

Comparison of Postoperative Pain in Patients Undergoing Arthroscopic Repair by Spinal or General Anesthesia

Arman Parvizi¹, Soudabeh Haddadi^{2*}, BahramNaderi Nabi³, Mohsen Mardani Kivi⁴, Soodabe Makhlooghi Azad⁵, Ali Davoudi Kia Kalayeh⁶, Zakiyeh Jafary Parvar⁷ and Milad Pour Akbari⁸

¹Assistant Professor of Anesthesia and critical care, Anesthesiology Research Center, Velayat Burn and Reconstructive Surgery Hospital, Guilan University of Medical Sciences, Rasht, Iran

²Associate Professor of Anesthesia and critical care, Anesthesiology Research Center, Velayat Burn and Reconstructive Surgery Hospital, Guilan University of Medical Sciences, Rasht, Iran

³Pain Fellowship, Associate Professor of Anesthesiology, Anesthesiology Research Center, Velayat Burn and Reconstructive Surgery Hospital, Guilan University of Medical Sciences, Rasht, Iran

⁴Orthopedic Specialist, Associate Professor, Anesthesiology Research Center, Velayat Burn and Reconstructive Surgery Hospital, Rasht, Iran

⁵Anesthesiologist- Anesthesiology Research Center, Velayat Burn and Reconstructive Surgery Hospital, Guilan University of Medical Sciences, Rasht, Iran

⁶Social Medicine Specialist, Guilan University of Medical Sciences, Rasht, Iran

⁷Master of Science in critical care nursing, Razi Clinical Research Development Center, Guilan University of Medical Sciences, Rasht, Iran

⁸B.Sc.of Anesthesia, Guilan University of Medical Sciences, Rasht, Iran

*Corresponding author: Soudabeh Haddadi, Department of Anesthesia and critical care, Anesthesiology Research Center, Velayat Burn and Reconstructive Surgery Hospital, Guilan University of Medical Sciences, Rasht, Iran, Tel: (+98) 9111323739; E-mail: so_haddadi@yahoo.com

Received: 18 Dec, 2017 | Accepted: 19 Jan, 2018 | Published: 26 Jan, 2018

Citation: Parvizi A, Haddadi S, Nabi BN, Kivi MM, Azad SM, et al. (2018) Comparison of Postoperative Pain in Patients Undergoing Arthroscopic Repair by Spinal or General Anesthesia. J Clin Anesth Manag 3(1): dx.doi.org/10.16966/2470-9956.133

Copyright: © 2018 Parvizi A, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Knee arthroscopy can be performed under general anesthesia and regional techniques such as spinal or local anesthesia. However, in recent years, spinal anesthesia has become more common because of faster recovery and greater comfort after surgery. After arthroscopy, an appropriate analgesia facilitates the recovery and returns the patients faster to the active status. Thus, we decided to compare length of analgesia, severity of pain, and duration of stay in recovery after knee arthroscopy using two techniques of spinal (with 5% lidocaine) and general (total intravenous) anesthesia.

Materials and methods: In this clinical trial, 81 patients (ASA I-II) were included and randomly assigned to one of the groups of spinal (5% lidocaine) or total intravenous anesthesia (propofol and remifentanyl). The postoperative pain was recorded by VAS pain score at the time intervals of 30 minutes, 1, 2, 6, 12, and 24 hours after the operation together with the duration of stay in recovery, duration of postoperative analgesia, first analgesic prescription, and total analgesic intake. All the collected data were analyzed in SPSS 20.

Findings: In this study, the patients had not significant difference in terms of demographic characteristics. The mean duration of stay in recovery among the patients under ACL arthroscopic repair was 31.22 min in the spinal group and 35 min in the general group (P=0.002). The frequency distribution of opioid drugs and analgesics or, in general, the statistical difference between the spinal and general groups was not significant. In terms of mean duration of analgesia after the surgery (h) using Mann-Whitney U test, the patients had analgesia for 8.11 h after spinal anesthesia and 2.53 h after general anesthesia (P=0.0001); the statistical difference was quite significant.

Discussion and conclusion: According to the findings of this study, it seems that the postoperative pain in the patients undergoing ACL arthroscopic repair with general anesthesia was higher and the duration of analgesia after the surgery was shorter. However, no significant difference was found in terms of total dose of analgesic consumed.

Keywords: Arthroscopy; Postoperative pain; General anesthesia; Spinal anesthesia

Introduction

Knee arthroscopy is one of the developing diagnostic techniques, which plays an important role in the diagnostic and non-invasive interventions for a wide range of knee diseases [1,2]. One of the most prevalent injuries in knee ligaments is damage to the anterior cruciate ligament (ACL) such that, in the United States, nearly 200000 tears annually

occur [3]. There are no precise statistics on the prevalence of ACL in Iran. However, in the study, which conducted in Guilan Province in 2012, 44.7% of the cases with interior knee injury belonged to ACL tears, which was the most common among sport knee injuries [4]. Arthroscopy is a therapeutic approach for anterior cruciate ligament injuries. Several methods of anesthesia, including general anesthesia, spinal or epidural anesthesia, nerve block, or local anesthesia, are used alone or with sedatives for arthroscopic surgeries. Selection of anesthesia technique is depended on the diagnostic or therapeutic nature of arthroscopy, the predicted duration of arthroscopy, severity of interventions, experience of anesthesiologist, and also patient's preference. During the past three decades, along with advances in knee arthroscopy techniques, the relevant anesthesia methods have tended to reduce complications, increase simplicity, decrease risk, and promote patient and surgeon satisfaction [5-7].

One of the problems that can be observe after knee surgeries such as arthroscopy is postoperative pain [8,9], which is one of the major problems and complaints after surgery and, if left untreated, it might lead to serious problems [10]. The postoperative pain is one of the most common concerns of patients such that up to 8% of patients postpone the surgical operation due to fear of pain. Unfortunately, despite the advances in pain control in terms of drugs and techniques, 50-70% of patients experience moderate to severe postoperative pains. Uncontrolled pain can increase the risk of chronic pains and, by increasing the sympathetic tone, cause cardiovascular, respiratory disorders (such as increased blood pressure and cardiac ischemia, etc) [11] and prevent postoperative physiotherapy. This complication also causes delaying in patient recovery, prolonged hospitalization, and increase therapeutic's costs [12]. Therefore, today, pain is proposed as the fifth vital sign which should be measured and controlled frequently after surgery along with blood pressure, heart rate, body temperature, and other vital signs [13]. The usual methods of pain control often do not provide an adequate analgesia in half of the patients [14]. Hence, important strategies are proposed for postoperative pain control, including standard pain assessment strategy, preventive and pre-emptive analgesia, particularly multimodal analgesia [15]. As mentioned, knee arthroscopy may be performed under general anesthesia or regional techniques such as spinal or local anesthesia [16-19]. However, in recent years, the spinal anesthesia with a low dose of local anesthetic has become more common because of faster recovery and greater comfort after surgery [20]. Lidocaine and bupivacaine are local anesthetic drugs which are used for this surgery [21-26]. In the study performed by Hassan Hi in 2015, bupivacaine 3 mg and intrathecal Fentanyl 10 µg were compared with lidocaine 20 mg and intrathecal Fentanyl 25 µg. Results showed that both methods were effective, but patients receiving lidocaine were able to move faster [27].

On the other hand, knee arthroscopy can also be conducted under general anesthesia [1] using TIVA. Two drugs that can

be used in general anesthesia are propofol and remifentanyl. Remifentanyl is a selective opioid agonist with analgesic effect, which is chemically classified as fentanyl, with an ester structure along with faster metabolism, and hepatic and extra hepatic metabolism, and it's metabolism is not affected in hepatic and renal failure [28]. Although Rodgers and coworkers have recommended the intrathecal anesthesia for arthroscopy [29], but Harsten and coworkers concluded that the general anesthesia with propofol and remifentanyl leads to less postoperative pain, nausea, and vomiting compared to spinal anesthesia using 0.5% bupivacaine in the patients undergoing total knee arthroscopy [30]. In the regional anesthesia technique, postoperative pain is properly controlled during the first hours after the surgery, but the question is whether this benefit of regional anesthesia is preferred to modern general anesthesia techniques or not. Thus, we decided to compare these two anesthesia techniques in terms of duration of analgesia, severity of pain, duration of stay in post anesthesia care unit (PACU) after ACL arthroscopic repair to determine the method with the maximum postoperative analgesia to take a step towards faster recovery of these patients, who are mostly young, and reduce treatment costs.

Materials and Methods

In this randomized clinical trial (after approval of the research project and validation of Ethics Committee and Registration at Iranian Center for Clinical Trials), 81 patients aged 18-45 years with physical classes of (American Society of Anesthesiologists physical status) ASA I-II undergoing ACL elective arthroscopic repairment were recruited using random fixed block method.

The inclusion criteria were age of 18-45 years, ASAI-II, no history of heart disease, seizure, coagulation disorder, hepatic and renal disorders, or chronic bronchitis. The patients with the history of mental disorders, alcohol, narcotic, or analgesic abuse, history of chronic pain, consumption of anticoagulants, antidepressants, and antibiotics, and sensitivity to the drugs used in the study were not included.

After giving some explanation to the patients and obtaining the informed written consent, the patients were randomly assigned to general or spinal anesthesia groups (computer based by Random fixed block). ACL arthroscopy surgery was performed using the standard technique by a fellow orthopedic specialist. After establishing a peripheral vein, monitoring was performed by heart monitoring, pulse oximetry, non-invasive blood pressure, and heart rate measurements (monitoring device; model: Alborz B5, manufactured by Saadat Co., Iran).

- Patients in the general anesthesia group were anesthetized via the intravenous injection of fentanyl (2 µg/kg body weight), lidocaine (1 mg/kg body weight), propofol (2 mg/kg body weight), atracurium (0.5mg/kg body weight), and I-gel with proper size was embedded for the patients and were ventilated by oxygen and nitrous oxide (50%). Anesthesia was maintained with the intravenous infusion of propofol (50 to 100 µg/kg body weight per min) and

remifentanyl (0.1 µg/kg body weight per min). At the end of the operation, the patients were reversed with atropine (0.02 mg/kg body weight) and neostigmin (0.04 mg/kg body weight).

- In the spinal anesthesia group, the patients were anesthetized using spinal needle 25 manufactured by Excell from L4-L5 space by injecting 75-100 mg of 5% lidocaine.
- In the presence of bradycardia, (heart rate below 50 per min), atropine was prescribed for the patients and, in case of systolic blood pressure drop below 90 mmHg (7 mic/kg) and systolic blood pressure drop by more than 20%, Ephedrine was used.

If the anesthesia technique were changed from spinal to general or surgery method varied, the patient would be excluded.

Residence of anesthesia and anesthesia nurse were blinded to the patient's study group.

Patients information including demographic data (age, sex, and weight), type of anesthesia, duration of analgesia, time of first analgesic prescription, total dose of analgesic consumed, duration of stay in recovery, and duration of ACL arthroscopic repair was recorded. Discharge criteria (modified Aldrete score 9-10) (Activity 0-2, Breathing 0-2, Circulation 0-2, Consciousness 0-2, Oxygen Saturation (Pulse Oximetry) 0-2) from the PACU to the ward was assessed every 15 min by a nurse unaware to study groups. To measure the postoperative pain, Visual Analog Scale (VAS) was used [31], in which 0 shows no pain and 10 is worst imaginable pain [18,32].

In this study, 0 is analgesia, 1-3 is mild pain, 4-6 is moderate pain, and 7-10 is severe pain. After arthroscopy, in the first 30 minutes and, then after 1, 2, 6, 12, and 24 hour, the pain intensity of the patients was measured using VAS.

All patients received 1g of intravenous Apotel in the last 20 min of surgery and, after the ending of operation, in the presence of pain (VAS of more than 3), they received 0.05 mg/kg of intravenous morphine at each of the mentioned intervals. If pain still existed 1h after the administration of the first dose of morphine, morphine would be repeated with dose of 0.02 mg/kg. The patients were monitored in terms of systemic blood pressure (SBP), respiratory rate (RR), nausea, vomiting, and consciousness level after receiving morphine; in case of blood pressure drop above 20% of the baseline or systolic blood pressure less than 90 mmHg, they would receive 500 to 1000 ml of normal saline. Nausea and vomiting were treated with the injection of 0.15 mg/kg ondansetron, and respiratory depression (RR less than 10 minutes) was treated with the injection of titrated naloxone. The patients with severe, intolerable, and annoying itching following the administration of naloxone were treated with anti histamine were recorded and excluded.

All the collected data were analyzed in SPSS 20 using student t-test, Chi-squared test, Fisher's exact test, Repeated Measurement and Mann-Whitney U test.

Results

In this study performed in 2015, 81 patients were included, 40 of whom underwent ACL with spinal anesthesia and 41 with general anesthesia. The frequency distribution of the age group, sex distribution, (Table 1) and duration of surgery (min) had no significant difference between the two groups (SA 75.37 ± 15.24 min /GA 76.09 ± 12.22 min) (p=0.814).

Regarding the average duration of stay in recovery (per min) among the patients undergoing ACL arthroscopic repair, the average duration was 31.12 min in spinal group and 35 min in the general group (P=0.002); the difference was significant based on Mann-Whitney U test.

In terms of the frequency distribution of opioid and analgesic drug consumptions, there was no significant difference between the spinal and general groups (P=0.054).

Regarding mean time of analgesia after the surgical operation (h), using Mann-Whitney U test, the patients had mean 8.11 and 2.53 h of analgesia after spinal and general anesthesia, respectively (P=0.0001); the statistical difference was quite significant.

Repeated measurement test was significantly different in the mean VAS using spinal and general anesthesia at the studied time intervals (P=0.0001).

There was also a significant difference between the two groups of VAS at time intervals of 30 and 60 min after the end of surgery.

However, in other research time intervals, the statistical difference of VAS was not significant (Table 2).

Also, using repeated measurement test, there was a statistically significant difference in average morphine consumption between the two groups at time intervals of 30 and 60 min and 6 h after surgery, and morphine consumption was higher in the general group (P=0.0001, P=0.003, P=0.011). But, there was no significant difference at other time intervals (Figure 1 and Table 3).

Table 1: Demographic characteristics between GA, SA groups.

Age group (year)	Spinal		GA		Total		P value*
	n	%	n	%	n	%	
Less than 30	18	45	22	53.7	40	49.4	0.508
More than 30	22	55	19	46.3	41	50.6	
total	40	100	41	100	81	100	
Male gender	35	87.5	33	80.5	68	84	0.39
Female gender	5	12.5	8	19.5	13	16	
total	40	100	41	100	81	100	

*Chi-square test

Table 2: Statistical estimation in mean VAS in the time intervals between GA, SA groups.

Time interval	Group		Statistical estimate*	Partial Eta Squared (Effect size)	Observed Power _m
	SA(40)	GA(41)			
30 min post-op	0.42 ± 0.98	4 ± 1.5	Z=7.51,p=0.0001	0.669	0.99
60 min post-op	1.72 ± 1.03	3.12 ± 1	Z=5.57,p=0.0001	0.324	0.99
2 hours post-op	2.9 ± 1.53	2.68 ± 1.03	Z=0.64,p=0.517	0.007	0.115
6 hours post-op	2.8 ± 1.43	2.24 ± 1.04	Z=1.72,p=0.84	0.048	0.505
12 hours post-op	1.82 ± 0.9	1.68 ± 1.21	Z=0.7,p=0.484	0.004	0.091
24 hours post-op	0.92 ± 0.61	0.87 ± 0.74	Z=0.7,p=0.484	0.001	0.061
Intra group	F=35.96,p=0.0001	F=53.13, p=0.0001			
Between groups	F=50.14, p=0.0001			0.388	0.99

*Repeated Measurement and Mann-Whitney U test, m. Computed using alpha = 0 .05

Table 3: Average morphine consumption between the two groups at time intervals.

Time interval	Group		Statistical estimate*	Partial Eta Squared (Effect size)	Observed Power _m
	SA(40)	GA(41)			
30 min post-op	0.1 ± 0.63	3.01 ± 1.94	Z=6.29,P=0.0001	0.506	0.99
60 min post-op	0.26 ± 0.98	1.4 ± 2.01	Z=2.96,P=0.003	0.117	0.891
2 hours post-op	1.78 ± 2.04	0.93 ± 1.72	Z=1.89,P=0.059	0.049	0.514
6 hours post-op	1.7 ± 2.02	0.62 ± 1.53	Z=2.55,P=0.011	0.085	0.761
12 hours post-op	0.25 ± 0.91	0.25 ± 92	Z=0.01,P=0.992	0.000	0.050
24 hours post-op	0 ± 0	0 ± 0	Z=0.0,P=1.0	-	-
Intra group	F=15.03,P=0.0001 Partial Eta Squared= 0.278 Power = 0.99	F=20.03,P=0.0001 Partial Eta Squared= 0.334, Power = 0.99			
Between groups	F=20.8,p=0.0001			0.208	0.99

*Repeated Measurement and Mann-Whitney U test, m. Computed using alpha = 0 .05

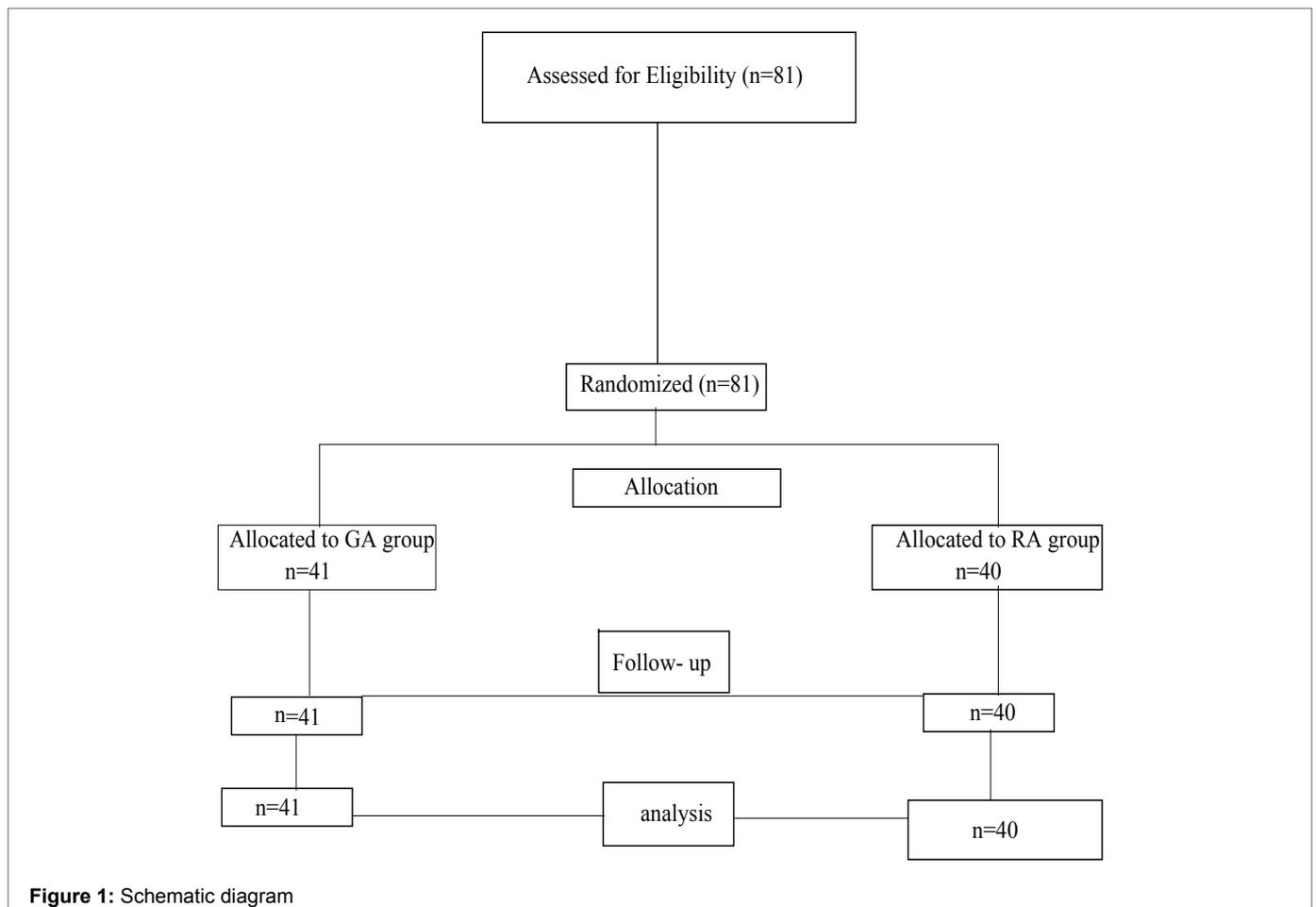


Figure 1: Schematic diagram

Discussion and Conclusion

Knee arthroscopy has a considerable postoperative pain; if the patient's pain is not properly managed, it can lead to delayed patient recovery, prolonged hospitalization period, increased patient costs, and prevent postoperative physiotherapy. Also, the patient even refuses continuing physiotherapy due to severe pain [31]. ACL is vital for normal knee functioning and high rate knee arthroscopy surgeries are dedicated to ACL [18].

In the present study, postoperative pain was examined using two methods of general and spinal anesthesia in patients undergoing arthroscopic repair. There was no statistically significant difference between two groups in age, sex distribution, and duration of surgery (min), frequency distribution of opioid and analgesic drug consumption.

In this study, the spinal anesthesia in knee arthroscopy caused a delay in demand for narcotics and reduced consumption of narcotic compared with the general anesthesia such that the average consumption of morphine was significantly different between the two groups at time intervals of 30 and 60 min and 6 h after surgery ($P=0.0001$, $P=0.003$, $P=0.011$, respectively). But, at other time intervals, there was no statistically significant difference.

Morphine consumption was also higher in the general group. The decreased pain with less morphine consumption is a golden standard in choosing anesthesia method because high morphine consumption for postoperative pain control is associated with respiratory depression [32]. In this study, the mean duration of analgesia in the patients after the end of surgery was higher in the spinal than general anesthesia and there was statistically significant difference, which was consistent with Jacobson et al. [1] findings.

For pain control after arthroscopy, different methods have been studied so far, which include ongoing epidural anesthetic with a catheter, femoral nerve block (with or without catheter insertion), patient-controlled analgesia (PCA), and intra-articular injection of topical anesthetics (such as lidocaine, bupivacaine, etc.), opiates (such as Fentanyl, morphine, pethidine, etc.), and ancillary drugs (clonidine, neostigmine, ketamine, etc.). Each of these methods has various advantages and disadvantages. The use of these methods depends on various factors such as experience and interest of anesthesiologists and orthopedics, conditions and facilities of the operating room and hospital, costs of drugs and equipment, etc. [33].

Jacobson et al. [1] compared the three methods of local, spinal, and general anesthesia in the patients undergoing arthroscopic repair. They reported that complications were found only in 5% of LA patients. From among three types of anesthesia in the majority of the patients undergoing elective arthroscopy, this study suggested LA as the first choice of anesthetic method as it is safer and more effective than the other two methods. In this study, 90% of LA patients were satisfied with the surgery and had less pain. Mulroy et al. [18],

who compared spinal, epidural, and general anesthesia in the patients undergoing outpatient arthroscopic repair, reported no serious complication in any of these three groups. The mean duration of postoperative analgesia was higher in the spinal than general and epidural groups, which was significant and which was consistent with our study. Harsten et al. [30] reported that the general anesthesia with propofol and remifentanyl led to less postoperative pain, nausea, and vomiting than spinal anesthesia technique using 0.5% bupivacaine in the patients undergoing total knee arthroscopy, which was not consistent with the present study. Nevertheless, Rodgers et al. [29] suggested the regional anesthesia with intrathecal technique.

In the present study, the mean duration of stay in recovery was less in the spinal than general group. The mean duration of stay in recovery (min) was less in the spinal (31.12 min) than general (35 min) groups, and the statistical difference was significant ($P=0.002$).

There was statistically significant difference in mean of VAS using spinal and general anesthesia at the studied intervals ($P=0.0001$). There was also statistically significant difference between the VAS among two groups at time intervals of 30 and 60 min after the end of surgery, but the statistical difference of VAS was not significant at other time intervals.

In this study, the postoperative complications were slightly more in the general anesthetic group than the spinal one, but the difference was not statistically significant. Many studies have stated that, for many orthopedic procedures, regional anesthesia can reduce perioperative complications and might provide a better analgesic status [34].

In our study, we had some limitations such as the patient's collections because of their operations were done by a surgeon.

According to the findings of this study, it seems that the postoperative pain in the patients undergoing ACL arthroscopic repair with general anesthesia was higher and the duration of analgesia after the surgery was shorter. However, no significant difference was found in terms of total dose of analgesic consumed.

References

- Jacobson E, Forsblad M, Rosenberg J, Westman L, Weidenhielm L (2000) Can local anesthesia be recommended for routine use in elective knee arthroscopy? A comparison between local, spinal, and general anesthesia. *Arthroscopy* 16: 183-190.
- Goranson B, Lan S, Cassidy J, Dust W, McKerrel J (1997) A comparison of three regional anesthesia techniques for outpatient knee arthroscopy. *Can. J Anaesth* 44: 371-376.
- Friedberg R (2010) Anterior cruciate ligament injury: Up To Date.
- Asadi M, Haghshenas M, MoghaddamSPR, Azizi A, hashemi-Motlagh K, et al. (2013) Evaluation of the Factors Associated with knee Injuries among Guilan Athletes. *Journal of Guilan University of Material Science*. 22: 48-53.
- Buckley J, Hood G, Macrae W (1989) Arthroscopy under local anesthesia. *J Bone Joint Surg* 71: 126-127.

6. Wredmark T, Lundh R (1982) Arthroscopy under local anaesthesia using controlled pressure-irrigation with prilocaine. *J Bone Joint Surg Br* 64: 583-585.
7. Weiker G, Kuivila T, Pippingier C (1991) Serum lidocaine and bupivacaine levels in local technique knee arthroscopy. *Am J Sports Med* 19: 499-502.
8. Wu C, Bronstein R, Chen J, DH Lee, Rouse L (2000) Postoperative analgesic requirements in patients undergoing arthroscopic anterior cruciate ligament reconstruction. *Am J Orthop* 29: 974-978.
9. Edkin B, Spindler K, Flanagan J (1995) Femoral nerve block as an alternative to parenteral narcotics for pain control after anterior cruciate ligament reconstruction. *Arthroscopy* 11: 404-409.
10. Nesioonpour S, Akhondzadeh R, Pipelzadeh M, Rezaee S, Nazaree E, et al. (2013) The Effect of Pre-emptive Analgesia with Bupivacaine on Postoperative Pain of Inguinal Hernia Repair under Spinal Hernia: A Randomized Clinical Trial *Anaesthesia. Hernia* 17: 465-470.
11. Mohammadian- Erdi A, Poorfarzy F, Sammani A-r, Radmehr M, Nourozi V (2011) Comparison of analgesia and side effects fentanyl or sufentanil with bupivacaine in lower limb orthopedic surgery patients using continuous infusion epidural. *Anesthesiol Pain* 1: 57-63.
12. Klasen J, Opitz S, Melzer C, Thiel A, Hempelmann G (1999) Intra articular, epidural, and intravenous analgesia after total knee arthroplasty. *Acta Anaesthesiol Scand* 43: 1021-1026.
13. Sinatra R (2009) Acute pain management. In: 1st, editor. Cambridge University press. P. 216-236.
14. Ruben S, Ekman E (2007) The Effect of Initiating a preventive Multimodal Analgesic Regimen on Long- term Patient Outcomes for Outpatient Anterior Cruciate Ligament Reconstruction Surgery. *Anesth Analg* 105: 228-232.
15. Ben- David B, Solomon E, Levin H, Admoni H, Goldik Z (1997) Intrathecal fentanyl with small dose dilute bupivacaine: better anesthesia without prolonging recovery. *Anesth Analg* 85: 560-565.
16. Parnass S, McCarthy R, Bach BJ, Corey E, Hasson S, et al (1993) Beneficial impact of epidural anesthesia on recovery after outpatient arthroscopy. *Arthroscopy*. 9: 91-95.
17. Jankoesy C, Helb J, stuart M, Rock M, Pagnanom MW, et al. (2003) A comparison of psoas compartment block and spinal and general anesthesia for outpatient knee arthroscopy. *Anesth Analg* 97: 1003-1009 .
18. Mulroy M, Larkin K, hodgson P, Helman J, Pollock J, et al. (2000) A comparison of spinal, epidural and general anesthesia for outpatient knee arthroscopy. *Anesth Analg* 91: 860-864.
19. Wrong B, Marshall S, Chung F, Sinclair D, Song D, et al. (2001) Spinal anesthesia improves the early recovery profile of patients undergoing knee arthroscopy. *Can J Anaesth* 48: 369-374.
20. Kawamata Y, Nishikawa K, Kawamata T, Omote K, Igarashi M, et al. (2003) A comparison of hyperbaeic 1% and 3% solutions of small dose lidocaine in spinal anesthesia. *Anesth Analg*. 96: 881-884.
21. Valenzuela C, Synders DJ, Bennett PB, Tamargo J, Hondeghem LM (1995) Stereo selective block of cardiac sodium channels by bupivacaine in guinea pig ventricular myocytes. *Circulation* 92: 3014-3024.
22. Griswood RW (2002) Cardiac and CNS toxicity of levobupivacaine: strengths of evidence for advantage over bupivacaine. *Drug Safety* 25: 153-163.
23. Bardsley H, Gristwood R, Baker H, Watson N, Nimmo W (1998) A comparison of the cardiovascular effects of levobupivacaine and rap- bupivacaine following intravenous administration to healthy volunteers. *Br J Clin Pharmacol* 46: 245-249.
24. Frascarolo P, Reiz S, Morrison SG, Dominguez JJ (2000) A comparison of the electrocardiographic cardio toxic effects of racemic bupivacaine, levobupivacaine and ropivacaine in anesthetized swine. *Anesth Analg* 90: 1308-1314.
25. Huang YF, Pryor ME, Mather LE, Veering BT (1998) Cardiovascular and central nervous system effects of intravenous levobupivacaine and bupivacaine in sheep. *Anesth Analg* 86: 797-804.
26. Burm A, Meer A, Kleef J, Zeijlmans P, Grogen K(1994) Pharmacokinetics of the enantiomers of bupivacaine following intravenous administration of racemate. *Br J Clin Pharmacol* 38: 125-129.
27. Hassan Hi (2015) Comparison between two different selective spinal anesthesia techniques in ambulatory knee arthroscopy as fast- track anesthesia. *Anesth Essays Res* 9: 21-27.
28. Del- Rio- Vellosillo M, Gracia- Medina JJ, Abengochea- Contania A, Pianzo- Duran MD, barbera- Alacreu M (2014) Spinal anesthesia for knee arthroscopy using isobaric bupivacaine and levobupivacaine: anesthetic and neuroophthalmological assessment. *Biomed Res Int*.
29. Rodgers A, Walker N, schug S, A McKee, H Kehlet, et al. (2000) Reduction of postoperative mortality with epidural or spinal anesthesia: results from overview of randomized trials. *Br Med J* 321: 1439.
30. Harsten A, kehlet H, Toksvig- Larsen S (2013) Recovery after total intravenous general anaesthesia or spinal anaesthesia for total knee arthroscopy: a randomized trial. *Br J Anaesth* 111: 391-399.
31. Momin A, Raza S, Aziz A. (2016) Comparison of the Efficacy of Intra-Articular Bupivacaine with Intra-Articular Admixture of Bupivacaine and Tramadol in the Immediate Postop Management of Pain after knee Arthroscopy. *P J M H S* 10: 387-391.
32. Grassi A, Vascellari A, Combi A, Tomaello L, Canata GL, et al. (2016) Return to sport after ACL reconstruction: a survey between the Italian Society of Knee, Arthroscopy, Sport, Cartilage and Orthopaedic Technologies (SIGASCOT) members. *Eur J Orthop Surg Traumatol* 26: 509-516.
33. ImaniF, HassaniV, Razi M, Entezari (2007) A Comparison of Intra-Articular Pethidine and 0.5% Bupivacaine at the end of Knee Arthroscopy on Postoperative Analgesia. *Razi Journal of Medical* 14: 53-61.
34. Teunkens A, Vermeulen K, Van Gerven E, Fieuws S, Van de Velde M, et al. (2016) Comparison of 2-Chloroprocaine, Bupivacaine, and Lidocaine for Spinal Anesthesia in Patients Undergoing Knee Arthroscopy in an Outpatient Setting: A Double-Blind Randomized Controlled Trial. *Reg Anesth Pain Med* 41: 576-583.