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Research Article

COMPARISON OF COMPLICATIONS OF SPINAL AND GENERAL ANESTHASIA IN PERCUTANEOUS KIDNEY STONE REMOVAL

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ABSTRACT

While the complications of spinal anesthesia are much less than general anesthesia, percutaneous nephrolithotomy (PCNL) is still performed under general anesthesia in most centers. Therefore, in this study spinal anesthesia is compared with general anesthesia in patients undergoing PCNL. This research was a double-blind clinical trial study which was conducted on 130 patients with inclusion criteria. Patients were nonrandomly assigned into two general anesthesia (n=65) and spinal anesthesia (n=65) groups and underwent PCNL surgery.

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In group A, patients were given intravenously midazolam (2 mg), fentanyl (100 µg), atracurium (0.5 mg/kg), propofol (2 mg/kg) and morphine (10 mg) and then were incubated. In group B, Marcaine 0.5% (15 mg) was injected into the L3-L4 or L4-L5 lumbar spinal space in a sitting position. Patient's blood pressure was measured and recorded at various times and in recovery as well as in the surgery room. Intra-operative bleeding, pain in the surgery area, nausea and vomiting, shortness of breath and sore throat were recorded for the two groups in the ward and during hospitalization.

Changes of blood pressure were the same in both groups. In the general anesthesia group, intra-operative bleeding, pain at the site of the surgery, nausea and vomiting, shortness of breath and sore throat and duration of hospitalization were significantly higher. Changes in other tests were equal in both groups. Spinal anesthesia might be a safer method than general anesthesia for PCNL surgery.

Keywords: Complication, Spinal Anesthesia, General Anesthesia, Kidney Stone Removal, Percutaneous

1. INTRODUCTION

Urinary tract stones are one of the major problems in clinical medicine which ranks third among kidney and urinary tract diseases after urinary tract infections and prostate problems [1,2]. Over 10 percent of world population experience urinary tract stones during their life and about 10-30% of these patients need urologic interventions [3].

Calcium salts, uric acid, cysteine and struvite (staghorn calculi) are major components of kidney stones. Calcium oxalate and calcium phosphate stones make up 75 to 85 percent of all stones and can also exist in one stone. Calcium stones are more common in men. The mean age of onset of symptoms is in the third decade of life, and almost 60 percent of patients will build another stone within the next 10 years. Uric acid stones are most common in men and cysteine stones are among the lowest. Struvite stones are common and potentially dangerous, which can be observed more in women or patients who need chronic bladder catheterization [4].

Urinary stones are either alone or multiple with different shapes and sizes that concentrate in the kidney texture or urinary collecting system [5]. Ureteral stones less than 4 mm usually pass through the ureter, but rarely pass spontaneously with much more than 6 mm and need medical interventions [6].

Given the advances in medical and surgical areas, the techniques that are minimally invasive are preferred [1,2]. Recently, the treatment of urinary stones has completely changed and ureteral stones that do not pass spontaneously can be crushed and removed by various methods such as transurethral lithotripsy (TUL), extracorporeal shock wave lithotripsy (ESWL), percutaneous Nephrolithotomy (PCNL), laparoscopy and open surgery [7]. In percutaneous nephrolithotomy (PCNL) stones are crushed and removed with a few millimeters probe through the skin [8-10].

PCNL is a selective treatment for kidney stones with a diameter of more than 2-3 cm, staghorn calculi, multiple stones in renal pelvis, large stones in ureter upper part, diverticulum kidney stones and cases in which extracorporeal shock wave lithotripsy (ESWL) is not successful, such as calcium oxalate monohydrate and cysteine stones [11,12], therefore, surgeons prefer this procedure.

PCNL is often performed under general anesthesia, while the complications of general anesthesia is much greater than spinal anesthesia for various reasons, including the possibility of difficult intubation, severe respiratory failure after anesthesia, and the risk of anaphylaxis due to the use of multiple drugs [11,13]. Also, studies show that patients undergoing lower abdominal and extremity surgeries incur much lower costs in spinal anesthesia compared to general anesthesia. On the other hand, general anesthesia has some complications, such as pulmonary complications, atelectasis, pulmonary infection, neurological complications, such as brachial plexus injuries, vascular injuries, such as deep vein thrombosis (DVT), mouth and teeth injuries, the displacement of the endotracheal tube or its complete removal, especially at the time of changing patient's status [1,3]. According to anesthetists, spinal anesthesia is more appropriate due to a quick start, easy technique, acceptable nerve block, quick block and reduced complications [14,15]. In a study (2011) conducted on 59 patients undergoing PCNL in two general and spinal

anesthesia, patients were evaluated in terms of mean changes in blood pressure, heart rate and intra-operative bleeding, duration of surgery and anesthesia duration and the amount of analgesic drug after surgery that no difference was observed between changes in average blood pressure and heart rate, but the duration of surgery and anesthesia, intra-operative bleeding and the amount of analgesic drug after surgery significantly decreased in the spinal anesthesia group [16]. In a retrospective study performed on 1004 patients (from 2004 to 2011), it was found that the length of hospitalization and duration of surgery were significantly decreased in the spinal anesthesia group and the need for analgesic drug and blood transfusion were also significantly lower in this group and PCNL under spinal anesthesia was introduced a safer method [17].

This method cannot be used in some situations, such as when the patient does not prefer this method, patient is unable to maintain his stability during the spinal injection, there are neurological/structural problems, the patient is mentally ill, the patient is mentally retarded, and when there is a high intracranial pressure. The relative contraindications include situations in which the patient has used anticoagulant drugs such as heparin, Coumadin, etc., there is skin infection or soft tissue at the injection site, patient has severe intravascular volume depletion, and the anesthesiologist has not enough experience [13].

This study aimed to compare the complications of spinal anesthesia with general anesthesia in percutaneous kidney stone removal.

2. RESULTS

A total number of 130 patients participated in this study and were equally assigned into two groups. The overall frequency and in terms of gender in each group are shown in Table 1. The mean age and standard deviation of patients are shown in Table 2, indicating that the mean age of men is 40 years and their standard deviation is about 11 years and the mean age of women is 42.5 years and their standard deviation is 9.5 years.

Table 1. Gender and age of the participants

Groups	General anesthesia		Spinal anesthesia	
Variables	Frequency	%	Frequency	%
Man	45	69.23	52	0.80
Woman	20	30.77	13	20
	Mean	Standard deviation	Mean	Standard deviation
Age (year)	39.95	11.18	42.51	9.53

In Table 2, systolic blood pressure was compared in both groups before undergoing general anesthesia and spinal anesthesia, after general anesthesia and spinal anesthesia, in the tenth minute, at the end of the surgery, after recovery and six hours after surgery in the ward and the results showed that the mean systolic blood pressure before general anesthesia was 132.77 with a standard deviation of 16.35 and in the spinal anesthesia group was 147.477 with a standard deviation of 19.16; there was no significant difference between the two groups, P=0.110. The mean systolic blood pressure after general anesthesia was 142.93 with a standard deviation of 22.46 and in the spinal anesthesia group was 137.93 with a standard deviation of 17.46, there was a significant difference between the two groups, P=0.041. The mean systolic blood pressure in the tenth minute of surgery in the general anesthesia group was 112.52 with a standard deviation of 14.12 and in the spinal anesthesia was 113.43 with a standard deviation of 16.28, there was no significant difference between the two groups, P=0.779. The mean systolic blood pressure at the end of surgery in the general anesthesia group was 127.75 with a standard deviation of 17.07 and in the spinal anesthesia group was 123.90 with a standard deviation of 13.38, there was no significant difference between the two groups, P=0.095. The mean systolic blood pressure after surgery in the recovery in general anesthesia was 131.10 with a standard deviation of 13.68 and in the spinal anesthesia was 124.92 with a standard deviation of 18.87, there was no significant difference between the two groups, P=0.900. The mean systolic blood pressure six hours after

surgery in the general anesthesia group was 112.69 with a standard deviation of 11.01 and in the spinal anesthesia group was 121.69 with a standard deviation of 16.96, there was no significant difference between the two groups, P=0.210. According to Table 2, systolic blood pressure changes showed no significant difference in both groups at all times except after general anesthesia and spinal anesthesia.

In Table 2, the diastolic blood pressure was compared in both groups before undergoing general anesthesia and spinal anesthesia, after general anesthesia and spinal anesthesia, in the tenth minute, at the end of the surgery, after recovery and six hours after surgery in the ward and the results showed that the mean diastolic blood pressure before general anesthesia was 86.84 with a standard deviation of 12.02 and in the spinal anesthesia group was 89.92 with a standard deviation of 12.65; there was no significant difference between the two groups, P=0.068. The mean diastolic blood pressure after general anesthesia was 95.13 with a standard deviation of 18.18 and in the spinal anesthesia group was 84.8 with a standard deviation of 13.13, there was no significant difference between the two groups, P=0.060. The mean diastolic blood pressure in the tenth minute of surgery in the general anesthesia group was 88.1 with a standard deviation of 12.91 and in the spinal anesthesia was 70.86 with a standard deviation of 11.91, there was no significant difference between the two groups, P=0.290. The mean diastolic blood pressure at the end of surgery in the general anesthesia group was 86.56 with a standard deviation of 15.2 and in the spinal anesthesia group was 77.61 with a standard deviation of 10.13, there was a significant difference between the two groups, P=0.046. The mean diastolic blood pressure after surgery in the recovery in general anesthesia was 84.61 with a standard deviation of 10.34 and in the spinal anesthesia was 87.27 with a standard deviation of 9.26, there was no significant difference between the two groups, P=0.091. The mean diastolic blood pressure six hours after surgery in the general anesthesia group was 71.23 with a standard deviation of 8.47 and in the spinal anesthesia group was 75.53 with a standard deviation of 10.86, there was no significant difference between the two groups, P=0.091. According to Table 2, diastolic blood pressure changes were insignificant in both groups at all times, except at the end of the surgery.

In Table 3 the frequency and percentage of intra-operative bleeding in three groups were compared: less than 300 ml, between 300 ml and 500 ml and more than 500. The frequency of bleeding less than 300 ml was observed in the general anesthesia group (n=42, 46.6%), and in the spinal anesthesia group (n=58, 89.2%). The frequency of bleeding between 300-500 ml was observed in the general anesthesia group (n=14, 31.5%), and in the spinal anesthesia group (n=7, 10.8%). The frequency of bleeding more than 500 ml was observed in the general anesthesia group (n=9, 13.8%), and it was zero in the spinal anesthesia group, that this relationship is insignificant, P=0.00.

In Table 3, nausea and vomiting in each group and totally were compared. No nausea and vomiting were observed in the general anesthesia group (n=41, 63.1%) and in the spinal anesthesia group (n=51, 78.5%). Four patients (6.2%) in the general anesthesia group and 8 patients (12.3%) in the spinal anesthesia group had only nausea. Twenty patients (30.8%) in the general anesthesia group and 4 patients (6.2%) in the spinal anesthesia group had vomiting once or twice. Two patients (3.1%) in the spinal anesthesia group had more than twice vomiting and in the general anesthesia group no patient had vomiting more than twice, that this relationship is significant, P=0.015.

Shortness of breath was evaluated in the two groups in the ward six hours after the surgery. According to Table 3, from a total of 65 patients in the general anesthesia group, 4 patients (6.2%) had shortness of breath. This value was zero in the spinal anesthesia group, that this relationship is significant, P=0.04.

Sore throat was evaluated in the two groups in the ward six hours after the surgery. According to Table 3, from a total of 65 patients in the general anesthesia group, 20 patients (30.8%) had sore throat. This value was zero in the spinal anesthesia group, that this relationship is significant, P=0.0.

Table 2 .The mean and standard deviation of systolic and diastolic blood pressure, postoperative pain and intra-operative bleeding in the two groups

		General anesthesia		Spinal anesthesia		p-value
		Mean	Standard deviation	Mean	Standard deviation	
Systolic blood pressure (mmHg)	Before anesthesia	132.77	16.35	19.17	147.48	0.11
	After anesthesia	22.46	142.94	17.46	137.94	0.041
	In the tenth minute of surgery	14.12	116.52	16.28	113.43	0.779
	At the end of the surgery	17.06	127.75	13.38	123.91	0.095
	In the recovery	13.68	131.11	18.87	124.92	0.9
	Six hours after the surgery	11.01	112.69	16.96	121.69	0.21
Diastolic blood pressure (mmHg)	Before anesthesia	12.02891	86.8462	12.65191	89.9231	0.068
	After anesthesia	18.18213	95.1385	13.13059	84.8	0.060
	In the tenth minute of surgery	12.16189	77.1077	11.1621	70.8615	0.290
	At the end of the	15.20893	86.5692	10.13736	77.6154	0.046

	surgery					
	In the recovery	10.34815	84.6154	9.26605	78.2769	0.455
	Six hours after the surgery	8.47933	71.2308	10.86577	75.5385	0.091

Table 3. Frequency and percentage of pain after surgery, intra-operative bleeding, nausea and vomiting, shortness of breath and sore throat in the two groups

		General anesthesia		Spinal anesthesia		p-value
		Frequency	%	Frequency	%	
Intra-operative bleeding (ml)	Less than 300	42	64.6	58	89.2	0.00
	300-500	14	31.5	7	10.8	
	More then 500	9	13.8	0	0	
Nausea and vomiting	No	41	63.1	51	78.5	0.15
	Nausea	4	6.2	8	12.3	
	Vomiting 1-2 times	20	30.8	4	6.2	
	Vomiting more than twice	0	0	2	3.1	
Shortness of breath	Yes	4	6.2	0	0	0.04
	No	61	93.8	65	100	
Sore throat	Yes	20	30.8	0	0	0.00
	No	45	69.2	65	100	

In this study, pain at the site of the surgery was measured in both groups six hours after the surgery in the ward with scoring from zero to ten based on the severity of pain. Table 7 shows the frequency and percentage of pain values. In the general anesthesia group, the scores of 1, 2, 3, 5, 6, 7, 8, 9, and 10 were considered for pain at the site of the surgery by 5, 8, 6, 21, 8, 2, 10, 1, and 4 patients, respectively. In the spinal anesthesia group, the scores of 0, 1, 2, 3, 4, 5, 6, 8, 9 and 10 were considered for pain at the site of the surgery by 2, 11, 14, 6, 12, 6, 6, 5, 1, and 2 patients, respectively, that the difference was significant (Table 4) (P=0.01).

Table 4. Frequency and percentage of pain in the two groups

Pain			Zero	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Significance
Type of anesthesia	General anesthesia	Frequency	0	5	8	6	0	21	8	2	10	1	4	P=0.01
		%	0	7.7	12.3	9.2	0	32.3	12.3	3.1	15.4	1.5	6.2	
	Spinal anesthesia	Frequency	2	11	14	6	12	6	6	0	5	1	2	
		%	3.1	16.9	21.5	9.2	18.4	9.2	9.2	0	7.7	1.5	3.1	
	Total	Frequency	2	16	22	12	12	27	14	2	15	2	6	
		%	1.5	12.3	16.9	9.2	9.2	20.8	10.8	1.5	11.5	1.5	4.6	

3. DISCUSSION

Hemodynamic changes in terms of systolic and diastolic blood pressure were evaluated in both groups at different times, and their mean was almost similar in both groups. Most often, this relationship was not statistically significant and almost similar hemodynamic changes were obtained in both groups.

In a study conducted by Movasaghi et al. in Shahid Hashemi Nejad Hospital (Tehran), hemodynamic changes were similar in both groups [17], which is consistent with this study. But, other studies conducted by Mehrabi et al. at the University of Yasouj [18,19] and by Roodneshin et al. in Shahid Beheshti Hospital [20], hemodynamic changes and blood pressure drop in the spinal anesthesia group were more, which is inconsistent with the result of the present study. In

the study of Borzooei and Mousavi-Bahar, 0.3% of patients undergoing PCNL surgery with spinal anesthesia experienced a severe drop in blood pressure [21].

Intra-operative bleeding is another complication which can occur during any surgery. In this study, the amount of bleeding was estimated in each group and compared with the other group. The amount of bleeding in the spinal anesthesia group was statistically significantly lower than the general anesthesia group. Similar results were obtained in the study of Movasaghi et al. in Shahid Hashemi Nejad Hospital [17].

In the spinal anesthesia, 51 patients (78.3%) gave the score of 5 and less for their pain, while in the general anesthesia 40 patients (61.5%) gave the similar scores, and pain was statistically significantly more in the general anesthesia group. In the study of Roodneshin et al. [20], Movasaghi et al. [17,22] and studies conducted in New York City [23] and Thailand [24] the need for analgesic drug was also statistically significantly reduced in the spinal anesthesia group. In studies conducted in Egypt [20] and Thailand [24] post-operative pain was also statistically significantly lower in the spinal anesthesia group. Previous studies show similar results, as a result, spinal anesthesia reduce significantly pain and the need for analgesic drugs.

In this study, the incidence of nausea and vomiting in patients undergoing general anesthesia were more than spinal anesthesia. Studies conducted in Egypt [20], Thailand [24] and New York City [23] suggest that nausea and vomiting in the general anesthesia group were higher than the spinal anesthesia group.

Patients in both groups were asked about shortness of breath six hours after surgery. Since in the spinal anesthesia group the respiratory system works normally and the patient has spontaneous breathing during surgery, none of the patients had postoperative shortness of breath, while 4 patients (6.2%) in the general anesthesia group had shortness of breath and needed oxygen.

In the general anesthesia group, 20 patients (30.8%) had sore throat and hoarseness after intubation of larynx. But, as there is no need for intubation in the spinal anesthesia group, no sore throat was observed. Shortness of breath and sore throat were not evaluated in the previous studies.

4. MATERIALS AND METHODS

This research was a clinical - trial study which was conducted after it was approved by the Research Council of Jahrom University of Medical Sciences and was confirmed by the Ethics Committee. A total number of 130 patients were enrolled after their written informed consent was obtained. Patients who enrolled in this study were between the ages of 20-60 years, and they were candidates for PCNL surgery (in 2014 and 2015) at Peymanieh Hospital, Jahrom, Iran, and were operated by a specific surgeon. Exclusion criteria included unsuccessful spinal anesthesia in the first step, any respiratory problem and any PCNL leading to opening operation or hospitalization in the ICU.

All patients were assessed by a questionnaire before entering the study and their age and gender were recorded and randomly (random number table) were assigned into one of the two groups of general or spinal anesthesia. Before anesthesia (general or spinal) the patient was placed on the operating table, and a good intravenous route was used and after installation of electrocardiography leads on his chest and pulse oximetry and wrapping blood pressure cuff around his arm, patient's vital signs including systolic and diastolic blood pressure were measured and recorded. Then the group A was given Marcaine 0.5% (15 mg) by spinal injection and group B was given midazolam (2 mg), fentanyl (100 mg), atracurium (0.5 mg/kg), propofol (2 mg/kg), and morphine (10 mg) and intubation was performed with a good sized tracheal tube. Blood pressure was measured immediately after general anesthesia or spinal anesthesia. After performing the preliminary steps, the patient was placed in the prone position by the surgical team. Blood pressure was measured and recorded again 10 minutes after surgery. Bleeding was recorded as follows, the blood in the suction bottle was measured in milliliters and 30 ml for each soaked gauze gas and about 70 ml for each soaked towel were added. At the end of the operation and during recovery blood pressure was measured and recorded again. After operation the patient was kept in the recovery for at least an hour and then was transferred to the ward. Six hours after the surgery in urology surgery ward, patients were asked about nausea and vomiting based on the scoring table. Zero score was given for the lack of nausea and vomiting, the score of 1 was given

for nausea, the score of 2 was given for 1-2 times vomiting, and the score of 4 was given for vomiting more than 2 times. Six hours after surgery, patients were asked about shortness of breath and sore throat and they were recorded. Pain at the site of the surgery was measured in both groups six hours after the surgery in the ward with scoring from zero to ten based on the severity of pain.

Then, the data were recorded by SPSS-16 and analyzed by chi-square test, repeated measurement test, ANOVA test, T-test, Fisher test, and correlation test. P less than 0.05 was considered as statistically significant.

5. CONCLUSION

Although it is thought that percutaneous nephrolithotomy with spinal anesthesia and regional methods is difficult and patient has difficulty to tolerate it, most patients easily tolerate the surgery, and different parts of kidney can be accessed easily like in the general anesthesia. Therefore, in this type of surgery the use of this method is recommended instead of using general anesthesia. According to the results of this study, spinal anesthesia in percutaneous nephrolithotomy is a safe method with lower complications and costs than general anesthesia.

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