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The Impact of Mivacurium and Rocuronium on Recovery Times in Ambulatory Anesthesia Procedures

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ABSTRACT

Purpose. This study was designed to evaluate the recovery times of patients undergoing ambulatory surgery with the short-acting, fast-emergence anesthetic muscle relaxants, mivacurium, and rocuronium.

Methods. After IRB approval, patients who received either mivacurium or rocuronium at five surgical centers were included in the analysis. The primary outcome was total time spent in the postanesthesia care unit (PACU) and/or second stage recovery unit. The ability to bypass the PACU was also evaluated.[1] The Wilcoxon rank sum test and chi-square test were used for comparisons. The interrelationships between patient characteristics, neuromuscular blocking agents, bypass of the PACU, surgery duration, surgical procedure, and use of reversal agent and inhalation agent were explored with a linear regression model. Statistical significance was defined as $p < 0.05$.

Results. A total of 344 patients received mivacurium and 190 patients received rocuronium. Recovery times and surgical times, stratified by type of neuromuscular blocking agent and by PACU requirements, are presented in the below table. Patients who received mivacurium had a shorter recovery time than patients who received rocuronium, $p < 0.0001$. In both groups, if a patient bypassed the PACU, the total recovery time was significantly shorter than if a patient needed care in the PACU, $p < 0.0001$. Surgical duration was statistically different between the mivacurium and rocuronium groups. Bypass rates for the PACU were 29.1% and 21.6% for the mivacurium and rocuronium groups, respectively, $p = 0.06$. The factors statistically related to total recovery time with a baseline duration of 144 minutes were mivacurium use (-18 minutes), bypass ability (-41 minutes), females (+19 minutes), ENT procedures (+21 minutes), and surgery duration > 1 hour (+24 minutes), $p < 0.05$.

	Mivacurium		Rocuronium	
	Did Not Bypass Mean (sd) min-med-max	Bypassed PACU Mean (sd) min-med-max	Did Not Bypass Mean (sd) min-med-max	Bypassed PACU Mean (sd) min-med-max
Total Recovery Time (min)	151.0 (79) 14-139-455	94.8 (56) 25-89-360	224.7 (120) 40-205-660	148 (77) 25-142-310
Total Surgery Time (min)	70.6 (49) 3-59-410	51.3 (28) 5-45-155	81.2 (42) 20-73-280	74.4 (36) 29-65-176

Conclusions. In ambulatory surgical procedures, total recovery time depends on multiple factors. The linear regression model demonstrated that recovery times were shorter with mivacurium than with rocuronium when patient characteristics, length of surgery, type of surgical procedure, and site effect were considered.

[1]Anesthesiology 2002; 97(1):66-74

INTRODUCTION

Residual paralysis after neuromuscular blockade can lengthen postoperative recovery and potentially influence ability to bypass the PACU in affected patients. In a retrospective analysis, Balantyne and Chang found mean postoperative recovery time was 30 minutes shorter in patients receiving short- and intermediate-acting muscle relaxants compared to those receiving long-acting agents.[1] Similarly, shorter-acting neuromuscular blocking agent use was associated with reduced time to tracheal extubation in patients undergoing CABG procedures.[2] In the ambulatory setting, administration of rocuronium (rapid onset with intermediate duration of action) rather than mivacurium (slower onset but shorter duration)[3,4] has potential implications for recovery duration and PACU bypass,[5] but has not been examined to date.

This analysis evaluates the influence of neuromuscular blocking agent selection and other pertinent factors on total recovery time and ability to bypass the PACU in patients who underwent an elective ambulatory surgery. Mivacurium and rocuronium are the specific neuromuscular blocking agents considered in this study.

METHODS

- Five hospital-based and free-standing ambulatory surgical centers
- Retrospective analysis
- 344 patients received mivacurium.
- 190 patients received rocuronium.
- Anesthesiologists were asked to evaluate patients in the operating room using recovery criteria traditionally used in the postanesthesia care unit. If the patient met the recovery criteria in the operating room, the patient bypassed the postanesthesia care unit and proceeded directly to a second stage recovery unit where the patient was prepared to go home.

METHODS, continued

Table 1: Short Acting Fast Emergence Recovery Criteria* for Admission to the Second Stage Recovery Unit**

- Patient should be awake, alert, oriented, responsive (or returns to baseline state).
- Pain should be minimal (unlikely to require treatment with parenteral medications).
- No active bleeding should occur (unlikely to require professional treatment).
- Vital signs should be stable (unlikely to require pharmacologic intervention).
- Nausea should be minimal.
- No vomiting should occur.
- If nondepolarizing neuromuscular blocking agent has been used, patient should now be able to perform a five-second head lift or train-of-four monitoring should indicate no fade.
- Oxygen saturation should be 94% or higher on room air (three minutes or longer) or oxygen saturation should return to baseline on room air.

*During the follow-up period, the patient should be evaluated in the operating room, immediately before discharge, using the above criteria regarding recovery from anesthesia. To bypass the postanesthesia care unit (PACU), a patient must meet all of these criteria and, in the judgment of the anesthesiologist, be capable of transfer to the second stage recovery unit.
**Anesthesiology 2002; 97(1):66-74

Inclusion Criteria

- Undergoing elective ambulatory procedures
- American Society of Anesthesiologists (ASA) physical status I, II, or III

Exclusion Criteria

- Inpatients, same-day admissions or 23-hour overnight-stay patients
- Undergoing emergency procedures or were ASA physical status IV or V

Data Collected

- Demographic information (e.g., age, sex, race, ASA classification, weight of the patient)
- Type of surgical procedure
- Anesthetic regimen and technique
- Time of critical events
- Use of an anticholinesterase agent
- Occurrence of adverse events
- Length of surgical procedure: defined as time induction began or block established to surgery end time
- Length of stay in postoperative recovery units: defined as time patient arrived in the postoperative care unit or the second stage recovery unit to time of patient discharge from the second stage recovery unit
- Whether patient bypassed the PACU

Statistics

- Outcome measures
  - Total length of time the patient spent in the recovery units
  - Whether a patient bypassed the PACU or not
- The Wilcoxon rank sum test, chi-square test, and Fisher's exact test were used (where appropriate).
- Statistical significance was defined as *p-value* < 0.05.
- A multivariable, backward selection, linear regression model was built to evaluate the interrelationship of factors related to patients' total recovery time. A *p-value* = 0.05 was used for removal of a factor from the model.

Demographic Results

- Differences in race and surgical duration existed between the patient groups.
- Patients receiving rocuronium were more likely to have intra-abdominal surgery (9.5% versus 2.9%) or general surgery (16.3% versus 8.1%), $p < 0.05$.
- Patients receiving mivacurium were more likely to have ENT surgery (19.5% versus 15.3%), $p < 0.05$.
- Patients administered rocuronium were more likely to experience vomiting (6.8% versus 2.9%), $p = 0.03$.
- Patients administered rocuronium were more likely to have unplanned hospital admissions after their surgery (3.7% versus 1.2%), $p = 0.05$.

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RESULTS

Table 2: Patient Demographics Stratified by Those Patients Receiving Mivacurium and Those Patients Receiving Rocuronium and Whether Patient Bypassed the PACU

		Mivacurium		Rocuronium		
Demographics	Categories	Bypass – No n (%)	Bypass – Yes n (%)	Bypass – No n (%)	Bypass – Yes n (%)	Significance
Age (years)	18 – 40	94 (48.7%)	49 (57.7%)	65 (49.2%)	20 (54.1%)	
	41 – 65	77 (39.9%)	31 (36.5%)	56 (41.5%)	15 (40.5%)	
	> 65	22 (11.4%)	5 (5.9%)	14 (10.4%)	2 (5.4%)	
Gender	Male	92 (38.0%)	32 (32.3%)	64 (42.3%)	14 (34.2%)	
	Female	150 (62.0%)	67 (67.7%)	85 (57.1%)	27 (65.8%)	
Race	Caucasian	229 (96.2%)	96 (98.0%)	127 (87.6%)	32 (82.1%)	1, 2, 3
	Other	9 (3.8%)	2 (2.0%)	18 (12.4%)	7 (18.0%)	
ASA Class	1	114 (47.1%)	49 (50.0%)	66 (36.7%)	23 (57.5%)	
	2	101 (41.7%)	43 (43.9%)	65 (39.2%)	16 (40.0%)	
	3	27 (11.2%)	6 (6.1%)	17 (38.6%)	1 (2.5%)	
Number of Comorbidities	< 4	228 (93.4%)	98 (98.0%)	140 (94.0%)	39 (95.1%)	
	≥ 4	16 (6.6%)	2 (2.0%)	9 (6.0%)	2 (4.9%)	
Surgery Duration	≤ 60 min	130 (53.5%)	69 (71.9%)	62 (41.6%)	19 (48.7%)	1, 2, 3
	> 60 min	113 (46.5%)	27 (28.1%)	87 (58.4%)	20 (51.3%)	

1 = $p < 0.01$ comparing mivacurium versus rocuronium
2 = $p < 0.01$ comparing mivacurium versus rocuronium in patients who did not bypass the PACU
3 = $p < 0.01$ comparing mivacurium versus rocuronium in patients who did bypass the PACU

Recovery Results

- Patients receiving mivacurium (121 min) had a shorter, median recovery time as compared to patients receiving rocuronium (190 min), $p < 0.0001$.
- In both the mivacurium and rocuronium patients, if the PACU was bypassed, the median total recovery time was significantly shorter than in patients who went to the PACU (mivacurium: 139 min versus 90 min; rocuronium: 205 min versus 142 min), $p < 0.001$.
- In the patients who bypassed the PACU, the patients who received mivacurium (median: 90 min) had a statistically significantly shorter recovery time than patients who received rocuronium (median: 142 min), $p < 0.0001$.
- This difference in recovery time was seen in several subpopulations including patients with a surgery duration ≤ 60 minutes, patients with a surgery duration 61-120 minutes, and whether or not a patient received a anticholinesterase agent.

Figure 1: Neuromuscular Blocking Agent Stratified by PACU Bypass

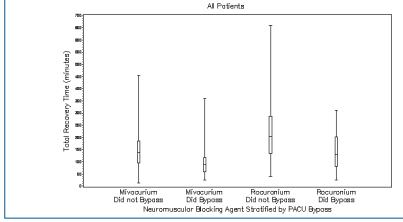


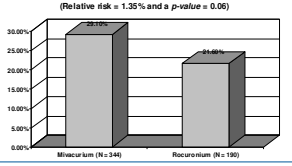
Table 3: Linear Regression Model of Total Recovery Time (minutes)

Factor	Parameter Estimate (Standard Error)	*p-value*
Mivacurium	**-17.7 (8.6)**	**< 0.0395**
PACU Bypass	-41.4 (7.5)	< 0.0001
Females	19.2 (6.7)	0.0044
ENT Procedure	20.8 (8.8)	0.0181
Surgical Duration > 60 Minutes	23.6 (6.6)	0.0004
Site 1	47.6 (12.1)	< 0.0001
Site 2	118.9 (12.7)	< 0.001
Site 3	-67.9 (7.7)	< 0.001
Intercept = 144 minutes		

Regression Results

- After controlling for several patient and surgical characteristics, patients receiving mivacurium still had an 18 minute shorter recovery time.
- As an example, a typical male patient who received mivacurium for a general procedure, bypassed the PACU, and had a surgical duration of 30 minutes would expect a total recovery time of 84.9 minutes. In the same scenario for a male patient who received rocuronium, the expected recovery time would be 102.6 minutes.

Figure 2: Postanesthesia Care Unit Bypass Rates Stratified by Mivacurium Use versus Rocuronium Use (Relative risk = 1.35% and a *p-value* = 0.06)



CONCLUSIONS

- In ambulatory surgical procedures, total recovery time depends on multiple factors.
- The linear regression model demonstrated that recovery times were shorter with mivacurium than with rocuronium typically by 18 minutes after adjustment and consideration for:
  - patient characteristics
  - length of surgery
  - type of surgical procedure
  - site effect
- Overall, the ability to bypass the PACU was not statistically dependent on the type of neuromuscular blocking agent administered. However, in patients who received a reversal agent (patients receiving mivacurium (50.0%) versus rocuronium (22.2%)) were more likely to bypass the PACU, $p = 0.0046$.

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