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Anesthesia-controlled time and turnover time for ambulatory upper extremity surgery performed with regional versus general anesthesia

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Abstract

Study Objective—To test the hypothesis that regional anesthesia (RA) employing a block room reduces anesthesia-controlled time for ambulatory upper extremity surgery compared with general anesthesia (GA).

Design—Retrospective cohort study.

Setting—Outpatient surgery center of a university hospital.

Patients—229 adult patients who underwent ambulatory upper extremity surgery over one year.

Interventions—Upper extremity surgery performed with three different anesthetic techniques: 1) GA, 2) nerve block (NB) performed preoperatively, or 3) local anesthetic (LA), either Bier block or local anesthetic, administered in the operating room (OR).

Measurements—Demographic data, anesthesia-controlled time, and turnover time were recorded. Since the data were not normally distributed, differences in anesthesia-controlled time and turnover time were analyzed using the Kruskal-Wallis test and post-hoc testing using one-way analysis of variance on the ranks of the observations, with Tukey-Kramer correction for multiple comparisons.

Results—Anesthesia-controlled time for NB (median 28 min) was significantly shorter than for GA (median 32 min, P=0.0392). Anesthesia-controlled time for patients who received LA (median 25 min) was also significantly shorter than GA (P<0.0001). However, turnover time did not differ significantly among the three groups.

Conclusions—Peripheral nerve block performed preoperatively in an induction area or LA injected in the OR significantly reduces anesthesia-controlled time for ambulatory upper extremity

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surgery compared with GA. Turnover time is unaffected by anesthetic technique. These results may increase acceptance of RA in the ambulatory surgery setting.

Keywords

Ambulatory surgery; orthopedic; anesthesia; regional; anesthesia-controlled time; operating room efficiency; turnover time

1. Introduction

Previous studies have shown the beneficial effects of regional anesthesia (RA), particularly peripheral nerve block techniques, on the quality and duration of postanesthetic recovery following outpatient orthopedic surgery [1–5]. Despite many reported advantages, RA techniques are not universally employed in the busy ambulatory surgery center setting. A survey of orthopedic surgeons showed that concerns about case delays and unpredictable block success remain barriers that prevent some surgeons from routinely recommending RA to their patients [6].

The use of a designated RA induction area, or "block room," to perform RA procedures preoperatively may reduce or even eliminate the time normally required for anesthesia induction [5]. Williams and colleagues showed that the use of a block room for RA decreases anesthesia-controlled time compared with GA for patients undergoing anterior cruciate ligament reconstruction [7]. Based on a previous Canadian study of brachial plexus block for upper extremity surgery, performing RA procedures outside of the operating room (OR) reduces pre-procedure anesthesia OR time [8]. However, pre-procedure OR time is only one component of anesthesia-controlled time, and we were determined to explore the additional OR time-related benefits of employing a block room model for RA. Therefore, we performed this study to test the hypothesis that RA for upper extremity surgery utilizing a block room reduces anesthesia-compared time compared with GA specifically in the ambulatory surgery setting.

2. Materials and methods

This study was approved by the Institutional Review Board at the University of California, San Diego School of Medicine.

2.1 Case Selection and Study Group Assignment

The OR scheduling database for a university hospital outpatient surgery center from September 1, 2004, through August 31, 2005 was reviewed. A new regional anesthesia service and training program utilizing a block room model was established the month prior to the start of this time interval.

Data from upper extremity orthopedic surgeries performed on the one day per week when both staff hand surgeons operated (due to block time allocation) were analyzed. This particular day was selected due to the high specialty-specific caseload, and therefore, increased demand for RA procedures.

Cases were grouped by anesthetic technique: 1) GA, 2) nerve block (NB) performed preoperatively in a block room with subsequent intravenous (IV) sedation administered intraoperatively, or 3) local anesthetic (LA), either IV RA (Bier block) or local anesthetic injection (metacarpal, wrist, or field blocks) administered in the OR with IV sedation.

The LA group was included for comparison with GA as an alternative type of RA performed in the OR that is appropriate for certain upper extremity surgical procedures and does not utilize a block room. First-case starts were excluded from analysis because anesthesia-controlled time and turnover time could not be computed for these cases. Patients who received combined GA-NB were excluded from the study due to possible confounding of anesthesia-controlled time by perioperative factors associated with a combined anesthetic technique (ie, use of positioning other than supine).

2.2 Block room model

Peripheral nerve block procedures of the brachial plexus were performed preoperatively in the RA induction area, a space reserved for RA procedures and equipped with standard ASA monitoring and resuscitation equipment. Third-year anesthesia residents (CA3) assigned specifically to the RA training rotation on a monthly basis performed all RA procedures under the direct supervision of RA faculty. The period of study occurred prior to the introduction of ultrasound-guidance to our practice; therefore, all nerve block procedures were performed using electrical nerve stimulation.

2.3 Definitions of outcome mMeasures

Anesthesia-controlled time was selected as the primary outcome of this study because we were most interested in the effect of anesthetic technique on time intervals under the direct influence of anesthesia practitioners. As a secondary outcome, we measured turnover time to determine the effect, if any, of anesthetic technique on this time interval.

Standard definitions from the Association of Anesthesia Clinical Directors’ Procedural Times Glossary for anesthesia-controlled time and turnover time were used [9,10]: **TOT** = time (min) from previous patient out of room to next patient in room; **ACT** = time (min) from surgical closure to out of room with previous patient + time (min) from next patient in room to anesthesia ready.

2.4 Statistical analysis

Descriptive statistics were used to summarize study data. Normality of distribution was determined using QQ plots and the Kolmogorov-Smirnov test (SAS Version 9; SAS Institute, Cary, NC, USA). Analysis of variance (ANOVA) was used for continuous, normally-distributed variables. The principal outcome variables of interest, anesthesia-controlled time and turnover time, were not normally distributed; therefore, nonparametric techniques were used for further statistical analysis. Differences in these outcome measures with regard to the type of anesthetic technique were evaluated using the Kruskal-Wallis test and post-hoc testing using one-way ANOVA on the ranks of the observations, with Tukey-Kramer correction for multiple comparisons. Since economic comparisons commonly measure differences in means rather than medians, mean anesthesia-controlled time values with 95% confidence intervals (CIs) for each group (Dunnett’s simultaneous CIs) were also calculated to provide further analysis using the GA group as the control. Pearson’s χ^2 or Fisher's exact test were used to analyze categorical variables. Statistical significance was accepted when $P<0.05$.

3. Results

Over the one-year study period, 344 upper extremity orthopedic surgery cases were performed on the day when both staff hand surgeons had block time. First-case starts and combined GA-NB were excluded, leaving 229 cases eligible for analysis. Demographic data are shown in Table 1. Age, gender, and ASA physical status distribution were similar among all three study groups. Median surgical duration was the same (70 min) for both the NB and GA groups. The LA group showed the shortest surgical duration among the three groups (median 19 min;

P<0.001). Surgical site was not evenly distributed (P<0.0001) with the distribution of cases in the LA group weighted heavily toward procedures limited to the hand.

Anesthesia-controlled time (median [interquartile range]) for the NB group utilizing a block room for preoperative RA procedures was significantly shorter than anesthesia-controlled time for the GA group (28 [15] min vs. 32 [12] min, respectively; P=0.0392). The reduction in anesthesia-controlled time for the LA group was also statistically significant compared with GA (25 [10] min vs. 32 [12], respectively; P<0.0001). Local anesthesia performed in the OR showed the shortest anesthesia-controlled time among the three groups (P=0.0246 vs. the NB group).

When mean anesthesia-controlled time values were compared, there was a reduction of 4.49 minutes when NB was used instead of GA, although this finding was not statistically significant based on CIs (95%CI: −9.38 – 0.40) since the interval included 0. Mean anesthesia-controlled time for the LA group was significantly shorter than GA by 9.83 minutes (95%CI: −15.25 – −4.40).

In contrast, a significant difference in turnover time was not detected between GA and either NB or LA (Table 2).

4. Discussion

Peripheral nerve block techniques performed preoperatively in a block room or LA administered in the OR significantly reduce anesthesia-controlled time for ambulatory upper extremity surgery compared with GA alone. The argument that RA delays cases by increasing pre-procedure or post-procedure OR time is not supported by our results.

Our study also showed that turnover time is unaffected by anesthetic technique, suggesting that turnover time depends greatly on factors other than choice of anesthesia, which is consistent with the findings of Williams et al [7]. A previous study performed for the main OR suites at our institution has shown that turnover time is consistent across most surgical subspecialties [10]. Preparing the OR between surgical cases incorporates the functions of environmental services, equipment sterilization, and nursing and surgical responsibilities (eg, marking the surgical site, verifying consent documentation, updating paperwork). All of these factors contribute to the turnover time interval, rendering turnover time a poor measurement of the impact of anesthetic technique on OR efficiency.

Certain local anesthetic techniques performed in the OR (IV RA and LA injections at the wrist or digits) generated the lowest anesthesia-controlled time of the three groups. These techniques are appropriate only for isolated hand or wrist procedures of limited duration. Although there is a clear advantage of LA over GA in anesthesia-controlled time, one should consider the site of surgery, tourniquet placement, duration of the procedure, and anticipated postoperative analgesic requirement when deciding on the proper RA plan.

At our institution, we use the block room model with one attending anesthesiologist and one resident dedicated to the preoperative administration of RA in a specialized induction area. Our study confirms the findings of Armstrong et al., who showed that the use of a block room for preoperative brachial plexus anesthesia reduces pre-procedure anesthesia OR time compared with brachial plexus anesthesia performed in the OR [8]. The results of these two studies performed at two different institutions and academic teaching programs with different patient populations and health care systems provide convincing evidence that a block room model reduces anesthesia-controlled time and does not delay cases.

The block room model is a “parallel processing” model that permits adequate time for teaching residents and for distal supplementation in the case of incomplete anesthesia prior to surgery [11]. The use of a block room has significantly increased the number of peripheral nerve blocks performed by residents in anesthesia training programs [11,12]. More time may be allotted to identifying surface anatomic landmarks and teaching various new approaches to peripheral nerve block without delaying surgical cases. By processing patients in parallel (ie, the next scheduled patient undergoes nerve block while the previous patient is still in the OR), teaching does not adversely affect OR efficiency. In spite of the fact that RA procedures were performed by trainees in this study, our results still show a reduction in anesthesia-controlled time.

Limitations of the present study include the retrospective design and lack of randomization, which introduce inherent bias. Cases and time intervals were identified from the OR scheduling database for inclusion in the analysis by an independent systems analyst so as to minimize selection bias. Although the sample size is relatively small for a retrospective study, there was sufficient power to detect a statistically significant difference in anesthesia-controlled time. Although it is speculative, the true difference in anesthesia-controlled time attributed to anesthetic technique alone may have actually been greater than that detected in our study. During the study period, the day chosen for analysis was particularly busy for our RA team (ie, one resident and one attending anesthesiologist) at the time who routinely performed RA procedures for patients undergoing joint replacement, orthopedic trauma, and outpatient foot/ankle surgery in addition to outpatient upper extremity surgery. Any delays in block placement due to an imbalance of supply and demand could have led to an underestimation of the true anesthesia-controlled time difference secondary to anesthetic technique alone (bias toward the null hypothesis). Perhaps the results of our study reflect a “real-life” estimate of the effect of RA on anesthesia-controlled time in a busy orthopedic surgery center. While retrospective studies are particularly useful for generating new hypotheses, a proper prospective study is warranted to confirm these results.

The decrease in anesthesia-controlled time resulting from RA techniques in our study had little impact on the number of surgical cases performed during a fixed period of time. Dexter et al. showed showed through computer modeling that even eliminating anesthesia-controlled time fails to facilitate the addition of surgical cases [13]. Regional anesthesia does not affect surgical time, a much greater determinant of the number of cases that can be performed in a given day [13,14]. Therefore, modest reductions in anesthesia-controlled time are unlikely to result in any meaningful economic benefit.

Although the reduction in anesthesia-controlled time does not affect caseload, our findings may increase the acceptance of RA in the outpatient surgery setting and promote RA training. When a block room is used, the proven benefits of RA to the ambulatory orthopedic surgery patient (eg, superior pain relief, less nausea and vomiting, rapid recovery and discharge) far outweigh any perceived risk of delaying cases.

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Table 1

Demographic data shown as n (%) unless otherwise specified.

	General anesthesia group n=67	Nerve block group n=99	Bier block/ local group n=63	P-value*
Age (yrs; mean±SD)	46±17	47±17	50±15	0.2119
Gender (male)	40 (60%)	58 (59%)	29 (46%)	0.2074
ASA-PS [median (IQR)]	2 (1)	2 (1)	2 (1)	0.8523
Surgical suration [min; median (IQR)]	70 (67)	70 (65)	19 (11)	<0.001†
Surgical site				<0.0001
Hand	40(60%)	54(55%)	60(95%)	
Wrist	14(21%)	24(24%)	3(5%)	
Forearm	5(7%)	14(14%)	---	
Elbow	6(9%)	6(6%)	---	
Humerus	---	1(1%)	---	
Shoulder	2(3%)	---	---	

The three study groups included patients receiving general anesthesia, those receiving a nerve block performed preoperatively, and those receiving local anesthetic, either Bier block or local anesthetic, administered in the operating room (OR).

ASA-PS=American Society of Anesthesiologists physical status.

* P-value is based on analysis of variance (ANOVA) for continuous normally-distributed variables, one-way ANOVA, on the ranks of the observations, with Tukey-Kramer correction for multiple comparisons for continuous non-parametric data, and Pearson's χ^2 test for categorical variables.

† Comparing Bier/local to nerve block and Bier/local to general. No difference was found between general and nerve block (P=0.9594).

Table 2

Turnover time in minutes as stratified by anesthetic technique.

Type of anesthesia	N	Turnover time (median and interquartile ranges)	P-value
General anesthesia	67	24 (12)	*
Nerve block	99	25 (20)	0.8765
Bier block or local anesthetic	63	21 (20)	0.9484

* P-value is based on one-way analyais of variance on the ranks of the observations, with Tukey-Kramer correction for multiple comparisons comparing general anesthesia with the other groups. No other comparisons were significantly different.