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Finding the optimal anesthetic technique during PCNL for renal stone disease: A comparison of general, spinal, and combined spinal epidural anesthesia

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ABSTRACT

Background: Renal stone disease is prevalent worldwide. Percutaneous nephrolithotomy (PCNL) has become an important mode of treatment for large size renal stones. Various anesthetic techniques have described for performing PCNL, with each having its own merits and demerits. There is lacuna in evidence for the ideal mode of anesthesia with best results and least associated complications. **Aims and Objectives:** PCNL is a common procedure for renal stones. It can be performed under various anesthesia techniques. Selection of an appropriate anesthetic technique is essential for successful outcome. In this study, we compared three anesthesia techniques during PCNL and their outcomes. **Materials and Methods:** Retrospective and observational study involved all cases of PCNL performed from February 2022 to January 2023. Baseline clinical and anesthesia parameters were recorded. Three groups based on anesthesia method were made; Group A for general anesthesia (GA), B for spinal anesthesia (SA), and C for combined spinal epidural anesthesia (CSEA). Intraoperative variables including heart rate (HR), blood pressure, operation time, and analgesia adequacy were noted. Post-operative pain level, hospital stay, stone free rate (SFR), complications, patient, and surgeon satisfaction were recorded. **Results:** Seventy-two cases (56 Male and 16 Female) with a mean age of 36.2 ± 15.9 years were included in the study. Age and body mass index were lower in Group A, while ASA status and comorbidities were comparable. Intraoperative HR and mean blood pressure were higher in Group A than in B and C (P = 0.000, P = 0.003). Hypotension was more frequent in Group B (24.1%, P = 0.046). Operation time, hospital stay, transfusion rates, SFR, and overall patient satisfaction were similar. Group A patients experienced more post-procedure pain (Visual analogue scale 4.1 vs. 2.2 vs. 2.1; P = 0.001). Nausea-vomiting and shivering episodes were also higher in Group A (P = 0.033, P = 0.021). Anesthetic effect weaned-off in 6 patients of SA. Post-operative headache was higher but non-significant in Group B and C (P = 0.621). **Conclusion:** CSEA appears a superior alternative to both SA and GA, with additional adequate post-operative comfort.

Key words: Percutaneous nephrolithotomy; Spinal anesthesia; Epidural anesthesia; General anesthesia

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INTRODUCTION

Renal stone disease has a high prevalence rate worldwide as well as in the Indian subcontinent. Percutaneous nephrolithotomy (PCNL) is an established modality of surgical treatment for medium and large sized renal stones. It provides all advantages of minimal access surgery in form of endoscopic removal of kidney stones with minimal morbidity,

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shorter hospital stay, and quicker recovery.[1] However, success of PCNL depends on many patient related factors, stone characteristics, and different perioperative parameters.[2] One such important issue is adequate, safe, and comfortable anesthesia. It not only provides relaxation to the patient but also provides comfort to the operating surgeon while dealing with the stone at different crucial steps of surgery.

A variety of anesthetic techniques have been used for PCNL, ranging from general anesthesia (GA) in the early days to various regional and local anesthetic techniques that have been reported to be successful.[3,4] Regional anesthesia (RA) in form of spinal anesthesia (SA) or epidural anesthesia (EA) or combined spinal EA (CSEA) has been suggested to provide effective anesthesia during surgery with added advantages of less incidence of post-operative nausea vomiting (PONV), shorter operating time, fewer neurological complication, acceptability in presence of cardio-pulmonary comorbidities, improved patient comfort, no risk of endotracheal tube displacement, and cost-effectiveness.[5,6] However, in many situations, GA is also preferred such as in anxious patients, pediatric patients, patient with spinal deformity, long duration surgeries, large stone burden, upper calyceal stones, and hyper-mobile kidney.[1] Weaning off of RA, particularly due to regression of SA, during surgery can significantly impede the success of the procedure, such as when creating an extra upper calyceal tract or when clearing large stone burden over a long period of time.[7] Occasionally procedure needs to be abandoned or staged if the anesthetic effect has completely weaned off.

To explore these issues further, we conducted a study in our hospital to assess the effects of three anesthesia techniques (GA, SA, and CSEA) for PCNL on various perioperative parameters to find out the most suitable technique.

Aims and objectives

Aim of this study was to assess and compare the various intra and postoperative parameters during PCNL under three anesthetic techniques.

MATERIALS AND METHODS

Study design

This retrospective and comparative study was conducted in our hospital from February 2022 to January 2023. All adult and pediatric patients of PCNL procedure for renal stones were included. A written informed consent was taken from all the participants. Declarations of Helsinki were followed. As it was a retrospective observational study; hence, ethical committee approval was not sought.

Study variables

Patience age, gender, symptoms, duration, comorbidities, renal stone number, size, side, and location were recorded. Routine pre-operative blood and urine investigations were noted. Patients body mass index (BMI) and ASA status were checked during pre-anesthetic work-up. Decision for anesthesia technique was taken after discussion between surgeon and anesthetist. Efficacy of anesthesia was noted in form of adequate or inadequate, depending on the patient's complaint of pain, discomfort, or body movements during the surgery. Operating time, intraoperative vitals, post-operative events, stone free status on post-operative day-1, pain level in immediate post-procedure period, and at 24-h period by visual analog scale (VAS) were noted. Blood transfusion (BT) rates and hospital stay were recorded. Surgeon satisfaction level at the end of the procedure and patient's overall satisfaction level at the time of discharge was also asked and graded from 1 to 5, (1 for poor to 5 for excellent). Perioperative complications were noted as per Modified Clavien classification. All the patients were divided in three groups based on the anesthetic technique used; Group A for GA, B for SA, and C for CSEA. Standard prone PCNL was performed in all cases with 18 Fr. Nephroscope using 22 Fr. Amplatz sheath and pneumatic lithotripter.

Anesthesia techniques

GA was given with premedication of Inj. Glycopyrolate, Inj. Midazolam. Induction was started with inj. Propofol, Fentanyl and Atracurium as per patient's body weight. Endotracheal tube of appropriate size was inserted. Anesthesia was maintained with mixture of Oxygen, N_2O and Isoflurane with timely top-up of muscle relaxant Inj. Atracurium. For Extubation, Inj. Neostigmine and Glycopyrolate were used.

For SA lumbar puncture was done with 25 G needle, inserted into subarachnoid space between L3 and L4 vertebrae in sitting position. Inj Bupivacaine (heavy) was instilled after confirmation of CSF tap from needle. Patient was positioned supine at around 10' head down for 3 min to check the sensory and motor blockade level.

CSEA was given with insertion of Toughy needle of size 18 G at L2-L3 level with confirmation of entry in subdural space with loss of resistance. EA catheter was inserted and timely dosing of Inj. Bupivacaine 0.0125% in 20 mL of saline was administered. EA was followed by SA at L3-L4 level as described earlier.

Cost analysis for specific anesthesia technique was performed after including the price of drugs and consumables, required specifically for that particular technique.

Statistical analysis

Parametric variables were described as mean and standard deviation while non-parametric variables were as number and percentage. Analysis of variance test and Kruksal–Wallis tests were used for group comparison among continuous variables. Chi-square test and Fisher's exact tests were utilized for categorical data. P-value was kept below 0.05 and confidence interval was set at 95%. All analysis was done using SPSS software (Version 21.0, IBM, USA).

RESULTS

Group characteristics

A total of 72 patients (56 Male and 16 Female) were included in the study with distribution of 16 participants in Group A, 29 in Group B, and 27 in Group C. Mean age of study participants was 36.2±15.9 years with a range from 6 to 77 years. Group A had much younger participants with lower BMI than in Group B and C (P=0.000 and P=0.011). Gender distribution, duration of symptoms, presence of comorbidities, and ASA status were comparable among all groups (Table 1). Number of renal stones and laterality were similar among groups, while largest stone size was more in Group C than in other two (P=0.022). Group C also has more pelvi-ureteric junction and upper ureteric stones while other two groups had more of pelvicalyceal stones (P=0.028) (Table 1).

Intra-operative parameters

Baseline heart rates (HR) were comparable among three groups. Group A patients experienced transient rise in HR during induction phase and extubation phase in GA, while Group B and C patients had slight decrease in HR initially following anesthesia. This difference in HR was significant statistically between 5 and 20 min interval and near the end of the surgery (P=0.000) (Table 2). Baseline mean blood pressure (MBP) was higher in Group B and C than in A (P=0.003). After SA in Group B and C, a significant drop in MBP was noted and remained so throughout the procedure (P=0.000) (Table 2). Occurrence of intraoperative bleeding, pelvicalyceal system tear, shoulder pain, and vasovagal activation were similar in all groups. Episodes of hypotension were significantly higher (24.1%) in Group B (P=0.046) (Table 3).

Table 1: Pre-operative clinical and stone parameters of study participants

Continuous variables (mean, SD)	Group A (GA, n=16)	Group B (SA, n=29)	Group C (CSEA, n=27)	P-value
Age (years)	22.8±17.9	38.5±11.2	41.6±15.1	0.000
Symptom duration (months)	8.69±8.459	12.93±17.084	8.93±11.522	0.458
Stone number	2.56±2.502	2.31±1.984	3.11±2.1	0.375
Largest stone size (mm)	21.094±8.9782	20.776±7.5541	27±9.973	0.022
BMI	22.138±2.4149	25.159±3.5406	24.844±3.4023	0.011
Categorical variables	**n (%)**	**n (%)**	**n (%)**	**P-value**
Gender				
Male	13 (81.3)	23 (79.3)	20 (74.1)	0.833
Female	3 (18.8)	6 (20.7)	7 (25.9)	
Stone side				
Left	7 (43.8)	15 (51.7)	18 (66.7)	0.297
Right	7 (56.3)	14 (48.3)	9 (33.3)	
Stone location				
Calyx	5 (31.3)	4 (13.8)	1 (3.7)	0.028
Calyx and Ureter	0	0	1 (3.7)	
Pelvis	5 (31.3)	4 (13.8)	8 (29.6)	
Pelvis and calyx	3 (18.8)	10 (34.5)	15 (55.6)	
Pelvis and ureter	1 (6.3)	1 (3.4)	0	
PUJ	1 (6.3)	7 (24.1)	2 (7.4)	
PUJ and calyx	1 (6.3)	1 (3.4)	0	
Upper ureter	0	2 (6.9)	0	
Comorbidities				
Alcoholism	0	1 (3.5)	0	0.943
CKD	1 (6.2)	4 (13.8)	3 (11.1)	
CKD and	0	2 (6.9)	1 (3.7)	
Hypertension	0	2 (6.9)	2 (7.4)	
Hypertension diabetes	0	2 (6.9)	0	
ASA status				
1	15 (93.8)	19 (65.5)	21 (76.4)	0.074
2	0	9 (31.0)	4 (18.1)	
3	1 (6.3)	1 (3.4)	2 (5.6)	
4	0	0	0	
5	0	0	0	

GA: General anesthesia, SA: Spinal anesthesia, CSEA: Combined spinal epidural anesthesia, BMI: Body mass index, CKD: Chronic kidney disease, PUJ: Pelviureteric junction

Table 2: Timely readings of heart rate and mean blood pressure during PCNL surgery among groups

Time interval	Heart rate (per min)				Mean blood pressure (mm of Hg)			
	Group A (GA)	Group B (SA)	Group C (CSEA)	P-value	Group A (GA)	Group B (SA)	Group C (CSEA)	P-value
Baseline	78±4.5	80.5±5.6	77.3±6.1	0.091	92.2±5.6	96.7±6.1	98.3±4.6	0.003
5 min	85.5±6.4	74.6±5.8	76.1±5.7	0.000	94.3±4.8	88.5±3.4	91.6±3.6	0.000
10 min	83.3±5.7	72.5±6.4	73.1±4.6	0.000	93.5±6.7	85±4.6	86.7±6.1	0.000
20 min	80.1±3.3	74.3±3.8	72.5±3.5	0.000	90±4.8	82.1±5.1	83.6±4.7	0.000
30 min	77.6±4.9	75.2±3.5	74.5±6.2	0.139	89.2±6.8	82.6±2.8	83.1±5.8	0.000
40 min	76.8±5.2	73.4±5.8	73.6±4.4	0.086	90.4±5.1	81.3±3.8	82.6±2.9	0.000
50 min	76.9±4.7	74±5.3	73.8±3.8	0.082	90.7±6.2	82.3±5.9	84.2±3.6	0.000
60 min	75.8±5.4	72.5±6.2	72.4±5	0.116	91.3±3.8	82.6±6.1	83.6±4	0.000
70 min	74.6±6.2	73.6±4.4	75.6±4.1	0.296	91.2±6.2	83.2±4.8	84±4.5	0.000
80 min	76.9±5.6	74.3±5	74.9±5.3	0.280	90.3±5.6	81.9±6.1	82.7±5.2	0.000
90 min	80.8±4.8	73.6±4.8	73.4±6.2	0.000	92.3±4.5	82.3±4.6	83.6±2.8	0.000
At the end of surgery	88.5±6.4	74.5±3.7	72.9±4.8	0.000	96.8±6.2	82±5.3	84.6±3.9	0.000

PCNL: Percutaneous nephrolithotomy, GA: General anesthesia, SA: Spinal anesthesia, CSEA: Combined spinal epidural anesthesia

Table 3: Comparison of intra-operative events during PCNL among study groups

Intraoperative events	Group A (GA, n=16)	Group B (SA, n=29)	Group C (CSEA, n=27)	P value
Bleeding	1	4	4	0.811
PCS tear	2	0	2	0.113
Shoulder pain	0	1	0	1.00
Vasovagal syncope	0	0	1	0.603
Hypotension	0	7	2	0.046

PCS: Pelvicalyceal system, PCNL: Percutaneous nephrolithotomy, GA: general anesthesia, SA: Spinal anesthesia, CSEA: Combined spinal epidural anesthesia

Post-operative outcomes

All groups had comparable operation time and hospital stay (P=0.093 and P=0.378). Group A patients experienced more pain and discomfort at the end of the procedure than Group B and C patients (mean VAS 4.1 vs. 2.2 vs. 2.1; P=0.001) (Table 4). However, this difference was negligible at post-operative day 1. A similar stone free rate (SFR) was observed among all the groups. Anesthetic effect weaned off in six patients of Group B (SA), while no such incidents were noted in the other two groups (P=0.006). Out of these six patients, two cases were converted to GA; two cases could be continued with additional IV anesthetics; and procedure was abandoned in two cases as the patients were unfit for GA. Surgeon satisfaction level at the end of procedure was significantly low in Group B (P=0.034) (Table 4). However, patient's overall satisfaction level was comparable among the groups. Cost of specific items of GA was around 11 times and 1.3 times higher than that of SA and CSEA, respectively (P=0.000).

Complications

Perioperative complications have been described in Table 5. PONV and shivering episodes were more frequent in Group A than in other groups (P=0.033 and P=0.021). Incidence of post-operative headache was higher in Group B and C, but was not significant statistically (P=0.621). Occurrence of all other grade complications was similar in study groups.

DISCUSSION

PCNL is a treatment of choice for large number of renal stone disease. Good stone clearance with patient's safety, comfort, and speedy recovery are the main goals of the surgery. Anesthesia plays a pivot role in achieving these. We retrospectively compared three most prevailing techniques of anesthesia used during PCNL. Decision of anesthesia was taken considering patient's age, comorbidities, BMI, ASA status, stone burden, and estimated time of surgery. Reason for higher age and BMI in SA and CSEA group patients may be the anesthetist's choice RA due to its better safety in old aged comorbid patients. Morsy et al., in his study on PCNL found good safety and feasibility of RA in 51 obese patients.[8] Gupta and Mahajan also reported suitability of RA in elderly, comorbid patients undergoing PCNL.[9] El-Husseiny et al., demonstrated that PCNL under SA or CSEA can be safely carried out in high-risk cases with ≥3 ASA class. Above finding suggests that SA and CSEA have better tolerability than GA in these cases.[10]

The mean intraoperative HR was lower in the SA and CSEA groups than in the GA group in our study, findings which were also reported by Turki et al., and Parikh et al., in their research.[11,12] Baseline MBP was higher in the SA and CSEA groups, likely due to the higher proportion of elderly and obese patients in these groups. Despite this, a fall in MBP was observed in these groups after anesthesia

Table 4: Comparison of post-operative parameters among study groups

Continuous variables	GA group A, (n=16) mean, SD	SA group B, (n=29) mean, SD	CSEA group C, (n=27) mean, SD	P-value
Operation time (min)	84.5±20.4	85.4±20.1	97.9±28.8	0.093
Hospital stay (days)	3.9±1.7	4.6±2.0	4.2±1.4	0.378
Pain score (VAS) at the end of the procedure	4.1±1.5	2.2±1.5	2.1±1.9	0.001
Pain Score (VAS) at postoperative day 1	2.1±1.9	3.2±1.8	3.0±1.9	0.196
Cost of drug and consumables* (INR)	3150±100	275±25	2375±75	0.000
Categorical variables	**n (%)**	**n (%)**	**n (%)**	**P-value**
Stone free status (<4 mm residual fragments)				
Yes	13 (81.2)	20 (69.0)	22 (81.5)	0.476
No	3 (18.8)	9 (31.0)	5 (18.5)	
Anesthesia efficacy				
Adequate	16 (100)	23 (79.3)	27 (100)	0.006
Inadequate	0	6 (20.7)	0	
Surgeon satisfaction level				
Excellent	13 (81.2)	17 (58.7)	16 (59.3)	0.034
Good	3 (18.8)	3 (10.3)	8 (29.6)	
Fair	0	3 (10.3)	3 (11.1)	
Poor	0	6 (20.7)	0	
Very poor	0	0	0	
Patient's overall satisfaction level				
Excellent	13	18	14	0.259
Good	2	4	9	
Fair	0	5	3	
Poor	1	2	1	
Very poor	0	0	0	

*Separate cost of items specifically required for particular anesthesia technique is taken. GA: General anesthesia, SA: Spinal anesthesia, CSEA: Combined spinal epidural anesthesia

Table 5: Chart showing perioperative complications among study participants

Modified clavien classification	Group A (GA, n=16)	Group B (SA, n=29)	Group C (CSEA, n=27)	P-value
Grade 1 (deviation from normal course without the need for intervention)				
Fever	2	4	2	0.714
Nausea vomiting	4	1	1	0.033
Shivering	7	3	3	0.021
Headache	0	5	4	0.621
Grade 2 (Requiring pharmacological treatment with drugs other than allowed for grade I)				
UTI	1	2	2	1.00
Blood transfusion	0	2	2	0.671
Atelectasis	0	1	1	1
Hematuria >48 h	1	1	1	1.00
Wound site leakage	1	0	1	0.514
Pyuria	1	0	0	0.219
Ileus	0	1	1	1.00
Abdominal pain	2	2	1	0.627
Grade 3a (Intervention under regional anesthesia)				
DJ stent placement for leak or PCS injury	0	1	0	1.00
PCN placement for leak or PCS injury	0	1	0	1.00
Pnemothorax	0	0	0	-
Hemothorax	0	0	0	-
Urinoma	0	1	0	1.00
Grade 3b (Intervention under general anesthesia)				
Arteriovenous fistula	0	0	0	-
Perirenal hematoma	0	0	1	0.603
Calculi in the ureter or bladder	0	0	0	-
Perinephric abscess	0	0	0	-
Perioperative bleed requiring quitting the Op.	1	1	0	0.694
Grade 4 (Life threatening complication requiring ICU management)	0	0	0	-
Grade 5 (death)	0	0	0	-

PCS: Pelvicalyceal system, GA: General anesthesia, SA: Spinal anesthesia, CSEA: Combined spinal epidural anesthesia

throughout the procedure compared to the GA cases. This was in accordance with the findings of Parikh et al.,[12] and Ranjan et al.;[13] however, Turki et al., reported an increase in blood pressure (BP) in the EA group, whereas Kumawat et al., found no significant difference in BP.[11,14] This was contrary to our observations.

BT rates and fever episodes were comparable in this study, corroborating similar observations by Liu et al., and Singh et al.[15,16] However, Pu et al., reported lower BT rates in RA patients.[17] Ranjan et al., and Movasseghi et al., also found that PCNL under SA resulted in less blood loss than in GA.[13,18] This discrepancy may be attributed to the lower blood pressure levels after RA compared to GA.

The duration of surgery and hospital stay period was similar in all groups. According to a meta-analysis conducted by Liu et al., a shorter hospital-stay and lesser operating time was noted in RA group. However, the difference in operation time and hospital stay was only 2–8 min and 0.5 day, respectively, which may not be clinically significant.[15] Dar et al., found no difference in these parameters in their comparative study.[19] Patients in the GA group experienced a higher level of pain (as measured by the VAS) at the end of the procedure than the SA and CSEA groups in this study; however, the VAS scores were similar at the 24-h interval. These findings were also echoed by Dar et al.,[19] Pu et al., and Liu et al., reported that the RA group experienced continued pain relief with lower VAS scores even after 24 h, but similar VAS scores after 48 h.[15,17] Therefore, RA appears to provide superior post-operative comfort to patients.

Six of our study cases reported inadequate analgesia, all of which were in the SA group. Two of these cases were converted to GA, while two more were completed with additional IV anesthesia. Unfortunately, the remaining two cases had to be abandoned due to the patients' unfitness for GA. This significant limitation of SA is also well-documented in the literature. Basiri et al., discovered that eight out of 50 cases of PCNL under SA experienced inadequate analgesia, with one case having to be postponed.[20] Kamal et al., reported that around 2% of their PCNL cases under SA experienced insufficient anesthesia, with eight cases being converted to GA and the rest continuing with intravenous sedation.[21] Basiri et al., and Karacalar et al., found that increased duration of anesthesia (>160 min) was associated with inadequate analgesia.[20,22] This difficulty can be overcome by CSEA, as demonstrated in our study with no cases of inadequate analgesia in the CSEA group. This was also the reason for the larger stone size in CSEA group cases, considering the increased duration of surgery and intraoperative analgesia. Out of the six SA group cases of inadequate analgesia, three were discovered while taking supracoastal access above the eleventh rib. This problem was not seen in the CSEA and GA groups. Singh et al., and Moslemi et al., also showed the feasibility of CSEA and EA during supracoastal PCNL approach.[16,23]

The stone-free rate was found to be equivalent among the groups in our study, a finding that was further supported by numerous other reports in the literature.[7,15,17] Kuzgunbay et al.,[24] Turki et al.,[11] and Shah et al.,[25] reported a higher patient satisfaction level in the RA group, while Moawad et al., showed better overall patient satisfaction in the GA group.[26] We observed a similar level of patient satisfaction among the study groups, which may be attributed to the multiple factors that affect satisfaction levels. Surgeon satisfaction was higher in our GA and CSEA groups, likely due to the higher incidence of inadequate anesthesia in the SA groups. Turki et al., reported similar findings in his comparative study on GA versus EA.[11]

PONV and shivering were more frequent in the GA group in our study. This may be attributed to the use of volatile anesthetics, use of neostigmine, and opioid drugs in the GA group. Similar findings are reported in the literature.[7,11,15] Intraoperative hypotension episodes were higher in the SA and CSEA groups in our study, which was in accordance with the findings of Kamal et al.,[21] and Solakhan et al.,[7] However, Turki et al.,[11] and Kumawat et al.,[14] did not find this difference. The reason for this discrepancy may be attributed to the preloading of crystalloid or the use of vasopressor agents in different studies. Incidence of post-operative headache was higher in the SA and CSEA groups in this study, with similar evidence supported from the literature.[21]

Pulmonary complications (PC) in may occur in 0.3–1% of PCNL cases.[1] Patients in SA or CSEA can complaint of symptoms such as chest or shoulder pain, dyspnea, and discomfort, which can alert surgeon and anesthetist. We found no PC in our study, which supports the safety of RA regarding PC. Borzouei et al., in his study found good tolerability of SA in PCNL in elderly patients with pulmonary compromise.[6] Açıkgöz et al., have also shown lower rate PC in PCNL under SA.[27]

Solakhan et al., estimated the cost of SA items being around 4 times cheaper than GA items (21.3 vs. 81.6 USD).[7] Cost analysis in our study also revealed GA and CSEA items being more expensive (11 times and 8 times, respectively) than those of SA. However, we did not study the overall hospital expense in these groups.

Limitations of the study

The limitations of this study include a small sample size, a retrospective design, a lack of randomization, a lack of

data from multiple centers, and no data on post-operative analgesic requirements. However, randomization in this scenario could create an ethical dilemma, particularly when a child is categorized as RA or when an elderly patient with comorbidities is chosen for GA instead of the reverse.

CONCLUSION

All three anesthetic techniques have been found to have similar SFR, operation time, hospital stay, transfusion rate, and overall patient satisfaction level at discharge. GA has some drawbacks, such as higher episodes of PONV, shivering, more post-operative pain, less suitability in elderly, comorbid, and obese patients, and an associated higher cost, when compared to SA and CSEA. However, GA is beneficial in pediatric patients, large stone burden, and supracoastal punctures, without the risk of hypotension, headache, or inadequate analgesia during the operation. SA has many of the aforementioned advantages, but comes with a higher risk of hypotension, headache, inadequate intraoperative analgesia, abandoning or GA conversion during surgery, decreased surgeon satisfaction level, and difficulty in supracoastal access. In conclusion, CSEA has been found to be a superior alternative to both SA and GA. The only exception to this being pediatric cases.

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