A Block Room in Parallel Processing Shortens the Anesthesia Utilization Time in Orthopedic Operating Rooms; A Prospective Cross-Sectional Study

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Objective: *Regional anesthesia (RA) can be time consuming, thus interfering with surgical schedule. We hypothesized that running a block room simultaneously to the operating routine accelerates the anesthesia related timing, and as a consequence, improving the utilization of operating rooms (OR).*
Material and Method: *After Institutional Review Board (IRB) approval, a prospective study was performed from January until June 2012 including extremity orthopedic operations. Parallel to the ORs a 'block room' was run by an anesthetic team to apply regional/neuraxial blocks. Demographic characteristics, anesthesia techniques, anesthesia utilization time, surgical preparation time, and operation turn over time were recorded. We also recorded the first case on-time starts (9 am) and the number of cases running overtime (4 pm).*
Results: *During the investigation period 854 (53.9%) out of 1,585 extremities orthopedic procedures had sole regional anesthesia (RA), 224 (14.1%) regional blocks combined with general anesthesia (GA and RA) and 507 (32.0%) general anesthesia (GA alone). Regional blocks were performed in either a separate block room (11.7%) or the OR (42.2%). Compared to the usual schedule the availability of a block room significantly reduced the anesthesia utilization time (12 vs. 29 minutes, $p<0.01$) but not the turnover time (5 vs. 10 minutes, $p = 0.12$). RA inside OR and GA with RA led up to longer anesthesia-controlled time than GA alone (29 vs. 38 vs. 27 minutes, $p<0.01$). First-case on-time starts (9 am) occurred only in 26.3%. Cases running overtime were 47%; most of them (96.2%) ending at 4 to 6 pm.*
Conclusion: *Using a block room in orthopedic surgery as additional work station resulted in reduced perioperative anesthesia-controlled time. Time consumption for RA inside OR was longer than for sole GA. Turnover time was rather unaffected by anesthetic techniques. Future studies should investigate if and how using a block room can improve OR productivity without financial damage.*

Keywords: *Parallel system, Regional anesthesia block room, Anesthesia utilization time, Operating room turnover time*

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Operating room (OR) departments are by far the most cost-intensive facilities in every hospital, requiring considerable amount of workload of highly specialized personnel as well as usage of expensive technical equipment, with revenues not always matching the expenses. Economic efficacy strongly depends on organization focusing on minimizing time-wasting, such as not on-time first case start, prolonged anesthesia- as well as surgeon-controlled time, resulting in over-average turnover time. One way anesthesia can contribute to improve OR efficiency is using parallel treatment areas, enabling to start the consecutive case while the respective OR is still running.

Previous studies have shown the efficiency of regional anesthesia (RA), peripheral and neuraxial blocks, applied parallel to the running schedule using an additional working area[1-3]. Mariano et al showed that in ambulatory surgery brachial plexus block performed in a separate block room or injection of local anesthetics in the OR significantly reduced anesthesia-controlled time compared to general anesthesia (28 vs. 32 minutes, $p = 0.04$), whereas turnover time was unaffected[1]. Dexter et al using an OR-information system analyzed the potential benefits of shortening

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the time allotted for anesthesia work[4]. They concluded that anesthesiologists alone cannot relevantly decrease time consumption per case, as this effect depends on various organizational and personal conditions. However, as shown by van Veen-Berkx et al scheduling anesthesia and surgical time had a significant positive effect on workflow in the OR thus reducing the number of cases cancelled due to organizational issues[5]. Application of regional anesthesia (RA) can be time consuming. Prolonged anesthesia-controlled time (ACT), but also unpunctual surgeons creating turnover delay, result in increased costs due to cancellation of cases and unnecessary overtime expenses. Rationale of the study was to raise anesthesiologists', surgeons' and OR personnel's awareness regarding OR efficiency. First objective was comparing the workflow in patients with upper and lower extremity orthopedic surgery when regional anesthesia was either applied parallel to the surgical schedule by using a block room or in the operating room. In addition patients with general anesthesia (GA) alone were analyzed. Secondary outcomes were surgeon-controlled time (SCT), turnover time (TOT), first-case on-time start, causes of delay if any, and number of patients running overtime.

Material and Method

This prospective cross-sectional study was approved by Institutional Review Board (Si 562/2011). All patients included in the study underwent orthopedic operations of upper and lower extremity during the regular OR working time from 9 am to 4 pm from 1st of January until 30th of June 2012. Anesthetic techniques were general, regional anesthesia or both combined. Pelvic and sacral surgeries were excluded. For orthopedic surgery at our hospital 7 operating and 4 preparatory rooms are routinely available. In addition, a block room in close proximity to the ORs is operated.

Data were recorded by anesthetic personnel in real time using a designed record form, and included demographic characteristics, ASA classification, diagnosis, type of operation, surgeon, anesthesia team, anesthetic technique, location of regional block, time of first-case start, cause of delay if any, and OR utilizing time, as described below. Four groups have been analyzed: 1) GA alone, 2) Block inside OR, 3) Block in separate block room (BR) outside OR and 4) GA plus block inside OR.The choice of anesthetic technique was up to the attending anesthesiologist. Applied regional anesthesia techniques were peripheral nerve block or neuraxial block or both. The same anesthetic teams that run the OR performed regional anesthesia either outside or inside the OR. The dedicated block room was prepared with complete equipment required for RA applications as well as monitoring patients' vital signs. There was an assigned nurse anesthetist working daily in the block room. All RA procedures were performed under ultrasound guidance, peripheral nerve stimulation or paresthesia technique by anesthetic residents or consultants. Patients with sole RA received intraoperative IV sedation.

The following periods have been defined and recorded. Anesthesia-controlled time (ACT), divided into ACT1 = first anesthesia contact until begin of surgical preparation, and ACT2 = end of surgery until moving the patient to the postoperative anesthetic care unit (PACU). Surgical-controlled time (SCT) is the period of surgical preparation (SPT) plus operation time (OT). Surgical preparation starts the moment of any surgeon-related measure, such as positioning or skin cleansing and ends accordingly, when the wound dressing is completed. Turnover time (TOT) is defined as the period between one patient leaving and another entering the OR (Fig. 1).

Statistical analysis

We used descriptive statistics to summarize patients' demographic and surgical data. Normally distributed data are shown as mean $\pm$ standard deviation (SD), skewed data as median (range). Demographic data were compared with the use of Chi-square tests for categorical data; one-way ANOVA and post hoc test by Games-Howell for continuous data with normal distribution; one-way ANOVA with post hoc test by Games-Howell and Kruskal-Wallis test with post hoc test by Dunn-Bonferroni method for continuous outcomes of multiple groups. Differences in categorical outcomes were compared by Chi-square tests. All reported *p*-values were two-sided; we considered *p*-values <0.05 as statistically significant. Statistical analyses were performed using PASW Statistics for Windows, 18.0 Chicago: SPSS, Inc.

Results

Over a 6 months period (116 work days), 2,140 orthopedic surgical cases were performed in 7 ORs (2.6 cases per day per room). This corresponds to 875 first cases (40.9%), 230 (26.3%) of them started punctually at 9 am and 689 (78.7%) delayed at 9:30 am. Reasons for delays were late surgeons (80.9%), late or absent anesthesiologists (12.9%), OR nurses (4.2%) and change of schedule (1.9%). The number of operations

running after 4 pm was 430, 355 of them (96.2%) completed within 4 to 6 pm. For this study 1,585 cases with lower and upper extremity surgery were included. Patients' characteristics within the different groups are shown in Table 1.

Anesthesia-controlled time using a block room was significantly shorter compared to GA alone, RA applied in the OR, or GA + RA, with RA in this group always applied in the OR (Table 2). Anesthesia-related time after surgery (ACT2) was significantly shorter in the groups with RA compared to those with GA (5±2 vs. 8±5 minutes, $p<0.01$ respectively). The surgical preparation time was similar (16 to 20 minutes) in all groups, but shortest in patients with GA. Operation time was similar in the two groups with RA only, but significantly shorter in the GA group and significantly longer in the group with GA and RA. Turnover time was similar in all groups.

Table 3 shows the results of subgroup analysis in unilateral total knee arthroplasty. Using the block room (BR) resulted in approximately 20 minutes economy of anesthesia-controlled time when comparing to RA performed inside the OR (12±8 vs. 32±11 minutes, $p<0.01$). Due to longer mean operation time in the group with RA performed in the OR, the total OR utilizing time per case 173 minutes was compared to 130 minutes in the block room group. The anesthetic time reduction can be assumed to add 1 more case per OR per day.

Discussion

The parallel use of a block room reduced anesthesia-controlled time by 50% per case compared to applying the respective block in the OR after moving the previous patient out and the room cleansing, whereas the turnover time was not affected. This difference of about 20 minutes was due to the reduction of anesthesia time before (APT1, $p<0.01$) but not after surgery (APT2, $p = 0.28$), the latter being statistically longer (5 minutes) in patients with GA compared to those with RA. Several studies have shown the effects of parallel processing on OR efficiency mainly by saving anesthesia-controlled time, ranging from 5 to 36 minutes[6-9]. Using a block room for application of brachial plexus block reduced the anesthesia-controlled time by 5[1] and 20 minutes[2]. Substantial reduction of time waste in the operative setting can be achieved by reassigning tasks of the OR personnel including anesthesiologists and nurse anesthetists, circulating nurses and housekeeping staffs[8]. Personnel costs can be limited by parallel performing of time consuming procedures within the existing schedule. Using a block room requires additional staff, equipment, and facilities, thus superficially increasing costs. However, relevant time saving means saving of costs, as it leads to effective personnel placement treating a higher number of cases per time interval. Under ideal conditions it will outweigh the financial concern[10].

Table 1. Demographic data of patients underwent upper and lower extremity orthopedic surgery

Anesthetic technique	GA alone	RA alone		GA and block in OR	*p*-value[a]
		Block in OR	Block in BR		
Number of patients	507 (32.0)	669 (42.2)	185 (11.7)	224 (14.1)	
Gender					
Male	280 (55.2)	266 (39.8)	75 (40.5)	97 (43.3)	<0.01[b]
Female	227 (44.8)	403 (60.2)	110 (59.5)	127 (56.7)	
Age (yr)	33.9±25.0	55.0±20.9	54.7±19.3	44.4±25.3	<0.01[b]
BMI (kg/m^2)	22.2±5.2	25.4±5.5	25.2±4.2	23.6±5.5	<0.01[b]
ASA physical status					
Class I-II	444 (87.6)	580 (86.7)	163 (88.1)	190 (84.8)	0.73
Class III-IV	63 (12.4)	89 (13.3)	22 (11.9)	34 (15.2)	
Surgical site					
Upper extremity	153 (30.2)	17 (2.5)	12 (6.5)	75 (33.5)	<0.01[b]
Lower extremity	354 (69.8)	652 (97.5)	173 (93.5)	149 (66.5)	

Data presented as mean±SD or n (%)
ASA = American Society of Anesthesiologists physical status; GA = general anesthesia; RA = regional anesthesia; BMI = body mass index; OR =operation room; BR = block room
[a]*p*-value based on one-way ANOVA for continuous normal distributed variable, chi-square test for categorical variables. [b] Comparing GA, GA and block in OR to RA alone

Table 2. Anesthesia- and operation-controlled time periods of 4 different groups (min); BR = block room

Anesthetic technique	GA alone (n = 510)	Block in OR (n = 667)	Block in BR (n = 186)	GA and block in OR (n = 224)	*p*-value
ACT1 (min)	18.6±10.1	23.5±10.6	6.9±6.2	29.9±12.4	<0.01[b]
ACT2 (min)	8.0±5.3	5.4±2.8	5.3±2.5	8.3±4.7	<0.01[c]
Total ACT (min)	26.6±12.3	29.0±11.1	12.2±6.9	38.3±13.9	<0.01[b]
Surgical prep time (min)	16.0±10.8	20.5±10.0	18.1±10.4	19.4±11.1	<0.01[d]
Operation time (min)	74.7±65.0*	101.4±46.2	93.8±46.3	124.2±82.4*	<0.01[c]
Turnover time (min)	10 (5, 150)	10 (5, 175)	5.0 (5, 155)	10 (5, 112)	0.12
PACU time	100.9±9.4	98.1±42.0	90.8±33.9	103.3±44.7	0.01[e]
ICU needed	13 (2.6)	6 (0.9)	1 (0.5)	8 (3.6)	0.01

Data presented as mean ± SD, median (min, max) orn (%)
GA = general anesthesia; RA = regional anesthesia; ACT = anesthesia-controlled time; ACT1 = anesthesia induction time; ACT2 = anesthesia emergence time
[b] ACT and ACT1 significantly different between all groups
[c] ACT2, OT significantly different in GA vs. GA and RA vs. RA alone
[d] SPT significantly different in GA vs. Block in OR, GA vs. GA and RA, Block in BR vs. Block in OR
[e] PACU time was significantly different between GA vs. Block in BR vs. GA and RA

Table 3. Sub-analysis of OR times in unilateral TKA

Anesthetic technique	RA in OR (n = 187)	RA in BR (n = 68)	*p*-value
Anesthesia-controlled time (min)	32.2±11.0	12.6±8.2	<0.01
Surgical prep time (min)	19.0±7.2	16.7±9.0	0.04
Operation time (min)	112.1±39.6	96.2±30.47	<0.01
Turnover time (min)	10 (5, 130)	5 (5, 45)	0.08
Total OR time utilization per case (min)	173	130	
Number of cases/day/room in 7-hour work day (cases)	2.4	3.2	

Data presented as mean±SD, median (min, max) or n (%)
RA = regional anesthesia; OR = operation room; BR = block room

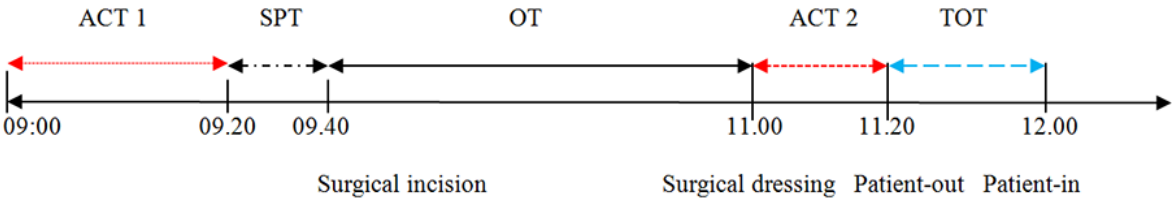

Fig. 1 Schematic illustration of the time periods recorded.
Total anesthesia-controlled time: summarizing ACT1and ACT2; SPT = surgical preparation time; OT = operation time; TOT = turnover time (Numbers for demonstration purpose; detailed definitions see text).

What exactly "relevant" is, depends on the individual structure and organization of the respective hospital. In the orthopedic department of our hospital running 7 ORs a net-saving of 20 minutes per case could result in additional 4-6 cases per day. The turnover time was quite short in our study and not influenced by the anesthetic technique; using a block room did not affect the turnover rate. Contrary to our results, Eappen et al reported long turnover times in an orthopedic setting, but also no impact on this parameter by using a block room[11]. However, OR turnover times mainly depend on organizational measures rather than anesthetic techniques, as demonstrated by Bhatt et al[12].

Independent from saving time and money, the additional potential benefits of a separate block room with its own, independent team are obvious, as it allows performing sophisticated regional blocking procedures in a less hurried and stressful environment, thus providing adequate time for addressing patients with empathy and teaching trainees.

Key factor to improve OR efficiency is to reduce idle periods to a minimum. Anesthesiologists can contribute to this goal by parallel application in a separate regional block room, whereas they have little influence on other organization-related problems. However, mutual respect between all individuals involved in patients care as well as proper and fast communication and compulsory organization procedures will contribute to avoid man made waste of time and money[13,14]. In our study, only 26.3% of the first cases started punctually at 9 am as scheduled, mainly due to delayed appearance of crucial personnel.

Limitations of this study include lack of randomization, the relative low number of block room patients when compared to the other three groups, and the different skill of the respective anesthesiologist in applying RA procedures. There were also varying operations and the individual surgeons' operative skill and plan. There may be some bias, as running a new system always creates additional motivation, demonstrated by a turnover time of 5 to 10 minutes. The OR personnel performance may not reflect the real-life situation. Our study does not provide any detailed economic analysis; something further studies have to do within a randomized setting.

Conclusion

Using a block room in surgery of upper and lower limb can reduce anesthesia utilization time by about 20 minutes per case, thus potentially allowing additional cases per day per room. However, running such a facility routinely fulltime requires an additional adequately equipped workplace plus skilled personnel. Future studies should investigate how to integrate a block room economically into anesthetic routine.

What is already known on this topic?

Regional anesthesia (RA), peripheral and neuraxial blocks, applied parallel to the running schedule using an additional working area reduced the anesthesia-controlled time in upper extremity surgery. Prolonged anesthesia-controlled time (ACT), surgeon-controlled time and also long turnover time resulted in increased costs due to cancellation of cases and unnecessary overtime expenses.

What this study adds?

Using a block room in orthopedic surgery as parallel processing resulted in reduced perioperative anesthesia-controlled time. Time consumption for RA inside OR was longer than for sole GA. Turnover time was rather unaffected by anesthetic techniques. Awareness of OR utilization time is important for OR efficiency and preoperative scheduling.

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Potential conflicts of interest

None.

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ห้องบล็อคสำหรับหัตถการการระงับความรู้สึกเฉพาะส่วนลดการใช้เวลาของทีมวิสัญญีในห้องผ่าตัด

สุวิมล ต่างวิวัฒน์, อริศรา เอี่ยมอรุณ, อังคณา เหลืองนทีเทพ, กีรติ เจริญชลวาณิช, จุฑาทิพย์ นันทวินิตย์, ภาวิณี อิ่มคง

วัตถุประสงค์: การระงับความรู้สึกเฉพาะส่วนเป็นหัตถการที่ใช้เวลาโดยเฉพาะเมื่อทำในห้องผ่าตัด การศึกษานี้ต้องการทราบว่าการระงับความรู้สึกเฉพาะส่วนในห้องบล็อคที่แยกส่วนจากห้องผ่าตัดสามารถลดการใช้เวลาของทีมวิสัญญีในห้องผ่าตัด เพื่อการใช้ห้องผ่าตัดให้มีประสิทธิภาพมากขึ้น

วัสดุและวิธีการ: การศึกษาแบบไปข้างหน้าสำหรับการผ่าตัดทางออร์โธปิดิกส์ของรยางค์บนและล่างในช่วงเวลา ตั้งแต่เดือนมกราคมถึงเดือนมิถุนายน พ.ศ. 2555 หลังผ่านการรับรองจากคณะกรรมการการวิจัยในคน ได้มีการจัดการเตรียมห้องบล็อคสำหรับการระงับความรู้สึกเฉพาะส่วนแยกส่วนจากห้องผ่าตัดโดยทีมวิสัญญี มีการเก็บข้อมูลทั่วไปของผู้ป่วย เทคนิคการระงับความรู้สึกที่ผู้ป่วยได้รับเวลาที่ใช้ในห้องผ่าตัดตั้งแต่ผู้ป่วยเข้าจนออกจากห้องผ่าตัดได้แก่ การใช้เวลาของทีมวิสัญญี (anesthesia-controlled time) เวลาเตรียมผู้ป่วยจนพร้อมลงมีดผ่าตัด (surgical preparation time) เวลาที่เสร็จการผ่าตัดและเวลาที่ย้ายผู้ป่วยเดิมออกจนถึงผู้ป่วยใหม่เข้ามา (turnover time) รวมถึงเก็บข้อมูลความตรงต่อเวลาของการเริ่มเคสแรกของวันและจำนวนผู้ป่วยที่รับเวรต่อวันจนถึงเวลาเสร็จของเคสสุดท้าย

ผลการศึกษา: ผู้ป่วยที่เข้ารับการผ่าตัดทางออร์โธปิดิกส์ของรยางค์บนและล่างจำนวนทั้งหมด 1,585 รายในเวลา 6 เดือน ได้รับเทคนิคการระงับความรู้สึกเฉพาะส่วน 854 ราย (ร้อยละ 53.9) โดยทำหัตถการในห้องบล็อครอยละ 11.7 และในห้องผ่าตัดร้อยละ 42.2 เทคนิคการระงับความรู้สึกเฉพาะส่วนร่วมกับการระงับความรู้สึกแบบทั่วตัว 224 ราย (ร้อยละ 14.1) และเทคนิคการระงับความรู้สึกแบบทั้งตัวเพียงอย่างเดียว 507 ราย (ร้อยละ 32.0) การมีห้องบล็อคลดเวลาของทีมวิสัญญีที่ใช้ในห้องผ่าตัดเมื่อเทียบระหว่างกลุ่มที่ทำหัตถการการระงับความรู้สึกเฉพาะส่วนในห้องผ่าตัด (12 และ 29 นาที, p<0.01) เวลาที่เสร็จการผ่าตัดและเวลาที่ย้ายผู้ป่วยเดิมออกจนถึงผู้ป่วยใหม่เข้ามาไม่ต่างกัน (5 และ 10 นาที, p = 0.12) การบล็อกในห้องผ่าตัดและการร่วมกับการระงับความรู้สึกแบบทั่วตัว ทำให้การใช้เวลาของทีมวิสัญญี (anesthesia-controlled time) นานขึ้นกว่าการระงับความรู้สึกแบบทั่วตัวอย่างเดียว (29, 38 และ 27 นาทีตามลำดับ, p<0.01) การเริ่มเคสแรกที่ตรงต่อเวลา 9.00 น. มีเพียงร้อยละ 26.3 มีการรับเวรนอกเวลา ร้อยละ 47 ของเคสสุดท้ายร้อยละ 96.2 ของผู้ป่วยที่รับเวรนอกเวลาการผ่าตัดมักเสร็จในช่วงเวลา 16.00 ถึง 18.00 น.

สรุป: การใช้ห้องบล็อคสำหรับเทคนิคการระงับความรู้สึกเฉพาะส่วนที่แยกจากห้องผ่าตัด สามารถลดเวลาที่เสียไปในห้องผ่าตัดจากส่วนของทีมวิสัญญีเมื่อเทียบกับการทำหัตถการในห้องผ่าตัด การบล็อคในห้องผ่าตัดใช้เวลานานกว่าการระงับความรู้สึกแบบทั่วตัวเพียงอย่างเดียว เวลาสำหรับย้ายผู้ป่วยเก่าออกและผู้ป่วยใหม่เข้าห้องผ่าตัดไม่แตกต่างกันจากเทคนิคการระงับความรู้สึก