring practices after implementation of a fast-tracking program. It can also be criticized for the use of sevoflurane and Diprivan (AstraZeneca, Wilmington, DE) rather than less expensive generic drugs (*e.g.*, isoflurane, propofol). However, with the availability of generic propofol, the costs to the institution when using local anesthesia and sedation would be expected to be even lower than in the present study. Similarly, if drug wasting is minimized, methohexital can be a cost-effective alternative to propofol for sedation during MAC.[24] More importantly, the cost savings associated with MAC would be even greater if additional cases were performed as a result of the shorter anesthesia time compared with both spinal and general anesthesia. Finally, the longer anesthesia times for the general and spinal anesthesia groups is related, in part, to the time required to perform these procedures before positioning the patient for the operation, and the additional time required after completing the procedure. All cases were performed by anesthesia trainees at a university-based teaching hospital.

It is important to determine patient acceptance of MAC techniques before widespread acceptance of this fast-tracking approach to providing ambulatory surgical care. It is also important to note that no patient failed local anesthesia–sedation or spinal anesthesia and required rescue with a general anesthetic technique during this study. Surgical conditions were satisfactory in all patients, and their satisfaction with the anesthetic services provided was high. However, the upper 95% confidence limits of the failure rate of sedation with a study of this size was 10%. In a larger scale study, there may have been some cases where spinal anesthesia and sedation failed, with a consequent decrease in patient satisfaction and an increase in total costs.

The high patient satisfaction with local anesthesia–sedation may be related to good control of postoperative pain and the absence of side effects, such as urinary retention, nausea, and vomiting, which were reported with the other two techniques. The success of the local anesthesia–sedation technique is also dependent on the skills of the surgeon in providing effective infiltration analgesia and gentle handling of the tissues. Extensive local anesthetic infiltration of the surgical field, as well as spinal blockade, can reduce rectal sphincter spasms and provides for better postoperative analgesia.[25] Acute urinary retention remains a well-known complication of spinal anesthesia[26,27]; however, use of smaller dosages of lidocaine (30 mg) combined with fentanyl (20 μg) contributes to a faster recovery of both motor and bladder function. Because the underlying cause of postoperative urinary retention after anorectal surgery is related, in part, to perineal pain,[26–28] the lower incidence of urinary retention in this study may be related to the use of local anesthetic infiltration to minimize the postoperative pain in all three groups.

Our findings suggest that there are clinically important advantages to the use of a local anesthesia–sedation MAC technique over both spinal and general anesthesia for anorectal surgery. These results are consistent with earlier studies involving patients undergoing inguinal hernia repair.[14,29] Shorter anesthesia time, the ability to bypass the phase 1 unit, and a decreased length of stay in the phase 2 unit with the use of the MAC technique reduces total costs to an institution.[30] In conclusion, use of local anesthetic infiltration combined with propofol sedation as part of a MAC technique decreased costs, postoperative side effects, and recovery times after outpatient anorectal surgical procedures.

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