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Effect of Epidural Analgesia in the Peri-Operative Haemodynamic Changes and Recovery Profile in Patients Undergoing Percutaneous Nephrolithotomy under General Anesthesia

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Abstract
General Anaesthesia with controlled ventilation is the most commonly used anaesthetic method for percutaneous nephrolithotomy. Although central neuraxial blockade provides good analgesia and stress suppression, spontaneous respiration with these techniques makes the procedure difficult for the surgeon. In this study Epidural analgesia is provided along with general anaesthesia to improve haemodynamic stability and decrease the peri-operative use of sedatives and analgesics thereby making recovery smooth. 100 patients undergoing PCNL were randomly allocated into two groups of 50 patients each. Group 1 (E) received Epidural Analgesia before induction of general anesthesia using 8ml of 0.2% Ropivacaine. Group 2 (C) patients received general anaesthesia alone like the group 1 patients. Haemodynamic responses [Systolic and diastolic BP, heart rate] were assessed in intraoperative period and in the immediate recovery. Recovery (pain & comfort) was assessed by 'VAS" (Visual Analogue Scoring system). In the recovery if there were complaints like pain, increased blood pressure or tachycardia further supplementation of epidural drugs was given in Group 1(E). In group 2 (C) these problems were managed by systemic drugs like tramadol, fentanyl or antihypertensives as needed. The results showed that epidural analgesia with 0.2% Ropivacaine is effective in controlling the intraoperative and postoperative rise in blood pressure associated with PCNL, but was not very effective in the control of rise in heart rate during the intraoperative and postoperative period. The recovery profile of patients in Group 1(E) showed lesser post operative pain and fewer patients in Group 1(E) had complications like shivering and hypertension.
Keywords: *Epidural analgesia, Ropivacaine, PCNL.*

Introduction

Percutaneous nephrolithotomy (PCNL) is the treatment of choice for large kidney stones, stag horn calculi & multiple calculi. First described by Fernster & Johnson in 1976, it is a minimally invasive procedure done for stone removal. PCNL is done under general or regional anaesthesia with the patient in prone position with Normal Saline or distilled water as irrigant solution. Studies have shown that PCNL under general anaesthesia was

associated with peri-operative complications especially haemodynamic changes [1],[2]. In a previous study in our department on peri-operative complications of PCNL under general anaesthesia significant haemodynamic changes were noted. Among 75 patients studied, hypertension was noted in 40% during intra operative and 20% during recovery period. Tachycardia was noted in 35% during intraoperative and 16% during postoperative period. 61.9% of the treated hypertensive patients had no perioperative complications, while 70% of previous normotensive patients had perioperative hypertension. One reason for the significant haemodynamic changes may be stress response of the renal surgery. Better suppression of the stress response in treated hypertensive patients may be due to the pharmacological suppression. Recovery related complications were delayed recovery (15%), respiratory distress due to laryngeal spasm, sedation etc. The regional anaesthesia techniques, spinal anaesthesia & epidural anaesthesia can effectively suppress the surgical stimulus, provide good analgesia and avoid recovery related problems. The complications of PCNL under spinal anaesthesia were studied and compared to those under general anaesthesia[3],[4]. Intra operative hypotension, post operative back pain and headache were higher in spinal anaesthesia group. Central neuraxial block provides good analgesia & stress suppression but inherent problems of neuraxial blocks like respiratory compromise, bradycardia and hypotension are difficult to manage with patient in prone position. Spontaneous respiration with these techniques makes the procedure difficult. Epidural analgesia along with general anaesthesia provides haemodynamic stability, control over respiration & makes the procedure safe. Epidural analgesia also helps to reduce the dose of muscle relaxants and sedatives making recovery smooth.

Regional anaesthesia and stress response [5]–

During surgery or trauma two types of stimuli are elicited.

1. Local inflammatory process with an increase of chemical mediators (IL 1, 2, 6, TNF) which stimulate hypothalamus-hypophysial-suprarenal axis.

2. Nociceptive afferent pathway: Impulse from injured area → dorsal horn of spinal cord → ascend by spinothalamic tract & reticulo spinal thalamic tract →para ventricular hypothalamic nuclei. These nuclei integrate the nociceptive stimuli, hormone response & anatomic response. It also has cells which contain corticotrophin releasing hormone which stimulate the release of ACTH & beta endorphin.

Stress response can also be seen by two other pathways:

a – Hormonal efferent pathway: increase in ACTH produce increase in suprarenal hormones like – cortisol, Renin-Angiotensin-Aldosterone, glucagon, ADH, GH and Prolactin, causing increased blood sugar, protein catabolism and decreased immunologic function.

b – Sympathetic efferent pathway: stimulus of cardiac fibres produce increase of heart rate, contractility with increased O_2 consumption & post operative ischemia.

Stimulation of splanchnic fibers produce reduction of visceral blood flow and increase in epinephrine production at the suprarenal medulla.

Innervation of the genito-urinary system [6]

Pain conduction pathways & spinal segmental projection of pain of genitourinary system

Organ	Sympathetic spinal segment	Para sympathetic	Spinal level of pain conduction
Kidney	$T_8 – L_1$	CN X (Vagus)	$T_{10} – L_1$
Ureter	$T_{10} – L_2$	$S_2 – S_4$	$T_{10} – L_2$
Bladder	$T_{11} – L_2$	$S_2 – S_4$	Dome $T_{11} – L_2$ Neck $S_2 – S_4$

Effective block of segments is necessary to provide adequate analgesia or anesthesia of bladder & ureter. Sympathetic fibers to bladder and urethra originate from $T_{11} – L_2$, Para

sympathetic fibers originate from S_2 – S_4. Parasympathetic fibers are the main motor supply to the bladder except trigone. During PCNL in the intraoperative period stimuli of the kidney (T_8 – L_1) leads to the haemodynamic changes; in the recovery nociceptive stimuli from the bladder due to catheterization & trigone spasm (S_2 – S_4) leads to discomfort and pain.

If local anesthetics are placed in the spinal cord, they can block afferent nociceptive and efferent sympathetic pathways and avoid hyperexcitability at dorsal horn & lateral horn level. This has beneficial effects in cardiovascular and splanchnic perfusion. The stress suppression attained during surgery continues in the postoperative period.

In this study the amide local anaesthetic Ropivacaine with 0.2% concentration is used at a dose of 8ml. Ropivacaine has less impact on the cardiac conduction and frequency of arrhythmias. It has vasoconstrictive properties at these concentrations which may explain its longer duration compared to Bupivacaine [(7)]. Sensory block with Ropivacaine is similar to Bupivacaine [(8)] but Ropivacaine showed greater separation of sensory and motor block [(9),(10)] and better patient satisfaction[(11)].

Studies have also showed that Ropivacaine is effective for intraoperative and postoperative analgesia in patients undergoing PCNL [(12), (13), (14)].

Objective

To study the effect of Epidural analgesia using the drug Ropivacaine in patients undergoing PCNL under General Anaesthesia with regard to:

1. Haemodynamic changes in the peri-operative period
2. Immediate recovery profile

Materials and Methods

The study was conducted in the Department of Anaesthesiology, Government Medical College, Kottayam. The study included 2 randomized groups posted for PCNL. Inclusion criteria was all patients undergoing PCNL during the study period aged 12 – 70. Exclusion criteria was age <12 or >70 years, contraindications to regional anaesthesia like patient refusal, IVDP etc. They were evaluated for GA & Epidural block. Informed consent was taken from all patients. The patients were randomly allocated into two groups of 50 patients each by using random number table. Group 1 (E) received Epidural Analgesia before induction of general anesthesia. Epidural was given at T_{12}-L_1 space using 8ml of 0.2% Ropivacaine after a test dose of 3ml 2% Lignocaine with adrenaline each to exclude any intravascular or subarachnoid injection. General anaesthesia was administered according to standard protocol using propofol, fentanyl and atracurium. If during the procedure haemodynamic responses were not controlled with epidural Ropivacaine drugs like nitroglycerine and beta blockers were given to control hypertension + tachycardia. Group 2 (C) patients received general anaesthesia like the group 1 patients. In the immediate recovery also haemodynamic responses were assessed. Recovery (pain & comfort) was assessed by 'VAS" (Visual Analogue Scoring system). In the recovery if there were complaints like pain, increased blood pressure or tachycardia further supplementation of epidural drugs was given in Group 1(E). In the group 2 (C) these problems were managed by systemic drugs like tramadol, fentanyl or antihypertensives as needed.

Observations

Comparison between Preoperative Systolic BP (SBP) and Intraoperative Maximum Systolic BP(SBP)

Here the null hypothesis is 'there is no significant difference between Preoperative SBP and intraoperative maximum SBP'. Paired t-test was used to test the above hypothesis. In paired t-test if the p-value is greater than 0.05 we accept the null hypothesis. Otherwise we reject the null hypothesis.

Group 1 (E)

Table 1a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative SBP	131.48	50	15.571
Intraop.max SBP	131.02	50	9.896

Table 1b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre SBP - Intra max SBP	0.46	14.1871	-3.57193	4.49193	0.229	49	0.82

Here the p-value is greater than 0.05. Hence we accept the null hypothesis. i.e; there is no significant difference between Preoperative SBP and intraoperative max.SBP.

Group 2 (C)

Table 2a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative SBP	136.96	50	13.070
Intraop.max SBP	161.10	50	15.970

Table 2b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre SBP - Intra max SBP	-24.14	14.71	-28.322	-19.959	-11.6	49	0.000

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative SBP and intraoperative max.SBP.

Comparison between Preoperative Diastolic BP (DBP) and Intraoperative Max. Diastolic BP (DBP)

Group 1 (E)

Table 3a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative DBP	81.82	50	7.477
Intraop.max DBP	82.62	50	5.594

Table 3b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre DBP - Intra max DBP	-0.8	6.5309	-2.6561	1.0561	-0.866	49	0.391

Here the p-value is greater than 0.05. Hence we accept the null hypothesis. i.e; there is no significant difference between Preoperative DBP and intraoperative max.DBP.

Group 2 (C)

Table 4a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative DBP	81.22	50	6.830
Intraop.max DBP	91.72	50	7.690

Table 4b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre DBP - Intra max DBP	-10.5	8.179	-12.825	-8.175	-9.077	49	0

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative DBP and intraoperative max.DBP.

Comparison between Preoperative Heart Rate [HR] and Intraoperative Max. HR

Group 1 (E)

Table 5a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative HR	80.98	50	12.923
Intraop.max HR	96.56	50	11.049

Table 5b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre HR - Intra max HR	-15.58	10.906	-18.6795	-12.4805	-10.101	49	0.000

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative HR and intraoperative max.HR.

Group 2 (C)

Table 6a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative HR	77.32	50	8.975
Intraop.max HR	98.48	50	9.925

Table 6b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre HR - Intra max HR	-21.16	9.873	-23.966	-18.354	-15.154	49	0.000

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative HR and intraoperative max.HR.

Comparison between Preoperative SBP and Recovery SBP

Group 1 (E)

Table 7a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative SBP	131.48	50	15.571
Recovery SBP	131.22	50	10.197

Table 7b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre SBP – Recovery SBP	0.26	16.42	-4.407	4.927	0.112	49	0.911

Here the p-value is greater than 0.05. Hence we accept the null hypothesis. i.e; there is no significant difference between Preoperative SBP and recovery SBP.

Group 2 (C)

Table 8a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative SBP	136.96	50	13.068
Recovery SBP	157.02	50	13.948

Table 8b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre SBP– Recovery SBP	-20.06	9.607	-22.790	-17.329	-14.764	49	0.000

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative SBP and recovery SBP.

Comparison between Preoperative DBP and Recovery DBP

Group 1 (E)

Table 9a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative DBP	81.82	50	7.477
Recovery DBP	82.90	50	6.299

Table 9b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre DBP - Recovery DBP	-1.08	8.03	-3.362	1.202	-0.951	49	0.346

Here the p-value is greater than 0.05. Hence we accept the null hypothesis. i.e; there is no significant difference between Preoperative DBP and recovery DBP.

Group 2 (C)

Table 10a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative DBP	81.22	50	6.825
Recovery DBP	90.76	50	7.093

Table 10b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre DBP - Recovery DBP	-9.54	6.827	-11.481	-7.599	-9.880	49	0.000

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative DBP and recovery DBP.

Comparison between Preoperative HR and Recovery HR

Group 1 (E)

Table 11a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative HR	80.98	50	12.923
Recovery HR	96.54	50	10.792

Table 11b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre HR - Recovery HR	-15.56	10.886	-18.654	-12.466	-10.107	49	0.000

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative HR and recovery HR.

Group 2 (C)

Table 12a

Paired Samples Statistics			
	Mean	N	Std. Deviation
Preoperative HR	77.32	50	8.975
Recovery HR	96.28	50	8.525

Table 12b

	Mean	Std. Deviation	95% confidence interval of the difference		t-statistic	Df	p-value
Pre HR - Recovery HR	-18.96	9.674	-21.709	-16.211	-13.858	49	0.000

Here the p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there is significant difference between Preoperative HR and recovery HR.

Complications in Recovery

Pain (VAS)

Table 13a

	Group 1(E)	Group 2(C)
No pain	37	0
Mild	13	34
Moderate	0	16
Severe	0	0

Independent Sample T-Test

Table 13b

		N	Mean	Std. Deviation
VAS	GROUP 1	50	0.5	0.90914
	GROUP 2	50	3.88	0.98229

Here the null hypothesis is that there is no difference between VAS of the two groups

Table 13c

Independent sample t-test			
	df	t-statistic	p-value
Equal variances assumed	98	-17.857	0.000
Equal variances not assumed	97.419	-17.857	0.000

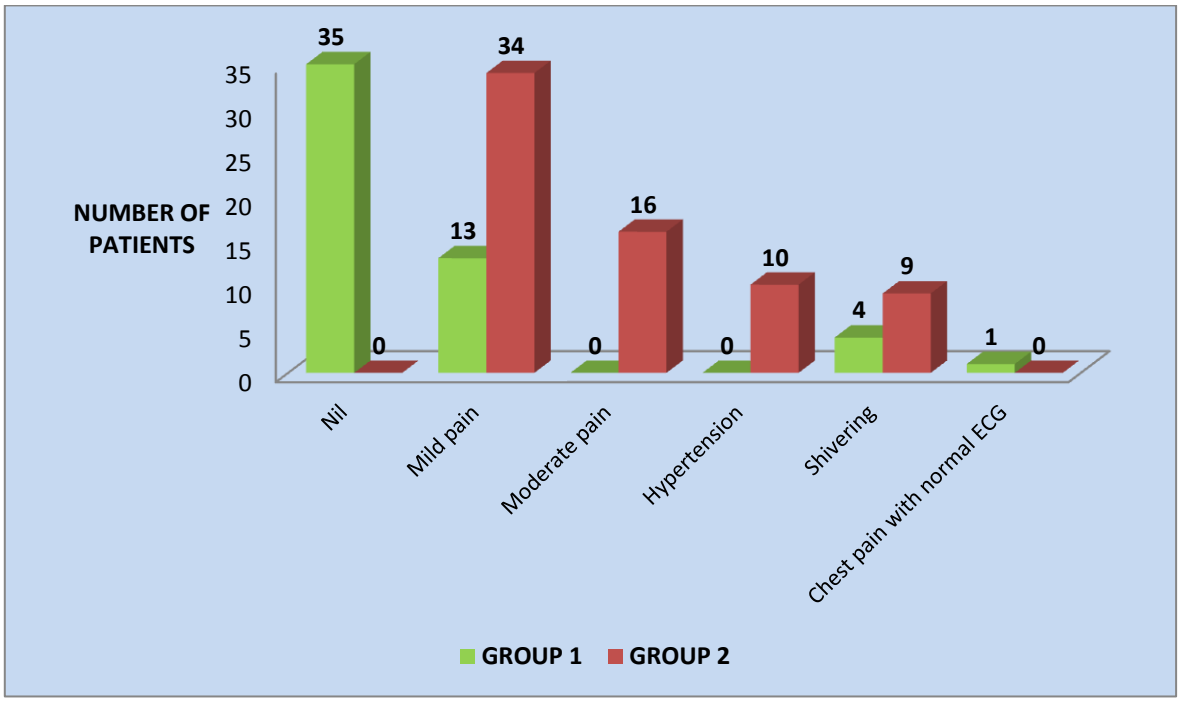
For this data p-value is less than 0.05. Hence we reject the null hypothesis. i.e; there exists significant difference between VAS of two groups.

Other complications

Table 14

COMPLICATIONS IN RECOVERY	NUMBER OF PATIENTS INGROUP 1	PERCENTAGE OF PATIENTS IN GROUP 1	NUMBER OF PATIENTS IN GROUP 2	PERCENTAGE OF PATIENTS IN GROUP 2
Nil	35	66.04	0	0
Mild pain	13	24.53	34	49.28
Moderate pain	0	0.00	16	23.19
Hypertension	0	0.00	10	14.49
Shivering	4	7.55	9	13.04
Chest pain with normal ECG	1	1.89	0	0
TOTAL	53	100.00	69	100

Chart 1



Discussion

The maximum intraoperative blood pressure, both systolic (SBP) and diastolic(DBP) were found to be significantly higher than the corresponding preoperative values in the control group ie., Group 2(C) [Table 2a,2b and 4a,4b]. In the epidural

group ie., Group 1(E) however, there was no significant increase in the intraoperative systolic (SBP) and diastolic(DBP) blood pressure [Table 1a,1b and 3a,3b]. Similarly the blood pressure in the recovery period following GA, both systolic (SBP) and diastolic(DBP) were found to be significantly higher than the corresponding preoperative values in the Group 2(C) [Table 8a,8b and 10a,10b]. There was no significant increase in the systolic (SBP) and diastolic(DBP) blood pressure [Table 7a,7b and 9a,9b] in the recovery period in Group 1(E). This showed that epidural analgesia with 0.2% Ropivacaine was effective in suppressing the hypertension associated with surgical stress as in similar studies [(10)].

The maximum intraoperative heart rate (HR) [Table 6a,6b], and recovery heart rate [Table 12a,12b] was found to be significantly higher than the corresponding preoperative value in Group 2(C). The maximum intraoperative heart rate (HR) [Table 5a,5b], and recovery heart rate [Table 11a,11b] in Group 1(E) was lesser than that in Group 2(C) but it was significantly higher than the corresponding preoperative values. This shows that epidural analgesia was not able to attenuate the heart rate responses to surgical stress effectively. Some studies have shown that epidural anaesthesia and associated sympathetic blockade do not significantly affect electrical functions of cardiac atria [(15)]. Intraoperative tachycardia may be due to several factors like light plane of anaesthesia, hypovolemia, vasodilatation, stress response to laryngoscopy and it is not necessarily a reflection of inadequate analgesia.

The post operative pain as assessed by VAS showed that 34 patients had mild pain and 16 had moderate pain in Group 2(C), while most patients had no pain and only 13 patients had mild pain in Group 1(E) [Table 13a,13b,13c]. This difference in VAS is statistically significant and shows that effective analgesia is achieved with epidural Ropivacaine[(11)]. Other complications in recovery included shivering and hypertension which were more in Group (C). One patient in Group 1(E) developed chest pain but was not associated with ECG changes or other sequelae [Table14, Chart 1].

Conclusion

Epidural analgesia with 0.2% Ropivacaine is effective in controlling the intraoperative and postoperative rise in blood pressure associated with PCNL, but was not very effective in the control of rise in heart rate during the intraoperative and postoperative period. The recovery profile of patients who received epidural analgesia showed lesser post operative pain and fewer patients had complications like shivering and hypertension.

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