Journal of Chemical Health Risks
www.jchr.org
JCHR (2024) 14(2), 2966-2972 | ISSN:2251-6727

Sugammadex – Reversal of Profound Neuromuscular Blockade in Laparoscopic Surgery

M. Bastina Jenoffia[1], Vinodh Mani[2], G. Nevetha Priyadarshini[3], B. Chandravathi[4*]
[1]MD in Anaesthesiology, Assistant Professor, Department of Anaesthesiology, Tagore Medical College and Hospital
[2]MD in Anaesthesiciogy, Associate Professor, Department of Anaesthesiology
[3]MD in Anaesthesiology, Assistant Professor, Department of Anaesthesiology
[4]DNB in Anesthesiology ,Senior Resident, Department of Anaesthesiology

(Received: 07 January 2024 Revised: 12 February 2024 Accepted: 06 March 2024)

KEYWORDS
Sugammadex, Laparoscopic Surgery, Rocuronium

Abstract
Introduction- Sugammadex is a modified γ-cyclodextrin, which promptly reverses the steroidal nondepolarizing neuromuscular blocking agents. **Methodology-** This interventional trial was commenced after Institutional ethical committee approval in Tagore Medical College and Hospital. Written informed consent obtained from patients before starting the study. A total number of 30 patients of ASA 1,2 between age-18 – 60 years, undergoing laparoscopic surgery, willing to participate in the study was selected. **Results-**Around 43.3% subjects belonged to age group 20-30 years, 16.6% subjects from age group 31-40 years, 26.6 % from age group 41-50 years, and 13.3% subjects from age group 51-60 years. Among all patients, 12 males and 18 were females. Sugammadex hastened the recovery of DNMB 3.2 times that of rocuronium - induced recovery of conventional blockade and pressure (CNMB) and is advocated as a reversal agent for this procedure. **Conclusion-** Laparoscopic surgeries under Deep Neuromuscular Blockade (DNMB**)/** Low Abdominal Insufflation Pressure (LIAP) procedure is feasible and safe with lower incidence and severity of shoulder tip pain (STP) and high surgeons' satisfaction

Introduction

Sugammadex is a modified γ-cyclodextrin, which promptly reverses the steroidal nondepolarizing neuromuscular blocking agents. Although previous studies have reported a sudden increase in bispectral index (BIS) values after sugammadex reversal of neuromuscular blockade, many studies have supported that BIS increases are likely to be influenced by increased electromyography (EMG) activity following sugammadex administration, rather than true arousal. However, unexpected and sudden arousal after sugammadex use baffles clinicians, and further investigation of the effect of sugammadex on arousal is required. Recent studies have reported that sugammadex can encapsulate other drugs, such as propofol and remifentanil, in addition to non-steroidal neuromuscular blockers.[1]

Laparoscopic surgeries are becoming popular for abdominal and pelvic surgeries.[1,2] But high intra-abdominal pressure induced in laparoscopic surgeries due to pneumoperitoneum affects ventilation and hemodynamic stability.[3,4,5] Deep neuromuscular blockade (DNMB) lowers intra-abdominal pressure (LAIP) and improves the outcome of laparoscopic surgeries, but it is associated with risk of post operative residual curarization.[7,8] Sugammadex potent and specific antagonist of aminosteroids non-depolarizing muscle relaxants can effectively reverse Rocuronium induced neuromuscular blockade without residual muscle relaxation. [9,10] In this study, we evaluate the efficacy of sugammadex as reversal for patients undergoing laparoscopic surgery with rocuronium.[11,12]

Methodology

This interventional trial was commenced after Institutional ethical committee approval (Ref No: IEC No: 03/NOVEMBER /2023) in Tagore Medical College and Hospital. Written informed consent obtained from patients before starting the study. A total number of 30 patients of ASA 1,2 between Age-18 – 60 years, undergoing laparoscopic surgery, willing to participate in the study was selected. Patient was shifted to OT, connected to standard monitors, Patient will be premedicated with injection glycopyrrolate 10mcg/kg IV, injection midazolam 0.1mg/kg IV, injection fentanyl 2 mcg /kg IV. Patient induced with injection propofol 2mg/kg IV, paralysed with injection rocuronium 0.6mg/kg IV and intubated with endotracheal tube of appropriate size. Anaesthesia maintained with oxygen 2L/min, nitrous oxide 3L/min, sevoflurane 2 %, injection

Journal of Chemical Health Risks
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JCHR (2024) 14(2), 2966-2972 | ISSN:2251-6727

rocuronium 0.15 mg/kg IV. At the end of the surgery, injection emeset 0.15mg/kg IV given, injection dexamethasone 0.15mg/kg IV given. Sugammadex was administered, with neuromuscular monitoring (post – tetanic counts 1-2 -injection sugammadex 4mg/kg IV and Train of four count ≥ 2 - injection sugammadex 2mg/kg IV).

Time taken for complete recovery from muscle relaxant indicated by neuromuscular monitoring with train of four > 0.9 was noted, hemodynamics monitoring was done after administration of sugammadex for 24 hours and watched for any adverse effects if any and managed accordingly.

Results

The present study was undertaken to evaluate the efficacy of Sugammadex as reversal for patients undergoing laparoscopic surgery with rocuronium in 30 consecutive cases. Around 43.3% subjects belonged to age group 20-30 years, 16.6% subjects from age group 31-40 years, 26.6 % from age group 41-50 years, and 13.3% subjects from age group 51-60 years. Among all patients, 12 males and 18 were females included in the study as shown in table 1.

Table 1: Distribution of patients based on the age and gender

Age (Years)	**Number**	**Percentage (%)**
20-30 years	13	43.3
31-40 years	5	16.6
41-50 years	8	26.6
51-60 years	4	13.3
Gender		
Male	12	40
Female	18	60

Fig 1: Distribution of patients based on the age

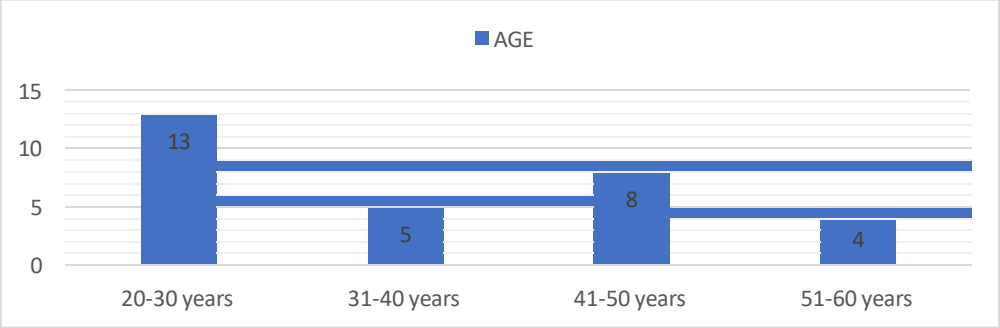

Table 2: Distribution of patients based on Diagnosis

Diagnosis	**Frequency**	**Percent**
Acute Appendicitis	13	43.3
Cholelithiasis	8	26.7
Fibroid Uterus	1	3.3
Left Ovarian Cyst	2	6.7
Multiple Gall Bladder Polyp	1	3.3

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Right Ovarian Cyst	1	3.3
Subacute Appendicitis	2	6.7
Umbilical Hernia	2	6.7
Total	**30**	**100.0**

Table 3: Distribution of patients based on Procedure

Procedure	**Frequency**	**Percent**
Laparoscopic Appendectomy	15	50.0
Laparoscopic Cholecystectomy	9	30.0
Laparoscopic Hernioplasty	2	6.7
Laparoscopic Left Ovarian Cystectomy	2	6.7
Laparoscopic Right Ovarian Cystectomy	1	3.3
Laproscopic Assisted Vaginal Hystrectomy	1	3.3
Total	**30**	**100.0**

Table 4: Distribution of patients based on Time of Onset

Time of Onset	**Frequency**	**Percent**
2 minutes 10- 30 seconds	8	26.6
2minutes 31-40 seconds	5	16.6
2minutes 41-50 seconds	7	23.5
2minutes 51 sec-3 min	4	13.3
3 minutes 00-20 seconds	6	20
Total	**30**	**100.0**

Figure 2-Correlation between age and diagnosis

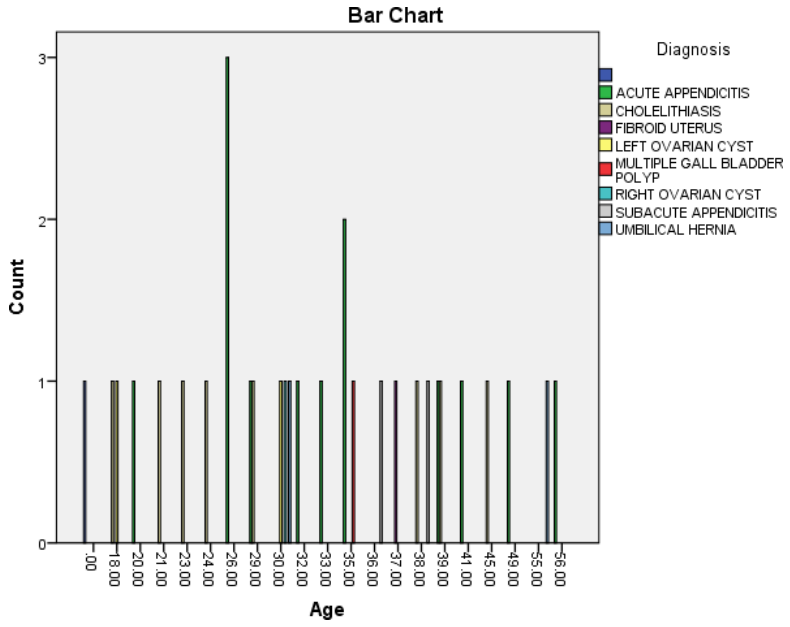

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Table 5: Distribution Of Patients Intraoperative Data

		N=30	P	
Heart rate (beats/min)	Before intubation	79.9±4.2	0.344	
	After intubation	86.6±4.3	0.155	
	Before insufflation	81±4.1	0.039	
	After insufflation	89±3.6	<0.001	
	% of change during insufflation	10±3.7	0.045	
	After table tilting	84.5±4.6	<0.001	
	After desufflation	80±4.7	0.848	
	After intubation	84±4.1	0.010	
Mean arterial pressure (mmHg)	Before intubation	88.2±3.1	0.465	
	After intubation	92.5±3.1	0.263	
	Before insufflation	86.6±3.3	0.142	
	After insufflation	89.5±3.7	0.023	
	% of change during insufflation	3.4±1.12	2.75±1.43	0.005
	After table tilting	84.2±4.6	84.1±3.3	0.751
	After desufflation	85.1±4.4	83.7±3.4	0.003
	After intubation	87.9±3.9	87.3±3	0.241
Operative field visibility scoring	Scores	3 (4.4%)	5 (7.5%)	0.609
		23 (33.8%)	28 (41.8%)	
		27 (39.7%)	22 (32.8%)	
		15 (22.1%)	12 (17.9%)	
	Median (IQR) of score	4 [3–4]	4 [3–4]	0.238
Operative time (min)		27±6.7	29.4±8.3	0.068

Table 6- Sugammadex Dose Requirement for Different Twitch Responses before Reversal

Twitch Response Before Reversal	Sugammadex Dose	P Value
Post tetanic Count	2.35±0.98	<0.0001
Train-of-four count 1,2 or 3	2.01±1.22	
Train-of-four ratio <0.4	1.29±0.67	<0.0001
Train-of-four ratio <0.4	0.90±0.60	
Train-of-four count <2*	2.30±1.18	
Train-of-four count >2*	1.24±0.83	

Discussion

Laparoscopic surgeries are becoming more accepted worldwide. In comparison with laparotomy, laparoscopic surgeries are minimally invasive, with less intraoperative blood loss, mild postoperative pain and faster recovery.[13,14] But artificial pneumoperitoneum created during laparoscopy causes high intraabdominal pressure which leads to hemodynamic instability which includes increased afterload and preload, reduced cardiac output, arrhythmia and increased blood pressure, associated with ventilatory complications which includes increased airway pressure, hypercarbia, atelectasis.[13]

Use of deep neuromuscular blockade in laparoscopic surgeries reduces pneumoperitoneum pressure which improves surgical field, reduces pneumoperitoneum induced peri-operative pain, inhibition of stress

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responses and improves postoperative outcome.[15-18] But significant disadvantage of application of deep neuromuscular block is high incidence of postoperative residual curarisation.[19] Residual muscle relaxation may cause airway obstruction, respiratory depression, aspiration pneumonia and hypoxemia.[20]

Cholinesterase inhibitors like neostigmine is commonly used for reversal of neuromuscular blockade but their effectiveness is limited in procedures where deep neuromuscular blockade is required due to risk of residual paralysis.

Sugammadex is a modified gamma-cyclodextrin, it encapsulates rocuronium and other aminosteroid non-depolarizing neuromuscular blocking agents creating a stable complex, removed by glomeruli , bypassing the hepatobiliary metabolic pathway.[21]Because of its unique antagonistic mechanism and metabolic pathway, it has faster reversal speed and efficacy with minimum side effecs.[22] It also optimizes the surgical field of vision, lessens the surgical time, lessens the cardiopulmonary complication ,reduced hospital stay and better prognosis. Sugammadex gives rapid reversal and better outcome in reversing the deep neuromuscular block induced by rocuronium than the commonly used neostigmine.[23-26] It also causes better recovery of gastrointestinal motility compared to glycopyrrolate and neostigmine mixture.[27] Paients receiving sugammadex recovered 3.4 times faster than those receiving sugammadex.[28] Most common side effects are nausea, vomiting ,dysgeusia, transient hypotension, movement before the end of anaesthesia.[29]There is also possible risk of QT interval prolongation.[30] The dose of sugammadex should be based on actual body weight of the individual.[31,32] The recommended dose of sugammadex is 4mg/kg IV for deep neuromuscular block (If PTC 1-2) and 2mg/kg IV (if TOFC $\geq$ 2).[33] If large single dose of rocuronium 1.2 mg/kg IV is used, or if NMB is enquired to be reversed within 3 minutes, then sugammadex is given as 16mg/kg IV.[34,35]

Conclusion

Laparoscopic surgeries under DNMB and using LAIP is feasible and safe with a minimal failure rate and high surgeons' satisfaction. The applied Deep neuromuscular blockade (DNMB)/ low abdominal insufflation pressure (LIAP) improved surgical outcomes with a reduction of the incidence and severity of shoulder tip pain (STP). Sugammadex hastened the recovery of DNMB 3.2 times that of rocuronium - induced recovery of conventional blockade and pressure (CNMB) and is advocated as a reversal agent for this procedure.

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