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RESEARCH ARTICLE

THORACIC SEGMENTAL SPINAL ANAESTHESIA/ GENERAL ANAESTHESIA FOR LAPROSCOPY SURGERY

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Abstract

Background: Laparoscopic surgeries are usually done under general anesthesia, but many patients with major medical problems sometimes cannot tolerate such anesthesia, and thoracic spinal anesthesia may be beneficial in such patients. A comparative study between two groups of patients using either general anesthesia or segmental thoracic spinal anesthesia.

Aim & objectives: The aim of this study is to compare mean hospital stay, patient, and surgeon satisfaction between two groups of healthy patients operated for various laparoscopic surgeries under general and segmental thoracic spinal anesthesia.

Study period&place: December 2022-January2023 (1 month),in Narendra Modi Medical collage& L.G hospital,Ahmedabad.

Patients and methods: Thirty adult patients of ASA I or II grade undergoing various laparoscopic surgeries, randomly divided into two groups of 15 patients each. Group G received conventional general anesthesia with endotracheal intubation and mechanical ventilation through Drager Fabious GS workstation.Group S received a segmental (T 7-8 inj.) thoracic spinal anesthesia using 1 .5ml of plain levobupivacaine 0.5% (7.5 mg) in addition to 25 µg fentanyl. In group G,after pneumoperitoneum for haemodynamic changes(hypertension,tachycardia) iv fentanyl alliquotes,increase sevoflurane concentration,needed.In cases not responding to them inj.Nitroglycerin infusion was given. In group S, drugs to manage patient anxiety or hemodynamic fluctuations (bradycardia or hypotension) were given when needed. Intraoperative haemodynamic monitoring, postoperative pain, complications, recovery time by modified alderte score>8 and patient & surgeon satisfaction,mean hospital stay were compared between the two groups.

Results: In the GroupS, spinal anesthetia was performed easily in all 15 patients, although two complained of paresthesia, which respondedto slight needle withdrawal; the block was effective for

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surgery in all patients, and five experienced some discomfort, shoulder pain which was readily treated with small doses of fentanyl, but none required conversion to general anesthesia; five patients required midazolam for anxiety, six patients required mephentermine and atropine for hypotension and bradycardia, and recovery was uneventful and without sequelae. In group G,3(20%) patients required infusion of Nitroglycerin for hypertension& 5(33%) patient required 2 times fentonyl alliquotes of 50 mcg iv.,3(20%) patients required increase concentration of sevoflurane (upto 5%)

Conclusion: Patients of Thoracic segmental spinal anesthesia group had shorter discharge time(time to achieve modified alderte acore>8) and better patient satisfaction. Surgeon satisfaction was higher in general anesthesia group. Segmental thoracic spinal anesthesia can be used successfully and effectively for laparoscopic surgery .

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Introduction:-

Thoracic segmental spinal anesthesia is a technique of regional anesthesia that can potentially be a suitable alternative to general anesthesia for certain cases such as laparoscopic surgeries.General anaesthesia is considered gold standered for laproscopy surgery.However in high risk,geriatric patients with compromised cardiopulmonary reserve regional anaesthesia is better perspective mode to decrease complications& polypharmacy. According to history & litreature review ,Jonnesco [1] described the use of general spinal anesthesia for surgeries in the skull, head, neck, and the thorax. The punctures were performed between the 1st and the 2nd thoracic vertebrae, which resulted in good analgesia for the head, neck, and upper limbs. He performed puncture between the 12th thoracic vertebra and the 1st lumbar vertebra, and this resulted in anesthesia for the lower half of the body. **Frumin** et al. [2] proposed the use of segmental spinal block using low thoracic puncture. **van Zundert** [3] proposed segmental spinal block for laparoscopic cholecystectomy in patient with severe obstructive lung disease using a low thoracic puncture (T10) for combined spinal–epidural block. Then, they performed a feasibility study of segmental spinal anesthesia in healthy patients submitted to laparoscopic cholecystectomy [4].

Anatomical studies of **Imbelloni**[5] have been performed using MRI to better define the space within the spine for regional anesthesia. These MRI images have shown that the mid to lower thoracic segment of the cord lies anteriorly, where there is a CSF-filled space between the dura and the cord. In contrast, the spinal cord and the cauda equina are touching the dura mater posteriorly in the lumbar region. This has demonstrated there is a greater depth of the posterior subarachnoid space in the thoracic spinal cord. In one MRI imaging study with 50 patients, the space between the dura mater and spinal cord in the thoracic spine measured at 7.75 mm at T5 and 5.88 mm at T10.

Narmatha Yangste etal [6]have used isobaric levobupivacaine for Thoracic segmental spinal anaesthesia for LSCS & stated that levobupivacaine is better alternative to bupivacaine.(6)

In contrast to open surgery, laproscopy procedure requires only very little incisions and has benefits such as less pain and shorter hospital stay due to less tissue damage and swift return to everyday life due to fast recovery [7]. However, considerable difficulties in anesthetic management could be encountered since wide hemodynamic fluctuation may develop due to pneumoperitoneum and position changes.[8]

Pneumoperitoneum induces systemic effects due to the absorption of CO2, and in venous return due to the increase in intra-abdominal pressure [8]. Initially, absorption of CO2 increases its elimination in the expired air, in the arterial, and venous blood [8,9]. This carboxemia induces metabolic and respiratory acidosis decreasing arterial and mixed venous pH and arterial PO2 [9]. Absorption of CO2 affects negatively the respiratory function, which is not observed with inert gases such as helium and argon [10]. Minute ventilation, peak inspiratory pressure, pulmonary vascular resistance, alveolar concentration of CO2, calculated physiological short circuit, central venous pressure, diastolic and systolic blood pressure, systemic vascular resistance, and cardiac index are all increased [8].

In recent years, advanced laparoscopic surgery has targeted older and high risk patients for general anesthesia; in these patients, regional anesthesia offers several advantages with improved patient satisfaction [11]. Thus, the aim of this study is to compare discharge time, patient, and surgeon satisfaction between two groups of healthy patients submitted to laparoscopic surgeries under general and segmental thoracic spinal anesthesia.

Methods:-

After obtaining an informed consent from 30 patients with inclusion criteria of ASA physical status classification groups I or II and ages 20–70 years, of various laproscopy surgeries were enrolled in study and exclusion criteria were:body mass index above 35 kg/m2, acute cholecystitis, pancreatitis or cholangitis, previous open surgery in the upper abdomen, contraindication for pneumoperitoneum and the presence of any condition contraindicating elective surgery or spinal anesthesia. A study to determine the size of the study groups was not undertaken, and the small number of patients is a limiting factor in this study. After informed and verbal consent, patients were randomized by sealed envelopes to receive either general (group G) or segmental thoracic spinal anesthesia (group S). Sequentialy Numbered

Opaque sealed envelopes were placed in the operating room and only opened at time of giving anaesthesia. Patients' preoperative evaluation and preparation were standardized. All patients, who were in spinal anesthesia group, were informed about spinal anesthesia in detail that any anxiety, discomfort, or pain during surgery would be given intravenous medication. The patients were also informed about the probability of conversion to general anesthesia, if needed. At the night before surgery, all patients received inj ondansatron 4 mcg/kg iv. Both anesthesia and surgery were performed in all cases by the same anesthetic and surgical team. In the operating room, after establishing noninvasive monitoring (electrocardiogram, arterial blood pressure, and pulse oximetry), 500–1000 ml of Ringer lactate solution was started intravenously to All patients with iv1 mg of midazolam

As premedication before the induction of anesthesia. The nasogastric tube was inserted only on surgeon's demand to decompress the stomach and avoid vomiting and aspiration; this is especially useful for the thoracic spinal group.

After obtaining baseline vital signs, oxygen at 5 l/min was commenced through a face mask. Patients randomized to thoracic Segmental spinal anesthesia were positioned at the sitting position and under full aseptic& antiseptic technique, A 25 G spinal needle inserted till the resistance of the dura mater was felt. The advancement of the spinal needle was very slow and cautious, the dura was then pierced, and once free flow of clear CSF began, 1.5ml of

Isobaric levobupivacaine 0.5%, 7.5 mg in addition to 0.5 ml 25 mcg fentanyl was injected. Hemodynamic parameters were recorded every 2 min for 10 min then every 5 min there afterupto20 min ,than at 15 min interval till end of surgery. Sensory loss was confirmed by pinprick determining its upper and lower level. Motor block was confirmed by using modified Bromage scale: 0, able to lift extended legs; 1, just able to flex knees, full ankle movement; 2, no knee movement, some ankle movement; 3, complete paralysis. Sensory and motor block were recorded just before the start of surgery and after the completion of surgery. Surgeon was allowed to start his incision once the block considered adequate (T4–L1 sensory block). Intravenous drugs were given to control patient anxiety, hypotension and bradycardia (30% decrease of baseline SBP,20%decrease of baseline HR respectively., 0.5 mg midazolam alliquots for anxiety, 5 mg alliquots of Mephentermine for hypotension, or 0.5 mg Atropine for bradycardia).Time to sensory& motor regression noticed.

In patients randomized to receive general anesthesia,in gr.G anesthesia was induced with propofol (2–3 mg/kg), fentanyl citrate (2 μg/kg), and sccynylcholine 2 mg/kg,maintainence by atracurium besylate (0.5 mg/kg). Balanced anesthesia was continued with sevoflurane, 1–2%, After intubation of the trachea, the lungs were ventilated with 50% oxygen in air using a semiclosed circle system of Drager Fabius GS workstation.Ventilation was controlled with a tidal volume of 6–8 ml/kg, and the ventilatory rate was adjusted to maintain a PaCO2 value of 35–40 mmHg. Residual neuromuscular block was antagonized with 2.5 mg of neostigmine and 1 mg of atropine sulfate at the end of surgery.

In both groups haemodynamic parameters maintained in physiological limits(SBPwith in 30% change of baseline values,Heartrate HR 20% change of baseline values) by means of pharmacological intervention.Need of iv drugs,premedication drugs,increase inhalation drugs,vasopressors(mephentermine),Vasodilators(Nitroglycerine), intravenous fluid requirement,complications were notified.when modified alderte score >8 patient were shifted to their respective wards.

The mean discharge time from PACU(MAC>8) in group S was 60 min, which was significantly less than in group G (90 min).

The mean postoperative visual analog score (VAS) at 4, 8, 12, and 24 h was significantly less in thoracic spinal group patients, when compared with general anesthesia group patients

All patients were monitored postoperatively for haemodynamic parameters,mean hospital stay,patient satisfaction,surgeon satisfaction.

Patient, and surgeon satisfaction were recorded by an observer using an objective scale for recovery assessment and a verbal rating scale for satisfaction (1/5 very dissatisfied, 2/5 dissatisfied, 3/5 neutral, 4/5 satisfied, and 5/5 very satisfied).

Delayed Neurological complications like PDPH(Post Dural Puncture Headache)& TNS(Transient neurologial sequale) were inquired if any were notified & treated with standered anaesthesia care.

Observations & Results:-

Table1:-

Demographic parameters:-

Parameter	Group S(n=15)	Group G(n=15)	P value	Inference
Age(yrs)	40+/-8.5	42+/-7.2	>0.05	NS
Gender(M:F)	7:8	8:7	>0.05	NS
ASA grade(l/ll)	10:5	9:6	>0.05	NS
Duration of surgery(mins)	118+/-10	114+/-12	>0.05	NS

Table 1 shows statistical comparable haemodynamic parameters.(p>0.05)

Table 2:-

Type of laproscopy surgery	Group S (n=15)	Group G (n=15)
Lap.cholecystectomy	8(55%)	7(46%)
Lap Apendecectomy	4(27%)	5(33%)
Lap .Hernia	3(20%)	2(13%)
Lap nephrectomy	-	1(6.6%)

Table 2 showed various laproscopy surgery counducted in each group.(p>0.05)

Table 3:- Sensory motor parameters of spinal anaesthesia in group s

Parameters(mins)	Groups(n=15)
Time to sensory blockT4-L1	3.8+/-1.2
Time to Bromage scale 3	5.1+/-0.8
Sensory regression time	145.5+/-14.4
Motor regression time	160.9+/-15.6

Table 4:- Intraoperative parameters(Ivdrugs,iv fluids requirement,complications).

Intraoperative Parameters	GroupS(n=15)	Group G(n=15)	P value	Inference
Midazolam alliquotes required	3(20%)	-	<0.001	HS
Fentanyl alliquots required	3(20%)	5(33%)	<0.05	S
Increase concentration of sevoflurane required	-	3(20%)	<0.001	HS
Mephentermine	6(40%)	-	<0.001	HS

Alliquotes				
Atropine required	6(40%)	-	<0.001	HS
Nitroglycerin infusion required	-	3(20 %)	<0.001	HS
Paresthesia elicited	2(13%)	-	<0.05	S
IV fluids given	2000-2200 ml	1200-1500 ml	<0.05	S
Shoulder pain	2(13%)	-	<0.05	S
Itching	1(6.6%)	-	<0.05	S
Nausea,vomiting	3(20%)	-	<0.001	HS
PDPH,TNS	-	-	-	
Modified alderte Score at 10 mins postoperatively	6.5+/-1.0	6.2+/-1.2	<0.05	S
Modified alderte Score at 30 mins	7.0+/-0.8	6.5+/-0.4	<0.05	**S**
Time to attain MAC>8	60+/-4	90+/-		

Table 5:- Postoperative VAS,,patient satisfaction,Surgeon satisfaction.

VAS	Group S(n=15)	GroupG(n=15)	P value	
4 hr	1.2+/-0.5	3+/-0.5	<0.001	HS
8 hr	1.7+/-0.8	3.5+/-0.6	<0.001	HS
12 hr	2.8+/-1.0	3.9+/-1.7	<0.05	S
24 hr	3.0+/-1.0	4+/-1.2	<0.05	S
Patient satisfaction	3.6+/-0.8	2.9+/-0.3	<0.001	HS
Surgeon satisfaction	3+/-0.5	4.1+/-0.1	<0.001	HS
Mean hospital stay(days)	2.0+/-0.5	3+/-0.8	<0.001	HS

The intraoperative cardiovascular changes in the thoracic spinal group were , hypotension, and bradycardia were encountered in 6 patients (40%), and they were given mephentermine and atropine, respectively. Three patients (20%) described some abdominal discomfort ,, all responded to alliquotes of fentanyl. 3 patients (20%) received increments of midazolam 1–2 mg for anxiety and 1 patient (6%) described some mild itching not requiring treatment. Three patients (20%) experienced intraoperative nausea and vomiting.

No patient showed evidence of respiratory depression, oxygen saturation being 97–98% throughout. The intraoperative respiratory rate showed significant increase in the thoracic spinal group when compared with the general anesthesia group. The mean time to full block regression was 160.9 min.

In Group G after pneumoperitoneum,significant rise in HR,SBP,DBP periodicaly,need of intraoperative fentanyl alliquotes,increase concentration of sevoflurane4-5%, need of vasodilators as Inj Nitroglycerin 1-2 mcg/kg/ hr till release of pneumoperitoneum.

Postoperative complications (hypotension, bradycardia, nausea, vomiting, headache, abdominal pain severe enough to require IV narcotics, urine retention and pruritus) showed insignificant difference between both groups except for abdominal pain and urine retention. 10 patients (70%) in group G required PACU opioid administration, while in group S, 2 patient (10%) only, this difference in consumption of opioid analgesics between both groups was statistically significant. 5 patients (30%) in group G developed postoperative urine retention, while none in group S, this difference between groups was statistically significant.

The mean discharge time from PACU in group S was 81 min, which was significantly less than in group G (111.9 min).

Postoperative VAS at 4,6,8,12,24 hrs was less in S group than group G.

Postoperatively, there were minor degrees of abdominal pain, shoulder pain, or itching in small numbers of patients, all readily treatable with standard oral medication, but no nausea or vomiting. Patients of group S gave a mean satisfaction score of 3.6, which was significantly more than patients of group G, whose satisfaction score was 2.9. Surgeon satisfaction score of 3 for group S was significantly lower than in group G, whose score was

Discussion:-

Regional anesthesia for laparoscopic surgery reduces the surgical stress response. In regional anesthesia, there is no airway instrumentation and there is low incidence of deep vein thrombosis [13]. Despite that, regional anesthesia carries the possibility of inadequate ventilation due to extensive thoracic nerve block. The main inspiratory muscle, diaphragm, will be unaffected because it is innervated from cervical level, and expiration is normally a passive phenomenon. However, forceful expiration and coughing will be affected because they are generated primarily by the muscles of the anterior abdominal wall which are innervated by the thoracic nerves [14,15].

Use of relatively large dose of local anesthetics can produce disastrous effects in patients with obstructive airway disease, which depends on active expiration in maintaining lung ventilation. Thus, the degree of nerve block and muscle weakness should be minimized by using adequate dose of local anesthetics. Another concern is careful control of the pneumoperitoneal pressure during surgery to ensure adequate diaphragmatic excursion. Because pneumoperitoneum by CO2 insufflation can stimulate vagal nerve and cause bradycardia, CO2 must be insufflated slowly, and the maximum intra-abdominal pressure should be lowered than 14 mmHg. The negative effects of the pneumoperitoneum with CO2 on the respiratory function have been widely investigated [16]. Usually, CO2 is used for safety due to its high water solubility and its high capacity of exchange in the lungs. The concentration of CO2 can be easily monitored by capnography and controlled by ventilation [17].SpO2 and PETCO2 remained within normal limits (no hypoxemia or retention of CO2) during the procedure, confirming that thoracic spinal anesthesia can be safe for laparoscopic cholecystectomy in patients without associated respiratory depression as the respiratory control mechanism is still intact and allows patients to adjust their minute ventilation [18]. It seems that regional anesthesia may be alternative method to general anesthesia for laparoscopic cholecystectomy in patients with cardiopulmonary disease when low intra-abdominal pressure and less degree of patient tilt during surgical procedure is used [19]. **van Zundert et al**. stated that segmental spinal anesthesia can be used safely for patient with impaired organ function [3]. **Lau et al.** also quoted that laparoscopic hernia can be performed successfully under spinal anesthesia [20]. **Yi et al.** used segmental spinal anesthesia in a patient with previous right pneumonectomy and moderate obstructive and restrictive pattern (was found on pulmonary function tests) and hypokinesia of apical anterior and septal segments (was seen on echocardiography), epidural catheter was inserted at 10th thoracic intervertebral space, and segmental spinal anesthesia was performed at L2–L3 intervertebral space with 5 mg of hyperbaric bupivacaine 0.5% and 20 μg of fentanyl. A segmental sensory block, extending from T3 through L2 dermatomes, was obtained. Surgery was performed smoothly and uneventfully [21].

Considering that the lower nerves are of higher origin and that the lumbar nerves come from a thoracic level, it is easy to understand why the thoracic puncture provides lumbar paresthesia (L1–S4). Two patients did experience some paresthesia during initial insertion of the spinal needle, these symptoms responded to needle withdrawal and did not lead to any postoperative sequelae. Paresthesia can occur with any technique of spinal anesthesia, but are of potentially greater significance when the needle is inserted above the termination of the spinal cord.Cardiovascular changes between groups were significant, but easily controlled, where 40% of patients in group S received mephentermine and atropine for hypotension and bradycardia. **Critchley et al**. reported 29% increase in mean arterial pressure after gas insufflation under general anesthesia [22]. **van Zundert et al**. [4] have provided preliminary evidence that segmental spinal anesthesia can be an effective anesthetic technique for routine laparoscopic surgery; in a group of 20 healthy patients, side effects were minimal, and patient satisfaction scores were high, although cardiovascular changes might be greater in older patients and those with intercurrent disease. Gupta et al. [26] during their study about thoracic epidural anesthesia for elective laparoscopic cholecystectomy found that hemodynamic changes were minimal.

In present study same as study of **N.walker& suchg S,** confirmed the superiority of spinal anesthesia in the control of pain in the immediate postoperative period when compared to general anesthesia, besides having a lower cost. Spinal anesthesia is associated not only to low mortality indices, but also a lower incidence of severe complications such as deep venous thrombosis, pulmonary embolism, pneumonia, respiratory depression, myocardial infarction, and renal failure when compared to general anesthesia [23]. In another series, spinal anesthesia was associated with a lower incidence of postoperative complaints and treatments as well as shorter observation time when compared to

general anesthesia [24-25]. Consequently, laparoscopic surgery under spinal anesthesia should be an appropriate method.

Conclusion:-

To conclude ,both TSSA& GA provide good operating conditions for laproscopy surgery . patients received TSSA had shorter discharge time from PACU and better patient satisfaction when compared to patients received GA. surgeon satisfaction was higher for GA group than TSSA group.

In nutshell,Thoracic segmental spinal anesthesia can be used successfully and effectively for various laparoscopic surgeries without any neurological complications .

Limitations:-

1.Unavailibility of BIS during all cases.
2.Small number of patients.
3.sample size calculation was not done
4.Blinding can not be posible as both technique are different,performer & observer can also reveal technique.

Future Recommendations:-

1.Large scale studies& BIS monitoring throughout study can make more precise conclusions.
2.Thoracic segmental spinal anaesthesia can be evaluated for ambulatory laproscopy surgery.

References:-

1.T.Jonnesco,Remarks on general spinal analgesia,British medical journal 2 (2550), 1396, 1909
2. M Jack Frumin, Herman Schwartz, J Burns, Bernard B Brodie, EM Papper,Dorsal root ganglion blockade during threshold segmental spinal anesthesia in man
Journal of Pharmacology and Experimental Therapeutics 112 (3), 387-392, 1954.
3.A.A.vanZundertG.StultiensJ.J.JakimowiczSegmental spinal anaesthesia for cholecystectomy in a patient with severe lung diseaseBJA: British Journal of Anaesthesia 96 (4), 464-466, 2006.
4.A.A.van ZundertG.StultiensJ.J.JakimowiczLaparoscopic cholecystectomy under segmental thoracic spinal anaesthesia: a feasibility studyBr J Anaesth98 (5), 682-686, 2007
5.Imbelloni LE, Quirici MB, Ferraz Filho JR, Cordeiro JA, Ganem EM. The anatomy of the
thoracic spinal canal investigated with magnetic resonance imaging. AnesthAnalg. 2010;110:1494–5.
6. S. Narmatha Yangste, K. Kalyana sundram etal,Thoracic Segmental Spinal Anaesthesia with Isobaric Levobupivacaine for Caeserian Section in a Patient with Eisenmengers SyndromeJ Anesth Clin Res, Vol.13 Iss.6 No:1001065
7.Loveleen Kour,Madan Lal Katoch,Comparison of levobupivacaine vs bupivacaine in thoracic spinal anaesthesia for laparoscopic cholecystectomies,International journal of medical sciences,volume7,number 12,December 2019.
8.Aditya Kumar Kejriwal, Shaheen Begum, [...], and Richa Agrawal
Laparoscopic Cholecystectomy under Segmental Thoracic Spinal Anesthesia: A Feasible Economical Alternative,Anesth Essays Res. 2017 Jul-Sep; 11(3): 781–783.
doi: 10.4103/0259-1162.174467
9.V Gandara, DS De Vega, N Escriu, I Garcia ZorrillaAcid–base balance alterations in laparoscopic cholecystectomy
Surgical endoscopy 11, 707-710, 1997
10.Tido Junghans, Bartholomäus Böhm, Kerstin Gründel, Wolfgang Schwenk,Effects of pneumoperitoneum with carbon dioxide, argon, or helium on hemodynamic and respiratory function ,Archives of Surgery 132 (3), 272-278, 1997
11.Jeannie F Savas, Robert Litwack, Kevin Davis, Thomas A MillerRegional anesthesia as an alternative to general anesthesia for abdominal surgery in patients with severe pulmonary impairment,The American journal of surgery 188 (5), 603-605, 2004
12.Mohamed Ellakany (2013) Comparative study between general and thoracic spinal anesthesia for laparoscopic cholecystectomy, Egyptian Journal of Anaesthesia, 29:4, 375-381.
Acta anaesthesiologica scandinavica 51 (10), 1394-1396, 2007
13.G Tzovaras, F Fafoulakis, K Pratsas, S Georgopoulou, G Stamatiou, C Hatzitheofilou
Laparoscopic cholecystectomy under spinal anesthesia: a pilot study

Surgical Endoscopy and Other Interventional Techniques 20, 580-582, 2006
14.Susan Standring,Gray's anatomy e-book: the anatomical basis of clinical practice
Elsevier Health Sciences, 2021
15.Felix G Freund, John J Bonica, Richard J Ward, Toshio J Akamatsu, William F Kennedy
Ventilatory reserve and level of motor block during high spinal and epidural anesthesia,The Journal of the American Society of Anesthesiologists 28 (5), 834-837, 1967
16.M Ben-Haim, RJ RosenthalCauses of arterial hypertension and splachnic ischemia during acute elevations in intra-abdominal pressure with CO2 pneumoperitoneum: a complex central …International journal of colorectal disease 14, 227-236, 1999
17.H Gebhardt, A Bautz, M Ross, D Loose, H Wulf, H SchaubePathophysiological and clinical aspects of the CO2 pneumoperitoneum (CO2-PP),Surgical endoscopy 11, 864-867, 1997
18.Raju N Pusapati, T Sivashanmugam, M RavishankarRespiratory changes during spinal anaesthesia for gynaecological laparoscopic surgeryJournal of Anaesthesiology, Clinical Pharmacology 26 (4), 475, 2010
19.Sarli L, Costi R, Sansebastiano G, Trivelli M, Roncoroni L. Prospective randomized trial of low-pressure pneumoperitoneum for reduction of shoulder-tip pain following laparoscopy. Br J Surg. 2000;87:1161–5. [PubMed] [Google Scholar]
20. Hung Lau, Cynthia Wong, Kitty Chu, Nivritti G Patil,Endoscopic totally extraperitoneal inguinal hernioplasty under spinal anesthesia,Journal of Laparoendoscopic & Advanced Surgical Techniques 15 (2), 121-124, 2005
21. Jae Woo Yi, Soo Eun Choi, Jun Young Chung
Laparoscopic cholecystectomy performed under regional anesthesia in patient who had undergone pneumonectomy: A case report.Korean Journal of Anesthesiology 56 (3), 330-333, 2009
22.LAH Critchley, JAJH Critchley, T Gin
Haemodynamic changes in patients undergoing laparoscopic cholescystectomy: Measurement by transthoracic electrical bioimpedance
British Journal of Anaesthesia 70 (6), 681-683, 1993
23.N Walker, S Schug, Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trial
Br Med J 321, 1493, 2000
24.Aditya Kumar Kejriwal, Shaheen Begum, [...], and Richa Agrawal ,Laparoscopic Cholecystectomy under Segmental Thoracic Spinal Anesthesia: A Feasible Economical Alternative.Anesth Essays Res. 2017 Jul-Sep; 11(3): 781–783
25.A Sagar, Manskuri Soujanya, Ramlal Porika, Joshua Dhavanam Y ,Anaesthetic management of cases where Thoracic segmental spinal anesthesia a suitable alternative to general anesthesia ,European Journal of Molecular & Clinical Medicine
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