Effect of Magnesium Sulfate or Dexamethasone on Postoperative Analgesia in Ultrasound-Guided Quadratus Lumborum Block in Pediatric Lower Abdominal Surgery

Mohammed Taher Edris[a*], Mustafa Mohamed Sabra[a], Abdelfattah Mohamed Daboon[a]
[a]Department of Anesthesiology, Surgical Intensive Care and Pain Medicine, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Abstract

Background: Magnesium sulfate ($MgSO_4$) is thought to provide analgesic effects by modulating pain pathways, while dexamethasone may reduce inflammation and prolong nerve block duration. By evaluating their combined effects with QLB, the study seeks to optimize pain management in children post-surgery, ensuring better comfort and reducing the need for opioid analgesics.

Objectives: To look at the impact of adding $MgSO_4$ or dexamethasone to bupivacaine in ultrasound (US) guided quadratus lumborum block (QLB) on pain management.

Patients and methods: This prospective, randomized, controlled, double blind trial was done on 90 children aged from 6 to 12 years of age, both genders, who underwent lower stomach medical surgery. Patients were split into three equal groups (all received US-directed QLB utilizing bupivacaine after fulfillment of medical procedure) in addition to $MgSO_4$ in group M, dexamethasone in group D and saline in group C.

Results: Time of first rescue analgesia and total paracetamol consumption were significantly lower in group D than group M and lower in group M and gathering D than group C ($P<0.05$). Facial pain score was substantially unique at 4h, 8h, 12h and 16h among three groups ($P <0.05$). Total pethidine consumption was lower in group M and group D than in group C ($P <0.001$).

Conclusions: In pediatrics going through lower stomach medical procedures, dexamethasone, and $MgSO_4$ were viable as adjuvant to bupivacaine in QLB in bringing down facial pain score and opioids utilization and deferring time to protect with better hemodynamics stability.

Keywords: Magnesium Sulfate; Dexamethasone; Bupivacaine; Ultrasound; Quadratus Lumborum Block.

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***Correspondence:** mtaher977@gmail.com

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Introduction

There are notable physical differences between adults and pediatric subjects. Physiologically, the developing pediatric nervous system differs from that of adults, with incomplete myelination at birth, a process that can take up to 12 years to fully complete. This allows for the use of lower doses of nearby anesthetics (LAs) in the pediatric population, thereby reducing the risk of toxicity**(Ponde, 2019)**.

Although the nociceptive pathways are largely similar in both children and adults, there are differences, with children experiencing more intense pain than adults. In children, the inhibitory pathways are underdeveloped, which may allow unregulated nociceptive inputs to affect the ascending spinal pain pathways, leading to inadequate pain control.**(Ponde, 2019)**.

LAs are infused between the quadratus lumborum and the erector spinae muscles during the ultrasound (US) directed back quadratus lumborum block (QLB). This fascial plane block steadies the thoracolumbar nerves **(Elsharkawy et al., 2019)**.

In addition to the abdominal segments of the lumbar arteries, a variety of A- and C-fiber nociceptors, mechanoreceptors, and sensory nerve fibers are located in the thoracolumbar fascia (TLF) that surrounds the QL muscle. **(Benetazzo et al., 2011)**.

Adjuvants incorporated into local anesthetics in nerve blocks are intended to prolong the duration of pain relief. Akutagawa, Luke, Hachiro, and Collins proposed that perineural magnesium sulfate ($MgSO_4$) could enhance LA nerve block **(Akutagawa et al., 1984)**.

Gunduz et al. **(Gunduz et al., 2006)** discovered that $MgSO_4$ provided a partial reaction pain relief effect. Lee et al. **(Lee et al., 2012)** found that $MgSO_4$ ensured the improved post-employment absence of pain with an impact of saving narcotics.

Dexamethasone is a potent and highly specific glucocorticoid, commonly used as an adjunct to local anesthetics in nerve blocks. It has pain-relieving and anti-inflammatory effects. **(Wahal et al., 2018)**.

The purpose of this study is to think about the impact of the adding $MgSO_4$ or dexamethasone to bupivacaine in US-directed QLB on pain management.

Patients and methods

This, prospective, randomized, controlled, double blind study was carried out on 90 children.

Age 6 to 12 years old, both sexes, with American society of anesthesiology (ASA) I and II physical status underwent lower stomach operation.

Exclusion criteria were patients with an, sensitivity to anesthetic medications, coagulation jumble, thrombocytopenia, , infection at the injection site, , and emergency procedures

Randomization and blindness

Computer-generated randomization numbers were utilized for irregular portions, and every patient's code was kept in a dark fixed envelope. Patients were randomized assigned with 1:1 portion proportion into three equivalent groups (all received US- guided QLB after finishing a medical procedure) in addition to bupivacaine and $MgSO_4$ in group M, bupivacaine and dexamethasone in group D and bupivacaine and saline in group C. The utilitarian information authorities were blinded to randomization until the preliminary.

Preoperatively, an assessment of the patients was completed on the day preceding a medical procedure through routine blood tests were completed, clinical assessments were conducted, and a valid clinical and thorough history of the patients was obtained.

Monitoring was conducted using pulse oximetry, a non-invasive pediatric blood pressure cuff, body temperature measurement, and electrocardiogram.

Each patient was informed about the evaluation of postoperative pain using the facial pain score. A score of 0 for facial pain indicates no pain, while a score of 10 indicates the severe pain. A facial agony score was utilized to survey the seriousness of agony upon landing in the sedation care unit (PACU).

Anesthetic techniques

Inhalational enlistment was finished utilizing sevoflurane and oxygen for all youngsters. In the wake of laying out intravenous access, fentanyl 1 mcg/kg and atracurium 0.5 mg/kg were used to work with intubation with support by sevoflurane focus (1.5-2%, 4 L O_2/min). During the activity, in the event that a 20% expansion happened in the heart rate (HR) contrasted with the pattern values, 0.5 µg.kg-1 fentanyl was controlled by the patient. Intravenous liquid support was accomplished by organizing an isotonic electrolyte arrangement as indicated by body weight.

Under the complete aseptic condition, 2.5ml of 10% (250mg) $MgSO_4$ **(Akerman et al., 2018)**., or 1ml of 8mg dexamethasone was added to 10ml of 0.5% (100mg) bupivacaine **(Singariya et al., 2020)**. Afterward, 0.9% typical saline was added to the combination to have an all-out volume of 20ml of 0.5% bupivacaine with considering the most significant portion of bupivacaine for every patient as 2.5ml/kg **(Akerman et al., 2018)**.

The technique of quadratus lumborum

It occurred while the patient was prostrate with head and neck in augmentation position. The assessment was finished using a US gadget (Semens-Acuson p300), which contains both bent (5 MHz) and straight (7.5 MHz) tests. The US assessment was led between the lower costal edge and the iliac peak along the axillary midline in a cross-over direction to envision the three muscles of the stomach wall: the outer diagonal, the inward sideways, and the transversus abdominis. The gonad was repositioned towards the back axillary line until the aponeurosis of the transversus abdominis muscle was recognized. This aponeurosis was followed until the quadratus lumborum (QL) muscle was noticed, alongside its connection to the cross-over course of the L4 vertebra. Following the framed philosophy, the needle was embedded 1 cm preceding the testing point at a point of 90 degrees to the skin. The needle was then diverted and progressed until it arrived at the center interfacial triangle situated on the back surface of the QL muscle, front to the focal thoracolumbar belt (TLF). After entering the focal point of the TLF, an unmistakable loss of opposition was noted. After an underlying confusion, the exact position of the needle was affirmed through hydro dissection with a 2 ml implantation of ordinary saline, which delivered a hypoechoic picture.

In the BM group, patients got two-sided quadratus lumborum block (QLB) with 20 ml (10 ml on each side) of 0.5% bupivacaine joined with 2.5 ml of magnesium sulfate, weakened in 7.5 ml of saline. In the BD group, patients were directed complementary QLB with 20 ml (10 ml on each side) of 0.5% bupivacaine alongside 2 ml of dexamethasone (8 mg), weakened in 8 ml of ordinary saline. In the BS group, patients got equal QLB with 20 ml (10 ml on each side) of 0.5% bupivacaine, weakened in 10 ml of typical saline. The review prescription was infused in 5 ml increases, joined by irregular desire and hypoechoic dispersion of the neighborhood sedative between the QL and erector spinae muscles **(Ponde, 2019)**.

After fulfilment of respective QLB, the remaining neuromuscular barricade was then threatened with IV 0.01mg/kg atropine followed by 0.04mg/kg neostigmine.

When the patient regained consciousness after surgery, tracheal extubation was performed, and they were transferred to the PACU. After 60 minutes of

observation in the PACU, the patients were discharged. It was advised that a regular pain management regimen be established throughout the post-surgical phase.

Patients with facial pain scores of more than 3 got paracetamol (15mg/kg) north of 10-20 min IV and were rethought after 30 min. Patients with a facial pain score above a certain threshold received pethidine (1.5mg/kg) intramuscularly and were reassessed after 30 minutes.

The number of patients who got paracetamol and pethidine and complete utilization of paracetamol and pethidine was recorded. Mean blood vessel pulse, HR, and oxygen saturation were estimated on appearance in the postoperative sedation care unit (time 0) and at 30, 60, 90 min, 2, 4, 6, 8, 12, 16, and 24 hours postoperatively (Oxygen saturation was estimated in the postoperative sedation care unit during the initial 6 hours). The span of the block (characterized as the stretch between playing out the block and the hour of the primary solicitation for the absence of pain). Guardians fulfilment score: guardians who were dazed to the block procedure assessed their youngsters' solace and movement level as indicated by the accompanying scale (1, incredible; 2, significant; 3, fair; 4, poor) **(Chen et al., 2019)**. Any unfriendly impacts or difficulties that were recorded were estimated in our review.

The essential result was the length of postoperative absence of pain accomplished by block as the first pain relieving demand. The auxiliary results showed restraint fulfilment, any unfavorable impacts or entanglements, and power of pain, which was evaluated by facial pain score and absolute pain relief in the initial 24 h.

Sample Size Calculation

Utilizing G*Power program 3.1.9.4, the base determined example size is 81 pediatric patients, in the wake of adding 10 % as dropouts. The example size was adjusted to 90 pediatric patients. The accompanying measures determine the example size: changing confidence level at 95% and power of 80%, contingent upon facial pain score.

Statistical analysis

A quantifiable investigation was finished utilizing SPSS v27. The normality of the data allotment was assessed using histograms and the Shapiro-Wilks test. The ANOVA (F) test and the post hoc test (Tukey) were utilized to examine the quantitative parametric information that had been presented using the mean and standard deviation (SD). Subsequent to introducing the center and interquartile range (IQR) of quantitative non-parametric information, the Kruskal-Wallis's test and the Mann-Whitney test were utilized to compare each group. Recurrence and rate (%) were added as subjective criteria, and the Chi-square test was used to analyze them. It was considered demonstrably essential when the two-followed P esteem was less than 0.05.

Results

Five patients declined to participate in the research, seven patients did not match the requirements, and 102 participants had their eligibility evaluated. Three equal groups of thirty patients each were randomly selected from the remaining ninety patients. Every patient who was assigned was tracked down and statistically examined, **(Fig.1).**

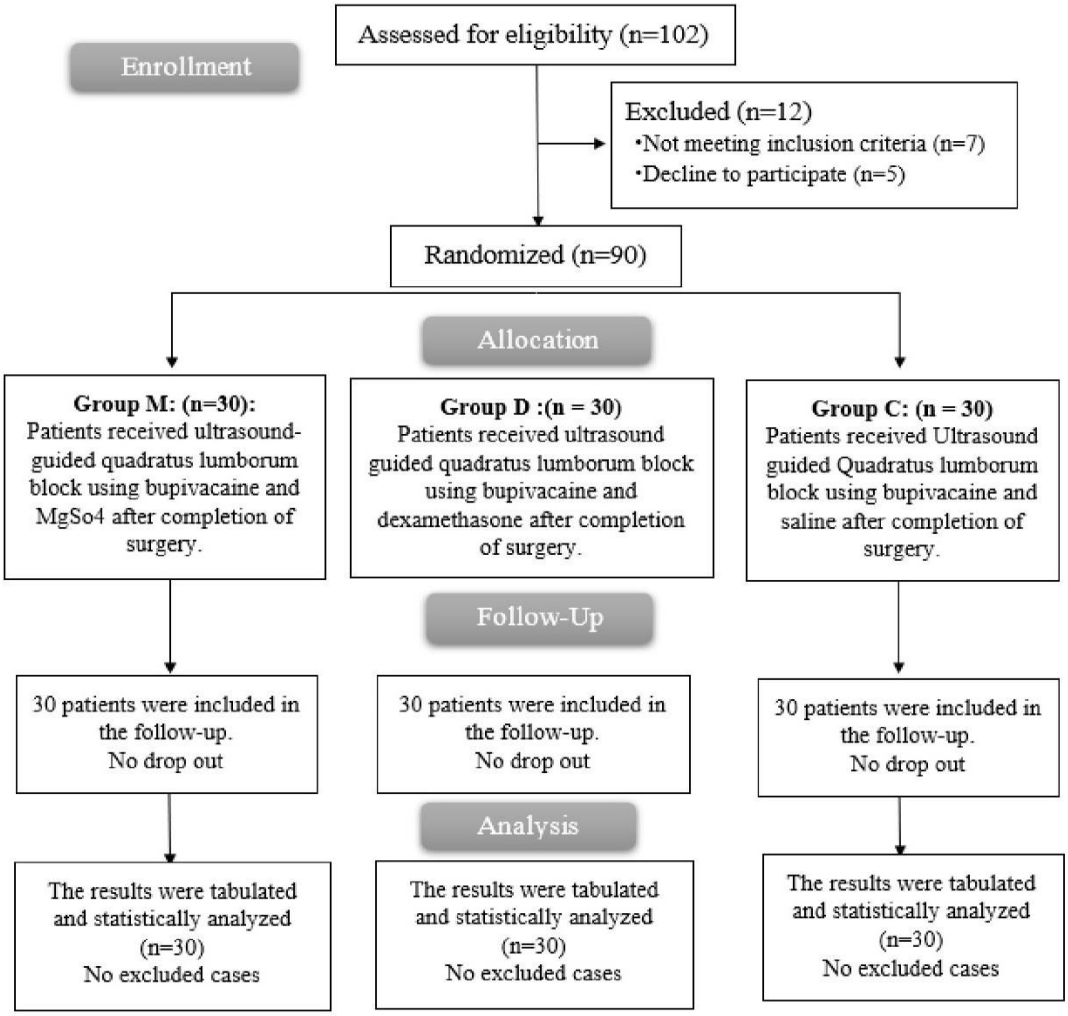

Fig.1. CONSORT flowchart of the enrolled patients

Between the groups, there were negligible differences in demographic information and surgical length. **(Table.1).** At PACU, 2 hours, and 24 hours, the three groups' facial pain scores were not substantially different, but at 4 hours, 8 hours, 12 hours, and 16 hours, they were (P <0.05) considerably different. At 4 and 16 hours, the facial pain score did not differ substantially between groups M and D. However, it was significantly lower in both groups than in group C (P <0.05). At 6 hours, 8 hours, and 12 hours, group D's facial pain score was considerably lower than group M's, and both groups' scores were lower than group C's (P <0.05), **(Table.2)**

Table 1. Demographic data and duration of surgery of the studied groups

Variables		Group M (n=30)	Group D (n=30)	Group C (n=30)	P
Age (years)		8.9±1.48	9.6±1.79	9.3±2	0.350
Sex	**Male**	18(60.0%)	16(53.33%)	17(56.67%)	0.873
	Female	12(40.0%)	14(46.67%)	13(43.33%)	
ASA physical status	**I**	19(63.33%)	20(66.67%)	17(56.67%)	0.718
	II	11(36.67%)	10(33.33%)	13(43.33%)	
Weight (kg)		40.1±5.43	38.6±7.37	37.8±7.77	0.409
Duration of surgery (min)		49.8±7.48	46.5±9.11	45.8±7.32	0.123

Data are presented as mean ± SD or frequency (%). ASA: American Society Anesthesiology.

Table 2. Facial pain score of the studied groups

Variables	Group M (n=30)	Group D (n=30)	Group C (n=30)	P
At PACU	0(0-1)	0(0-1)	1(0-1)	0.565
2h	2(1-2)	2(1-3)	2(1-3)	0.648
4h	2(1-3)	2(1-3)	3(2-4)	**0.004***
	P1=0.798, **P2=0.006*, P3=0.003***			
8h	3(2-4)	2(1 - 4)	4(3 - 6)	**<0.001***
	P1=0.038*, P2=0.045*, P3<0.001*			
12h	3(3-4)	2(1-3)	4.5(3-5.75)	**<0.001***
	P1=0.029*, P2=0.048*, P3<0.001*			
16h	3.5(3-4.75)	3.5(2 - 4)	4.5(3-6)	**0.006***
	P1=0.329, **P2=0.033*, P3=0.002***			
24h	4(3 - 5)	3(2-4)	4(3.25-4)	0.066

Data is presented as median (IQR). * Significant P value <0.05. P1:P value between group M and group D, P2: P value between group M and group C, P3:P value between group D and group C, PACU: post-anesthesia care unit.

HR and MAP were insignificantly different at PACU,30min, 60min, 90min, 2h, and 24h among three groups, while they were significantly different at 4h, 6h, 8h, 12h, and 16h among three groups (P <0.05). At 4 and 16 hours, there was no significant difference in HR and MAP between groups M and D; however, they were considerably lower in both groups than in group C (P <0.05). At 6 hours, 8 hours, and 12 hours, group D's HR and MAP were considerably lower than group M's, and both groups' HR and MAP were lower than group C's (P <0.05). Oxygen saturation was insignificantly different at PACU,30min, 60min, 90min, 2h, 4h and 6h among three groups, (**Fig.2).**

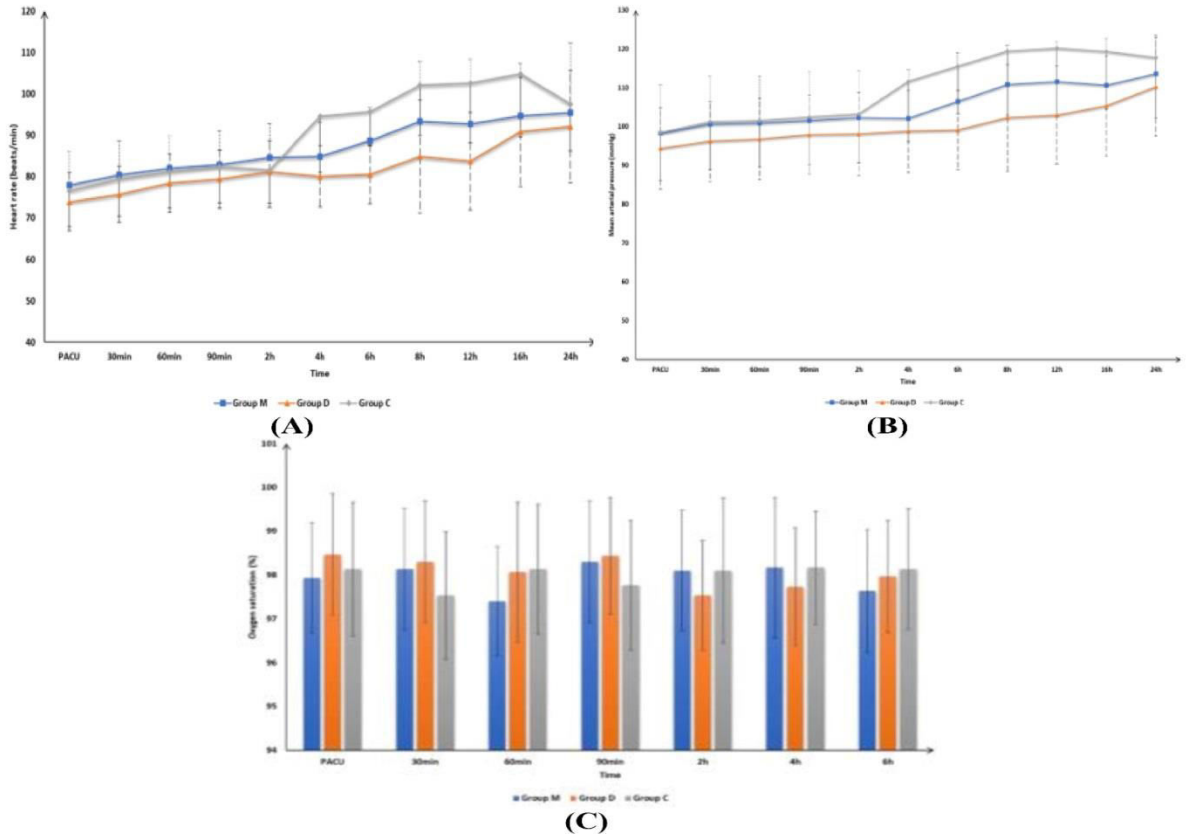

Fig.2.: (A) Heart rate, (B) Mean arterial pressure, and (C) oxygen saturation of the studied groups

The three groups' total pethidine, paracetamol, and time of initial rescue analgesia consumption differed considerably (P <0.05). Group D consumed considerably less paracetamol overall and at the time of initial rescue analgesia than group M. Both groups consumed less than group C (P<0.05). Groups M and D did not significantly vary from one another. Their consumption of total pethidine was significantly lower than that of group C (P <0.001). **(Table.3).**

Table 3.Time of first rescue analgesia, total pethidine, and paracetamol consumptions of the studied groups

Variables	Group M (n=30)	Group D (n=30)	Group C (n=30)	P
Time of first rescue analgesia (h)	8.1±1.39	9.9±1.55	4.9±0.76	**<0.001***
	P1<0.001*, P2<0.001*, P3<0.001*			
Total pethidine consumption (mg)	147.2±38.62	115.6±41.16	195.4±47.58	**<0.001***
	P1=0.014*, P2<0.001*, P3<0.001*			
Total paracetamol consumption (mg)	783.5±544.59	1066±577.61	1759.5±652.58	**<0.001***
	P1=0.161, **P2<0.001*, P3<0.001***			

Data are presented as mean ± SD.* Significant P value <0. 05. P1:P value between group R and group D, P2: P value between group R and group C, P3:P value between group D and group C.

Discussion

Abdominal surgeries are among the most commonly performed procedures, often associated with mild to severe pain, which is typically most intense during the first 24 hours post-surgery. **(Pirie et al., 2022)**.

The pain score in the current evaluation was notably lower in the $MgSO_4$ group and dexamethasone lot than in the control group, and it was irrelevantly different at 4 and 16 hours between the two groups. At six, eight, and twelve hours, the pain score was significantly lower in the dexamethasone group than in the $MgSO_4$ gathering, and it was lower in the $MgSO_4$ and dexamethasone group than in the control. Mansour et al. **(Mansour et al., 2024)** demonstrated that the dexamethasone-bupivacaine group had an aggravation score that was much lower than the control group, which is consistent with our findings. Furthermore, Peng et al. **(Peng et al., 2023)** demonstrated that the $MgSO_4$ lot's aggravation score was much lower than that of the ropivacaine group and control group.

In the ongoing review, HR and MAP were irrelevantly unique at 4h and 16 h between $MgSO_4$ group and dexamethasone group. They were altogether lower in $MgSO_4$ group and dexamethasone group than the control group.

In essence, HR and MAP were lower in the dexamethasone group than in the $MgSO_4$ group at 6 hours, 8 hours, and 12 hours, and lower in the $MgSO_4$ group and dexamethasone group than in the control group. Mansour et al. **(Mansour et al., 2024)** demonstrated that HR and MAP were significantly lower in the dexamethasone-bupivacaine lot compared to the control group, which is consistent with our findings.

In our outcome, the hour of first salvage absence of pain was altogether postponed in the dexamethasone group than the $MgSO_4$ group and deferred in the $MgSO_4$ group and dexamethasone group than the control group. Absolute paracetamol utilization was essentially lower in the dexamethasone group than the $MgSO_4$ group and was altogether lower in the MgSo4 and dexamethasone group than the control group. In concurrence with our outcome, Mansour et al. **(Mansour et al., 2024)** noticed that an opportunity to save initially was altogether postponed in the dexamethasone-bupivacaine group rather than the control . All-out narcotics utilization was markedly lower in the dexamethasone-bupivacaine group than in the benchmark group. Affirming our outcome, Peng et al. **(Peng et al., 2023)**

showed that an opportunity to save initially was essentially postponed in the MgSo4 group than in the ropivacaine group and control group. Absolute narcotics utilization was notably lower in the $MgSO_4$ group than in the ropivacaine gathering and control group.

Different examinations showed the impact of the adding of $MgSO_4$ or dexamethasone to bupivacaine on other blocks. A few instruments have been recommended to make sense of the pain-relieving impact of corticosteroids. An immediate effect on the nerve layer as opposed to a mitigating activity has been proposed as the corticosteroids had the option to restrain ectopic brain release beginning in exploratory neuromas.

$MgSO_4$ can create hostility to nociceptive outcome and voltage subordinate guidelines of calcium flood into the cell, notwithstanding the non-serious enmity of N-methyl-D-aspartate (NMDA) receptors **(Kumari and Chauhan, 2024)**. Concurred with El Sherif et al. **(El Sherif et al., 2023)** showed that an opportunity to protect initially was altogether deferred in levobupivacaine + $MgSO_4$ group than levobupivacaine alone group. When compared to the levobupivacaine-only group, the levobupivacaine + $MgSO_4$ group's overall narcotics consumption was much lower. Using a 25-gauge spinal needle and an infusion of 20 mg hyperbaric 0.5% bupivacaine and 25 µg fentanyl, ACB was performed in a fully aseptic setting. They showed that the dexamethasone gathering's exacerbation score was considerably lower than that of the benchmark group and notably lower than that of the MgSo4 group. The underlying saving time was a lot more limited in the dexamethasone group than in the MgSo4 group, and it was completely postponed in the two when contrasted with the benchmark group. The dexamethasone group used considerably less drugs overall than both the MgSo4 group and the control group.

Shambhavi et al. **(Shambhavi et al., 2023)** showed that an opportunity to safeguard initially was fundamentally postponed in the dexamethasone group than in the $MgSO_4$ group.

Restrictions of the review were incorporated, such as the review being conducted in a solitary community. The development of patients was restricted for a generally brief period. We didn't utilize various dosages of dexamethasone and MgSo4. We didn't use unexpected blocks in comparison to QLB.

Conclusions

Dexamethasone and $MgSO_4$ were superior to bupivacaine as adjuvants in QLB for pediatric patients following lower abdominal operations. They reduced pain scores and opioid intake while delaying the time to first rescue with improved hemodynamics.

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