ORIGINAL ARTICLE

Cost Comparison of General Anesthesia and Regional Anesthesia in Hand and Forearm Surgery

Damla Akman, Ferhunde Dilek Subaşi, Özlem Deligöz, Osman Ekinci

ABSTRACT

Introduction: **Economics is gaining importance all over the world. The high costs of health expenditures prompt preference for less costly methods in health practices. General and regional anesthesia are both commonly preferred methods in upper extremity surgery. In our study, we aimed to compare the cost of general or regional anesthesia in patients scheduled for hand and forearm surgeries.**

Methods: **The study was conducted in the Department of Anesthesiology and Reanimation, XXX Hospital, after ethics committee approval. Our study included 69 patients aged 18 years and older with ASA (American Society of Anesthesiologists) classification I-II-III who were planned for hand and forearm surgery. Patients were divided into two groups: infraclavicular block (ICB) and general anesthesia (GA). Ultrasonography-guided infraclavicular block was performed in the ICU group. The GA group underwent general anesthesia. For both groups, the patient's arrival time to the room, anesthesia starts and end time, and surgery start, and end time were recorded. Intraoperative and postoperative medications and consumables used for the patient were recorded.**

Results: **Comparing the two groups, the total intraoperative cost was found to be significantly lower in the ICB group than in the GA group ($p < 0.05$). Surgery durations were similar in both groups. Anesthesia control time, total anesthesia time, patient stay in the room and postoperative recovery room follow-up time were found to be statistically significantly shorter in the ICB group compared to the GA group ($p<0.05$).**

Conclusion: **We concluded that regional anesthesia is more advantageous than general anesthesia in terms of cost in hand and forearm surgeries.**

KEY WORDS

Brachial plexus block, cost, general anesthesia

INTRODUCTION

Today, the increase in anesthesia methods offers both patients and physicians the opportunity to choose the anesthesia method according to case-specific conditions. Before the operation, the anesthesiologist decides on a method according to the patient's clinic, the type of operation and clinical experience[1,2].

Both general anesthesia and regional anesthesia are frequently preferred methods in upper extremity surgeries. Each of these methods has its advantages. The advantages of the applied method should also be taken into consideration when making a choice. Examples include postoperative pain, nausea and vomiting, length of stay in the postoperative recovery room and hospital, patient satisfaction, drug and consumable use and cost.

There have been significant increases in health expenditures in recent years[3]. Given the importance of the economy worldwide, cost reduction is of paramount importance. Surgical operations command a large share in health expenditures[4]. In addition, the increase in the duration of use of the operating room increases the workload of the operating room staff, which is a second situation that increases the cost.

In this study, we aimed to determine the cost advantages of general anesthesia and regional anesthesia in hand and forearm surgery.

METHODS

Permission for this study was obtained from the XXX Hospital Clinical Research Ethics Committee (No: HNEAH-KAEK 2020/67). This prospective observational study was conducted between January and July 2021 in patients scheduled for hand and forearm surgery. All patients were informed about the study and their written and verbal informed consent was obtained.

ASA I-III patients aged 18 years and older were included in the study. Patients who were ASA IV, under 18 years of age, caught infection at the injection site, had alcohol and drug addiction, were allergic to the drugs to be used in the study, had known coagulopathy and a history of anticoagulant use, and were unable to perform pain scale assessment as cognitive function were excluded from the study.

As a result of the Power analysis using the G*Power program, the minimum sample size for each group was determined as $n = 17$ with a total of 34 patients for total cost for effect size d: 0.992, standard deviation value 9, Power: 0.80 and α: 0.05. We included 69 patients who underwent general anesthesia or infraclavicular block. Patients were divided into two groups as infraclavicular block (Group ICB) (n: 34) and general anesthesia (Group GA) (n: 35) using computer-assisted randomization method.

Patients to undergo infraclavicular block were taken to the preoperative room before the operation. Electrocardiography (ECG), noninva-

Received on June 13, 2023 and accepted on July 2, 2023
University of Health Sciences, Haydarpaşa Numune Training and Research Hospital
Istanbul, Turkey
Corresponding author: Özlem Deligöz
(e-mail: ozlem.deligoz@gmail.com)

ORCID ID:
Damla Akman: 0000-0002-2303-636X
Ferhunde Dilek Subaşi: 0000-0003-3269-9138
Özlem Deligöz: 0000-0002-5651-9827
Osman Ekinci: 0000-0002-7891-1774

Table 1: Medicine and Consumables Prices

Medicine	Price / Dollars	Medicine	Price / Dollars	Material	Price / Dollars
Fentanyl 500 mcq/10cc	1.00	Atropine 0.5 mg	0.06	Sterile drape	1.42
Propofol 1%	0.67	Neostigmine 0.5 mg	0.09	Peripheral block needle	7.41
Rocuronium	1.40	Buvasin 100 mg	0.50	Sterile gel	0.50
Dormicum iv 5 mg/5cc	0.12	Aritmal 2%	0.04	Breathing circuit	4.19
Sevoflurane liquid	57.4	Prilocain vial	0.42	Bacteria filter	0.48
Remifentanil 2 mg	2.41	Parol vial 1 gr	0.80	Intubation tube	0.76
Tramadol iv 100 mg	0.19	Tilcotil vial 20 mg	0.29	Laryngeal mask	7.84
Pethidine hydrochloride	0.29	Isotonic 0.9% 1000 ml	0.51	Oxygen mask	0.44
Ondansetron	0.17				

*1 dollar: 7.43 TL (01.01.2021)

Table 2: Sociodemographic Characteristics

	Type of Anesthesia n (%)		
	Infraclavicular Block (ICB)	**General Anesthesia (GA)**	**P**
Gender			
Female	15 (60)	10 (40)	0.275
Male	19 (43.2)	25 (56.8)	
ASA			
1	10 (41.7)	14 (58.3)	
2	23 (53.5)	20 (46.5)	0.733
3	1 (50)	1 (50)	
Operation type			
Hand Surgery	23 (47.9)	25 (52.1)	0.937
Forearm Surgery	11 (52.4)	10 (47.6)	
		X ± S.S.	
Age	39.79 ± 15.86	35.80 ± 11.42	0.236
BMI	26.44 ± 3.94	26.21 ± 4.23	0.824

ASA: American Society of Anesthesiologists, BMI: Body Mass Index S.D: Standard Deviation

sive blood pressure and peripheral oxygen saturation monitoring were performed. An intravenous line was opened, and 0.9% isotonic fluid was inserted. Skin preparation was performed using 10% povidone-iodine. Sterile drapes were then covered and a linear probe (Philips-Sparq device high speed 5.2 mHz) was placed in the infraclavicular area. Axillary artery and brachial plexus cords were visualized. Skin and subcutaneous analgesia was provided with 2-3 ml 2% lidocaine. In the follow-up, USG-guided peripheral block was performed with 20 ml 0.5% bupivacaine + 10 ml 2% prilocaine using a peripheral block needle (Stimuplex ultra-360, 22G*80 mm). Performance duration was recorded. Pinprick test was used to determine sensory block and modified Bromage scale was used to determine motor block. For patients where adequate motor and sensory block could not be achieved within 30 minutes, the block application was then considered unsuccessful and general anesthesia was performed. After adequate block was achieved, the patient was transferred to the operating room. Intraoperative intravenous (iv) midazolam (0.05-0.1 mg/kg) was administered if needed.

Patients in the general anesthesia group underwent ECG, noninvasive blood pressure and peripheral oxygen saturation monitoring in the operation room and intravenous access was established and 0.9% isotonic 0.9% fluid was started. Anesthesia induction was achieved with iv 1.5 mcg/kg fentanyl, 2-3 mg/kg propofol and 0.6 mg/kg rocuronium, following which laryngeal mask was placed. The size of the laryngeal masks was decided upon according to the weight of the patient. Patients who could not be placed a laryngeal mask were orotracheally intubated. O^2/air at a ratio of 2 l/min 1:1, 1-2% sevoflurane as inhalation agent and remifentanil iv 0.01-0.2 mcg/kg/min were used for anesthesia maintenance. Paracetamol 1 g iv, tenoxicam 20 mg iv, ondansetron 4 mg iv were routinely administered. When additional analgesics were planned, the drug administered, and the dose were recorded. At the end of the operation, all patients without contraindications received 0.01 mg/kg atropine and 0.03 mg/kg neostigmine.

The end of the operation was defined as the 0^{th} postoperative minute in Group ICB and the moment when the patient was extubated, and cooperation was established in Group GA. At 0. min postoperatively, the numeric pain rating scale (NRS) was used for pain assessment of the patients. NRS was defined as 0-2 no pain, 3-4 mild pain, 5-6 moderate pain, 7-8 severe pain, 9-10 unbearable pain. Patients with NRS > 4 were administered iv pethidine hydrochloride. Patients with a modified Aldrete score > 9 were sent to the ward.

All drugs and consumables used peroperatively for both groups were recorded. The drugs and material prices used in the cost calculation are presented in Table 1. The prices are based on the price at the hospital pharmacy and the prices paid by the social security institution in the health practice communique. Each vial or ampoule of medication used was considered for single use and the remaining medication was discarded.

For both groups, the patient's arrival time to the room, anesthesia starts and end times, and surgery start, and end times were recorded.

The periods are defined as follows:

- **Block implementation time:** Time from sterile preparation to needle withdrawal
- **Room entry-operation start time:** The time from the time the patient is admitted to the operating room until the start of the surgical incision.
- **Surgical duration:** The period from the start of the surgical incision until the bandage or splint procedure is completed and the patient is delivered to anesthesia.
- **Surgical end-stay time:** The time from the completion of the bandage or splint procedure until the patient leaves the room.
- Operating room length of stay: The time from the patient’s entry to the operating room to the patient’s exit.
- Anesthesia control time: The sum of the time from the patient’s entry into the room until the beginning of the operation and the time from the end of the operation until the patient leaves the room.
- Total anesthesia duration: The sum of block administration time and anesthesia control time.
- Postoperative duration: Time in the postoperative recovery unit

Statistical Analysis

The SPSS 22 software was used for data analysis. Kolmogrow Smirnov test was used as a normal distribution test. Parametric tests were preferred in the analysis of the data that fit the normal distribution, and non-parametric tests were preferred in the analysis of the data that did not fit the normal distribution. Data are presented as number, percentage, arithmetic mean, median, minimum, maximum. In the analyses, t test, Mann-Whitney U test, Chi-square test were used. $p < 0.05$ was considered significant.

RESULTS

The mean age of the 69 patients included in the study was 37.77 ±

Table 3: Comparison of Times According to Type of Anesthesia

	Type of Anesthesia						
	Infraclavicular Block (ICB)			General Anesthesia (GA)			
	X	S.D.	Median	X	S.D.	Median	P
● Room entry-Operation start time	15.53	6.48	15.00	26.60	8.91	30.00	**< 0.001**
● Duration of surgery	63.91	29.89	64.00	81.03	43.83	79.00	0.135
● Surgery end-Room exit time	7.02	3.39	6.000	13.029	3.89	13.000	**< 0.001**
● Room length of stay	86.47	30.80	88.00	121.23	45.23	115.00	**0.001**
● Anesthesia control duration	22.56	8.31	20.50	39.63	10.03	40.00	**< 0.001**
● Total duration of anesthesia	28.12	8.09	27.50	39.63	10.03	40.00	**< 0.001**
● Postoperative duration	13.97	2.39	15.00	19.00	5.25	20.00	**< 0.001**

Table 4: Comparison of intraoperative and postoperative costs by type of anesthesia

	Type of Anesthesia										
	Infraclavicular Block (ICB)					General Anesthesia (GA)					
	X	SD	Median	Min	Max	X	SD	Median	Min	Max	p
Intraop total cost	11.83	3.39	11.06	10.94	29.37	19.64	3.15	18.68	15.24	28.99	**< 0.001**
Postop recovery room cost	0.00	0.0	0.00	0.00	0.00	0.12	0.14	0.00	0.00	0.29	**< 0.001**

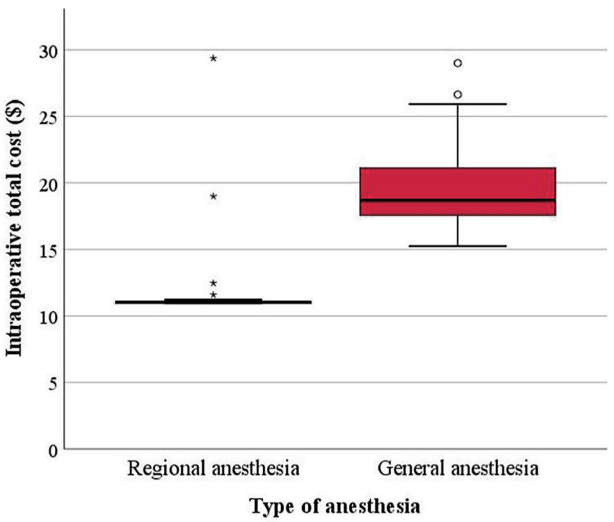

Figure 1: Distribution of Intraoperative Total Cost by Type of Anesthesia

13.83 (min: 18-max: 73). Sociodemographic characteristics of both groups were similar according to the type of anesthesia administered (Table 2).

Intraoperative and postoperative time periods were found to be statistically significantly shorter in patients who underwent infraclavicular block compared to patients who underwent general anesthesia ($p < 0.001$) (Table 3).

Both intraoperative and postoperative costs were statistically lower in Group ICB compared to Group GA ($p < 0.001$) (Table 4).

DISCUSSION

The advantages and disadvantages of general anesthesia and regional anesthesia have been debated for years. The choice of anesthesia technique takes into account both the experience and preference of the physician and the patient's wishes. In recent years, economic fluctuations around the world have led to significant increases in health expenditures attracting more attention. Therefore, cost is also important in the choice of anesthesia method. Therefore, in this study, we wanted to compare general anesthesia and regional anesthesia in hand and forearm surgeries in terms of cost.

In our study, intraoperative total cost was found to be statistically significantly lower in the regional anesthesia group than in the general anesthesia group (Table 4, Figure 1). In a study by Chan et al. the cost of intraoperative drugs and consumables in hand surgery was found to be 16 dollars in the transarterial axillary brachial plexus block group and 37 dollars in the general anesthesia group. However, there was no significant difference between brachial plexus block and general anesthesia group when intraoperative total cost was compared. In the same study, brachial plexus block application was performed in a different room before being taken to the operating room. After regional anesthesia was administered, the patients were kept under observation by a nurse until they were taken to the operating room. Since the personnel fee was included in the total intraoperative cost, no significant difference was observed between the groups in terms of cost[5)].

In another similar study, brachial plexus block and general anesthesia were compared in terms of cost in upper extremity surgery. Intraoperative total cost was found to be 38.45 TL in the brachial plexus block group and 109.97 TL in the general anesthesia group[6)].

Gonano *et al*. compared the costs of general anesthesia and brachial plexus block implementations in arthroscopic shoulder operations. The study concluded that brachial plexus block was more economical. The total intraoperative cost was 41 euros in the general anesthesia group and 31 euros in the brachial plexus block group. The total cost in the postoperative recovery room was 0.3€ in the brachial plexus group and 1.5€ in the general anesthesia group[7)].

Marhofer *et al*. applied brachial plexus block to one group and general anesthesia to the other group in forearm fractures. The cost was 324.26€ in the regional anesthesia group and 399.18€ in the general anesthesia group. In patients in whom adequate block could not be achieved and therefore general anesthesia was started, the cost increased to 482.55€ in the regional anesthesia group[8)].

In our study, considering that staff salaries and medical system costs may vary between hospitals, only medication and material costs were included in the cost analysis, as in the study by Goanna et al. Intraoperative total cost was found to be 18.68 dollars in the GA group and 11.06 dollars in the infraclavicular block group. In 1 patient, the block was unsuccessful, and the cost increased to 29.37 dollars in the infraclavicular block group because general anesthesia was initiated (Table 4).

The duration of use of the operating room is another important factor that increases the cost both in terms of increasing the workload and delaying the workflow. One of the situations that negatively affects the workflow is the excessive time spent for regional anesthesia. In a survey, some orthopedists reported that they did not prefer regional anesthesia because of case delays and unpredictable block success[9)]. In order to solve this problem, the application of regional anesthesia in a different room other than the operating room has been brought to the agenda in recent years.

Brown *et al*. thought that performing regional anesthesia in a different room other than the operating room would make more effective use of the operating room and increase the number of daily cases in upper extremity surgery and planned a study on this subject. At the end of the study, they showed that the number of cases per day increased by a rate of 0.42 and overtime work decreased by 43%[10]. Head *et al*. also applied regional anesthesia outside the operating room (in the block room) in upper extremity surgery and reported that effective use of the operating room increased in the regional anesthesia group when compared with general anesthesia[11].

Armstrong *et al*. created two different groups by applying regional anesthesia in the operating room and in the block room in upper extremity surgery and compared these groups with the general anesthesia group. As a result of the study, anesthesia control time (time excluding surgical time in the operation room) was 25 minutes in the general anesthesia group, 37 minutes in the group where regional anesthesia was applied in the operation room, and 15 minutes in the group where regional anesthesia was applied in the block room. They showed that the use of block room is advantageous[12].

Mercereau *et al*. preferred to perform brachial plexus block in the block room outside the operating room in upper extremity surgery and compared this group with the general anesthesia group. The time in the operation room other than the surgical time was 19 min in the regional anesthesia group and 57 min in the general anesthesia group. They showed an estimated 33% increase in daily yield[13]. In a different study, the researchers believed that the use of a block room for regional anesthesia might increase the cost, but they reported that this cost could be reduced by decreasing the wage paid for overtime and increasing patient circulation[14]. In the study by Goanna et al. comparing general anesthesia and brachial plexus block in arthroscopic shoulder surgery, the duration of anesthesia control was 12 minutes in the ICB group and 23 minutes in the GA group. In their study, the block application process was carried out in a different room and this time was 11 minutes on average. Total duration of anesthesia was 22 minutes in the brachial plexus block group and 23 minutes in the general anesthesia group[7].

Like other studies, we performed regional anesthesia in a different room outside the operation room by the same anesthesiologist under USG guidance. In our study, there was no difference between the surgical times in both groups, while the duration of the patient's stay in the room was 115 minutes in the GA group and 88 minutes in the ICB group. Anesthesia control time was 20.5 minutes in the ICB group and 40 minutes in the GA group. This duration includes the preparation, induction, and wake-up time of the anesthesiologist, in addition to the duration of the surgical procedure. General anesthesia induction and awakening periods prolong the patient's stay in the room and reduce surgical circulation. Both anesthesia control time and room stay time were statistically significantly shorter in the ICB group (Table 3).

The single-center and observational nature can be considered among the limitations of our study. Multicenter, prospective, and randomized studies will provide more clarity on this issue.

CONCLUSION

As a result of our study, we found that regional anesthesia is more advantageous than general anesthesia in terms of cost. We also concluded that performing regional anesthesia applications in a room other than the operating room contributed to the cost and workload. We believe that these results should be supported by other studies.

MAIN POINTS

- The high costs of health expenditures prompt preference for less costly methods in health practices.
- General and regional anesthesia are both commonly preferred methods in upper extremity surgery. The advantages and disadvantages of general anesthesia and regional anesthesia have been debated for years.
- The costs of anesthesia methods should also be investigated, and studies should be conducted on this subject.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Morgan EG, Michael SM, Murray MJ. Lange Klinik Anesteziyoloji 2015
2. Güdoğuş F,Gürkan Y. Rejyonal Anestezi Nobel Tıp Kitabevleri
3. WHO Global Health Expenditure Database. Geneva: World Health Organization. Available from: https:// apps.who.int/nha/database
4. Eric Muñoz. National and Surgical Health Care Expenditures, 2005-2025. *Ann Surg*. 2010; 251(2): 195-200.
5. Chan VWS, Peng PWH, Kaszas Z, *et al*. A comparative study of general anesthesia, intravenous regional anesthesia, and axillary block for outpatient hand surgery: clinical outcome and cost analysis. *Anesth Analg* 2001; 93: 1181-4
6. Abdullah Kahraman, Nureddin Y kat, Muhammed Bilal Çeğin, Volkan Baydi Comparison of ultrasound guided brachial plexus blockage with general anesthesia and cost analysis: *East J Med* 2017; 22(1): 10-14
7. C. Gonano, S. C. Kettner, M. Ernstbrunner, *et al*. Comparison of economical aspects of interscalene brachial plexus blockage and general anaesthesia for arthroscopic shoulder surgery *British Journal of Anaesthesia* 2009; 103 (3): 428-33
8. Marhofer, P., Kraus, M., & Marhofer, D. Regional anesthesia in daily clinical practice: an economic analysis based on case vignettes. *Der Anaesthesist*, (2019); 68(12): 827-835.
9. Oldman M, McCartney CJ, Leung A, *et al*. A survey of orthopedic surgeons' attitudes and knowledge regarding regional anesthesia. *Anesth Analg* 2004; 98: 1486-90.
10. Michael J. Brown, *et al*. Improving operating room productivity via parallel anesthesia processing *International Journal of Health Care Quality Assurance*; 2014; 27(8): 697-706
11. Head SJ, Seib R, Osborn JA, Schwarz SK. A "swing room" model based on regional anesthesia reduces turnover time and increases case throughput. *Can J Anesth* 2011; 58: 725-32.
12. Armstrong KP, Cherry RA. Brachial plexus anesthesia compared to general anesthesia when a block room is available. *Can J Anesth* 2004; 51: 41-4
13. Mercereau, P. Lee, B. Head, S.J. and Schwarz, S.K. "A regional anesthesia-based 'swing' operating room model reduces non-operative time in a mixed orthopedic inpatient/ outpatient population", *Canadian Journal of Anaesthesia*, 2012; 59: 943-949
14. Dexter, F., Epstein, R.H., Traub, R.D. and Xiao, Y. (2004), "Making management decisions on the day of surgery based on operating room efficiency and patient waiting times", *Anesthesiology*, 2004; 101(6): 1444-1453