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Effect of Adding Magnesium Sulphate as An Adjuvant to Bupivacaine in Ultrasound Guided Transversus Abdominis Plane (TAP) Block for Postoperative Analgesia After Inguinal Hernia Repair in Adults

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ABSTRACT

Background: One of the surgical techniques that is most frequently utilised in the globe, particularly in day-case settings, is inguinal hernia repair.

Aim and objectives: The goal of the study was to ascertain how patient outcomes can be affected by postoperative analgesia following adult inguinal hernia surgery with bupivacaine and magnesium sulphate in transversus abdominis plane (TAP) block.

Subjects and methods: Between March 2021 and January 2022, at Al-Azhar University Hospitals (Assiut). According to Class I or II American Society of Anesthesiologists (ASA), and planning for a main unilateral open elective inguinal hernia repair we recruited 60 adult male patients between the ages of 21 and 60 years old for the current study

Result: Group II had significantly lower VASr and VASm than group I. Mean VAS_r at 4 and 8 hours postoperatively were 3.43 and 3.87 respectively for group I and 2.33 and 3.37 respectively for group II. Mean VAS_m at 4 and 8 hours postoperatively were 4.72 and 5 respectively for group I and 2.78 and 3.52 respectively for group I.

Conclusion: Pre-emptive magnesium sulphate added to plain bupivacaine during a transversus abdominis plain block (TAPB) performed on patients under ultrasonographic guidance to treat an inguinal hernia lengthens the time until the first opioid administration is necessary and lengthens the duration of the block.

Keywords: Magnesium sulphate, Adjuvant, Bupivacaine, Ultrasound guided, Transversus abdominis plane block, TAP, Postoperative, analgesia, inguinal hernia repair.

INTRODUCTION

Inguinal hernia repair is one of the most frequently carried out surgical procedures globally, particularly in the day-case scenario [(1)].

The Lichtenstein "tension-free" hernioplasty surgery is currently one of the most popular ways to treat inguinal hernias and uses mesh prosthesis [(2)]. Although the Lichtenstein technique is the go-to surgical procedure for unilateral or bilateral hernia repair and has a low recurrence incidence, it is linked to moderate to severe postoperative discomfort that may delay return to regular activities or lead to the emergence of chronic pain [(3)].

Uncontrolled postoperative pain causes a surgical stress response that adversely impacts several physiological processes, even increasing perioperative morbidity and mortality. Consequently, providing surgical patients with good post-operative analgesia is crucial to their overall care [(4)].

The ilioinguinal, iliohypogastric, and lower intercostal (T7-T11) nerves are blocked by an efficient peripheral abdominal field block called the transversus abdominis plain (TAP) block that is guided by ultrasound as a component of a multimodal strategy for post-operative pain relief. TAP block has been employed in a range of surgical procedures involving lower abdominal wall incisions. While producing adequate operating circumstances for localised anaesthesia, local anaesthetics alone have a shorter duration of post-operative analgesia. To create a quick, dense, and long-lasting block, opioids, clonidine, and ketamine are some of the adjuvants utilised with local anaesthetics. But its use is constrained by side effects such nausea, vomiting, and urticaria [(5)].

The development of the NMDA antagonist magnesium sulphate ($MgSO_4$), which thanks to the discovery of NMDA receptors in the skin and muscles, is used in a variety of methods for brachial plexus blocking as well as via neuraxial pathway. The contribution of $MgSO_4$ to TAP inhibition as an adjuvant has not yet been properly analysed [(6)].

The goal of the study was to determine whether improving patient outcomes following adult inguinal hernia surgery involved using TAP block that combined magnesium sulphate and bupivacaine under ultrasound supervision.

PATIENTS AND METHODS

Between March 2021 and January 2022 at Al-Azhar University Hospitals (Assiut), 60 adult male patients between the ages of 21 and 60 were recruited for the current study. The patients were Class I or II American Society of Anesthesiologists (ASA), and planning for a main unilateral open elective inguinal hernia repair.

Exclusion criteria:

Preoperative use of opioids or NSAIDs, allergies to researched medications or anaesthetic agents, or other contraindication, emergency hernia repair, BMI 30 kg/m^2, patients with diabetes mellitus and those who are unable to adequately describe postoperative pain to the researcher (because of dementia, delirium, psychiatric

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disorders, neurological disorders, or coagulopathy) are a few examples of factors that should be considered.

Study design:

Randomized, double blind controlled study.

According to the adjuvant given to the local anaesthetic during a TAP block using ultrasonography, patients were split into two equal groups (each with thirty male patients).

Group I: On the same side of the procedure, a transversus abdominis plane block guided by ultrasound was performed. Patients were given 2 ml of normal saline (NS) and 18 ml of 0.25% simple bupivacaine (Sunny bupivacaine).

Group II: A transversus abdominis plane block was carried out on the same side of the surgery under ultrasound guidance. Each patient received 18 ml of sunny bupivacaine 0.25% simple bupivacaine, 1.5 ml of magnesium sulphate 150 mg, and 0.5 ml of normal saline (NS).

Preoperative preparation:

Patients were assessed using a comprehensive history interview, clinical examination, and routine laboratory testing (complete blood count, bleeding time, clotting time, PT, PTT, INR, urea, creatinine, AST, ALT, and blood sugar level). All patients got instruction on how to utilise a visual analogue scale (VAS) and information about the US guided TAP block technique.

Pre anesthetic preparation and premedication:

Fasting hours: No mouthwash for six hours before operation.

In preholding room:

In all patients, a peripheral line cannula (20G) was placed. All patients received an IV premedication of midazolam (0.02 mg/kg) 30 to 60 minutes before to anaesthesia. Monitoring of heart rate (beats per minute) and dysrhythmias (lead I). At baseline, blood pressure, heart rate, and oxygen saturation were recorded. Measurements of peripheral oxygen saturation (SpO_2%) and non-invasive arterial blood pressure (NABP).

Intraoperative procedure:

The same surgeons underwent each surgical surgery using Lichtenstein's approach (open repair of inguinal hernia with a mesh). After general anaesthesia was induced, the identical technique was followed for all patients to receive ultrasound-guided TAP blocks.

Anesthetic technique: For both groups, general anaesthesia was induced as follows: Patients were made to lie flat for three minutes while receiving 100% oxygen through a face mask. The patients were mechanically ventilated, and progressive doses of cisatracurium and isoflurane (1.2-1.5%) in 100% oxygen were employed to maintain anaesthesia (0.03 mg kg-1). After that, all patients had an ultrasound-guided TAP block for inguinal hernia repair on the same side of all patients.

Technique of ultrasound-guided TAP block:

A high-frequency linear array transducer probe was employed to scan the abdominal wall with a portable ultrasound instrument (6–13 MHz) (Ultrasound machine: Mindray 2200).

The probe was positioned perpendicular to a line connecting the anterior superior iliac spine and the inferior rib to obtain a transverse view of the abdominal layers, from superficial to deep, including external oblique (EO), internal oblique (IO), transverse atrium (TA), and, most deeply, the abdominal cavity.

The IO's aponeurosis moved anteriorly, and the TA muscles were pushed deeper, causing the local anaesthetic solution to grow and appear as a dark shadow. 20 mL of medicine are administered intermittently. (Plain bupivacaine 0.25% versus plain bupivacaine 0.25% plus 2 ml magnesium sulphate 10%, for groups I and II, respectively) once the needle tip is properly positioned in the required plane [(7)].

Atropine 0.01 mg kg-1 and neostigmine 0.04 mg kg-1 were used to restore any remaining neuromuscular block after the surgery in the post-operative care facility. Ketorolac 30 mg intravenously given every 6 hours helped to manage postoperative pain in the two patient groups. In a case of VAS 4, nalbuphine 4 mg was administered as a rescue dosage.

Measurements:

Vital signs: O_2 saturation (SpO_2%), heart rate, and mean arterial blood pressure (MABP) in mmHg (beats per minute). These vital signs were recorded for all patients before the induction of anaesthesia, every 15 minutes during the procedure, immediately following, hourly for the first four hours, and then every four hours for the final 24 hours of the initial postoperative phase (the study period).

Pain assessment:

Visual analogue scales utilised both still and moving (VASr and VASm). On the direct marking on (VAS) scale, a mark of 10 cm denoted the worst potential pain, with 0 cm signifying no discomfort. In order to compare their level of pain to two extremes, patients were asked to mark on the line how much they were hurted.

The following measurements were taken using a visual analogue scale: As soon as possible after surgery, every time the VAS score reached 4 within the first 24 hours after surgery, rescue analgesia in the form of nalbuphine 4 mg was infused intravenously (IV). Rescue analgesia was given every four hours for the first eight hours following surgery, then every hour for the next eight hours.

A rescue opioid analgesic's initial dosage is scheduled for: The time it took to give the first analgesic dose after the procedure was noted (in minutes). The duration of analgesia is the period of time between the termination of local anaesthetic treatment and the first time a rescue analgesic is necessary. Total opioids needed for analgesia (in milligrams). Calculations and statistical analysis were used to determine the total amount of nalbuphine administered to the patients after surgery.

Postoperative complications:

Hematoma at the site of injection, nausea, vomiting, and shivering are symptoms of local anaesthetic toxicity, along with tinnitus, peri-oral numbness, and seizures.

Ethical Approval

Every study participant provided a written informed consent after Al-Azhar University Ethics Board in Assiut approved the study. The Declaration of Helsinki, the World Medical Association's code of ethics, was followed when conducting this research on humans.

Statistical analysis of the data

IBM SPSS software, version 20.0, was used to enter and analyse data. The qualitative data were expressed in terms of numbers and percentages. Quantitative data were described using the range (minimum and maximum), mean, standard deviation, and median. The significance of the results was assessed at the 5% level of significance. [8].

RESULTS

60 adult male patients with ASA categories I or II were planned for elective primary unilateral open inguinal hernia surgery at Al-Azhar University Hospitals in Assiut. The successful application of the technique was devoid of any technical difficulties. All study participants successfully completed it, and all of them were included in the statistical analysis that followed.

Patients were categorized into two groups (30 patient each) :

- **Group I:** On the same side of the procedure, a transversus abdominis plane block guided by ultrasound was performed. Patients were given 2 ml of sterile saline and 18 ml of 0.25% simple bupivacaine (sunny bupivacaine).
- **Group II:** On the same side of the procedure, a transversus abdominis plane block guided by ultrasound was performed. The dosage for each patient was 18 ml of 0.25% plain bupivacaine (sunny bupivacaine), 1.5 ml of 150 mg of magnesium sulphate, and 0.5 ml of normal saline (NS). Comparing both groups revealed no statistical difference regarding age (p value was 0.9027). Comparing both group revealed no statistical difference regarding BMI (p value was 0.351).

Table (1): Comparison between the two studied groups according to age, BMI

	Age (Years)		**BMI**	
	Group I	**Group II**	**Group I**	**Group II**
Mean	**39.1666667**	**39.5333333**	**22.9966667**	**22.6833333**
SD.	**12.0718634**	**11.0382824**	**1.14995752**	**1.41740008**
p. value	0.902712975		0.351144109	

There was no discernible difference between the two groups' MABP levels during the preoperative "baseline" period, the actual surgery, or the recovery period (Figure 1).

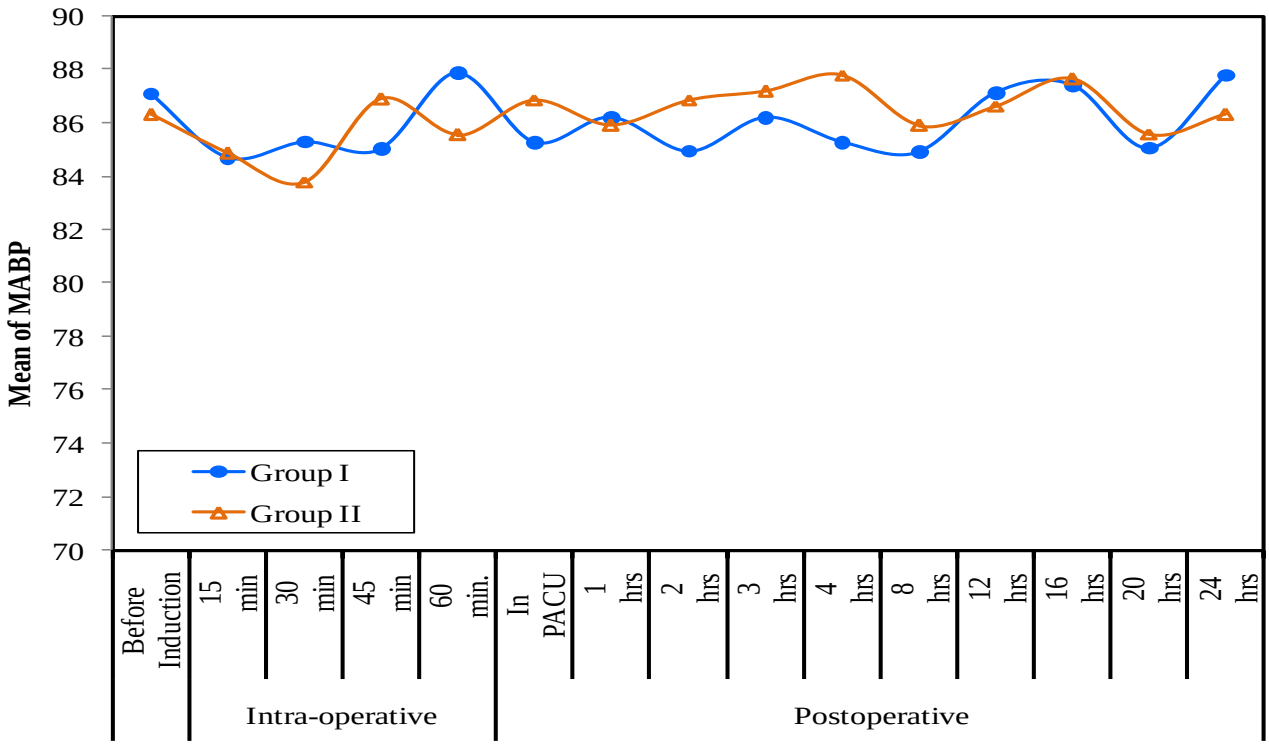

Figure (1): Comparison between the two studied groups according to changes of the mean arterial blood pressure (MABP) (mmHg).

There was no significant difference in both groups as regards mean HR at preoperative "base line" time and throughout the intra-operative and postoperative times (Figure 2).

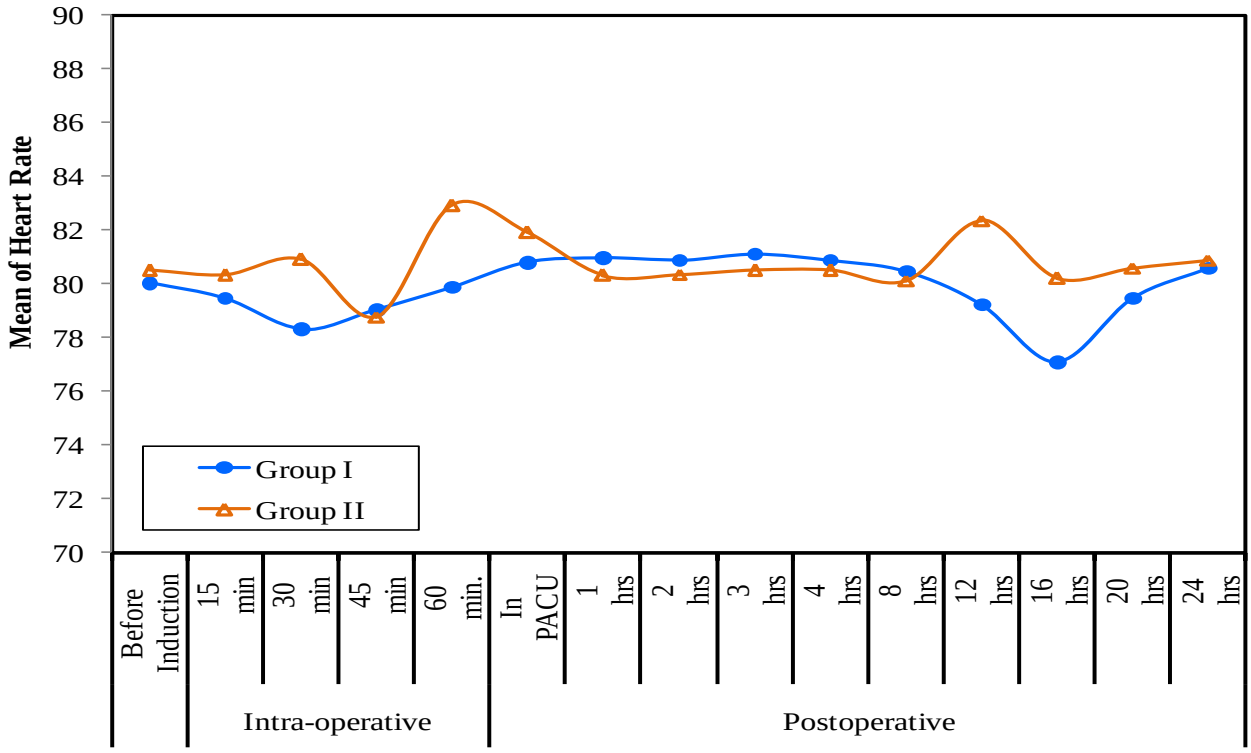

Figure (2): Comparison of the two study groups' average changes in heart rates (beats per minute).

Group I: The mean of SPO_2% preoperatively was 98.40 ± 0.50. There were no significant changes throughout the operation and postoperative period. **Group II:** The mean of SPO_2% preoperatively was 98.52 ± 0.51. There were no significant changes throughout the operation and postoperative period. Comparison of both groups at different intervals showed no significant statistical difference (Figure 3).

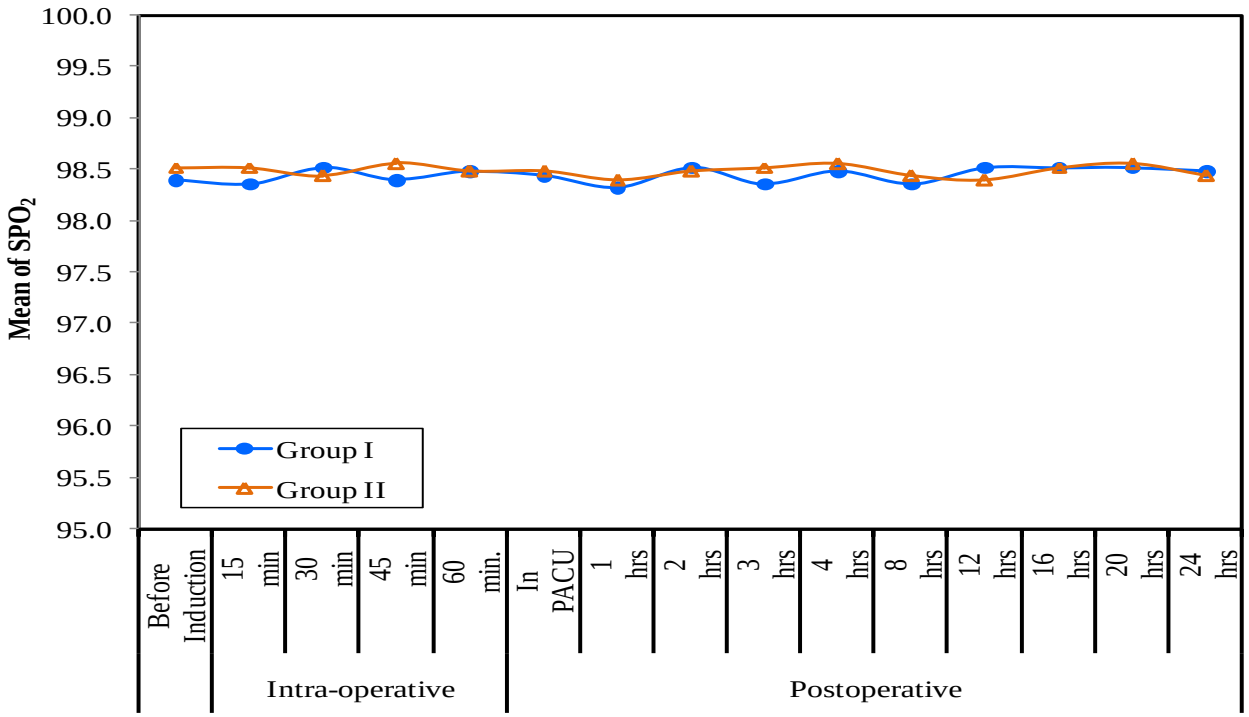

Figure (3): Comparison of the two research groups based on variations in SPO_2% (oxygen saturation).

Comparison between both groups as regards VAS_m at different intervals showed **statistically significant decrease in group II** compared to group I. Mean VAS_m at 4 and 8 hours postoperatively were 4.72 and 5 respectively for group I and 2.78 and 3.52 respectively for group II (p value <0.05) as shown in figure (4).

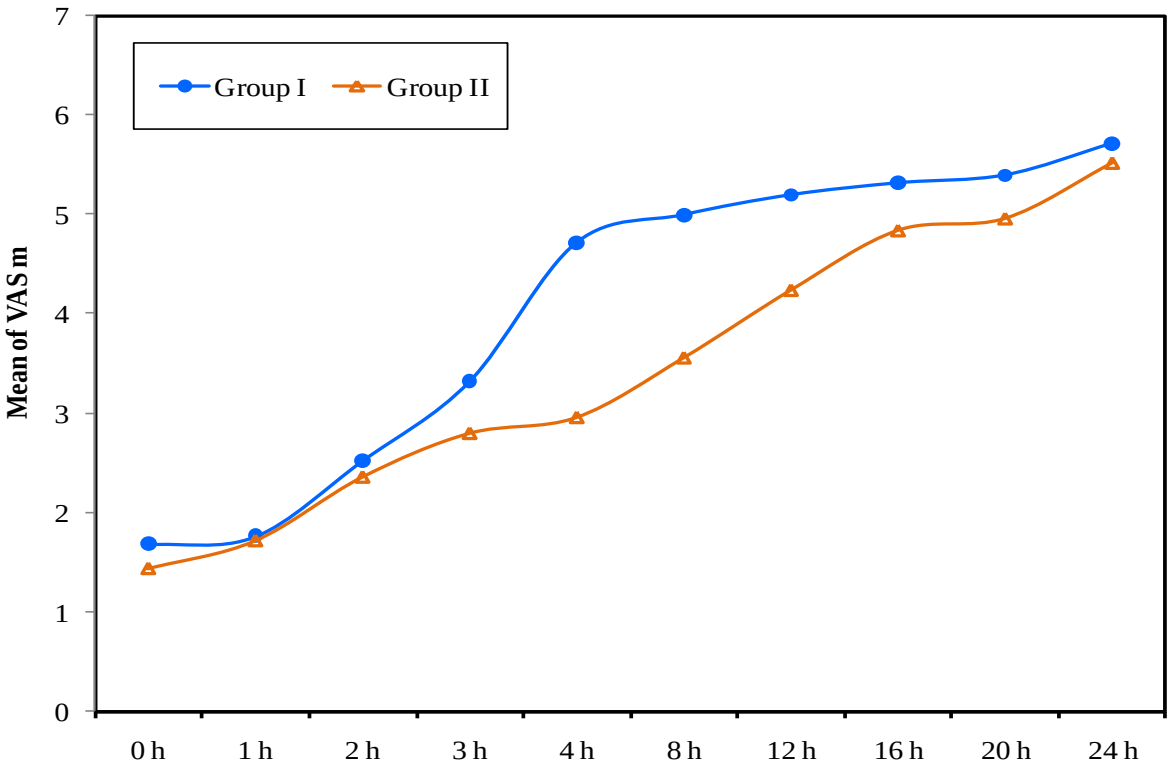

Figure (4): Comparison of the two study groups based on variations in the mean VASm.

When the study groups were compared, group II showed significantly increased duration of analgesia compared to group I (P 0.001*) as shown in table (2).

Table (2): Comparison between the two studied groups according to duration of analgesia

	Duration of analgesia (min)	
	Group I	**Group II**
Mean	226.833	519.783
SD.	65.132	158.508
p. value	0.000673416 **(<0.001*)**	

*: Statistically significant at $p \leq 0.05$

When comparing the study groups, it was found that group II had significantly more time since the first rescue analgesic dose than group I had (P 0.001) (Table 3).

Table (3): Comparison between the two studied groups according to time elapsed till 1st opioid dose

	Time till 1st opioid dose (Min.)	
	Group I	**Group II**
Mean	189.4	484.166
SD.	52.002	132.483
p. value	0.000115094 **(<0.001*)**	

*: Statistically significant at $p \leq 0.05$

It was evident from a comparison of the two groups that group II's total rescue analgesic dose requirement was much lower (P 0.001) as shown in table (4).

Table (4): Comparison between the two studied groups according to total opioid dose consumption

	Total opioid dose (Mg)	
	Group I	**Group II**
Mean	24.0	15.20
SD.	4.16	4.16
p. value	0.000673416 **(<0.001*)**	

*: Statistically significant at $p \leq 0.05$

DISCUSSION

The benefits of fast-track surgery are diminished as a result of post-operative pain from an inguinal hernia, which causes higher painkiller use resulting in respiratory depression, emesis, sleepiness, impaired ambulation, and delayed bowel function [9]. Appropriate pain management methods to lower postoperative morbidity, enhance surgical outcomes, and lower hospital expenses. A good quality of life, less postoperative cognitive impairments, and a lower likelihood of developing chronic or persistent postoperative pain are all connected with adequate postoperative pain treatment for patients [10].

The current study's objective was to assess the impact of pre-emptive magnesium sulphate, in order to reduce postoperative discomfort. Routine bupivacaine is combined with the transversus abdominis plain block (TAPB), an ultrasound-guided procedure used to treat inguinal hernias. According to the American Society of Anesthesiologists (ASA), that 60 adult male patients between the ages of 21 and 60 who were scheduled for elective primary unilateral open inguinal hernia surgery and had ASA classifications I to II were included in the current study. The study' findings demonstrated that the demographic characteristics of the two groups, including age and BMI, were equivalent. When compared to the preoperative value in either group, there were no appreciable differences in the current study's intraoperative or postoperative parameters (MABP, HR, SPO_2%). When the vital signs MABP, HR, and SPO2% were examined between the two groups at various time points, there was no statistically significant difference between them. In the current study, VSA of the two analysed groups were contrasted at rest and during movement. It was discovered that group II had much lower VASr and VASm values than group I.

The mean VASr at 4 and 8 hours postoperatively for group I was 3.43 and 3.87, whereas it was 2.33 and 3.37 for group II. Mean VASm was 4.72 and 5 for group I at 4 and 8 hours and 2.78 and 3.52 for group II at 4 and 8 hours postoperatively. Numerous investigations produced findings that matched those of the current study. With 60 patients undergoing full abdominal hysterectomy, the experiment was prospective, randomised, and double-blind. Two groups of participants were formed (30 patients per group). For group I, 2 mL of 10% magnesium sulphate and 20 mL of 0.25% plain bupivacaine were administered to each side of a TAP block (200 mg). A TAP block with 20 mL of regular 0.25% bupivacaine on each side was given to Group II. The study discovered that magnesium sulphate/bupivacaine group experienced significantly less pain within the first 24 hours following surgery than the group that received only bupivacaine [11].

For patients undergoing a full abdominal hysterectomy under a subarachnoid block, **Ranas *et al.*** [12] looked into the analgesic effects of combining magnesium sulphate (150 mg) with standard bupivacaine during an ultrasound-guided TAP block. They discovered that $MgSO_4$ reduced VAS scores at 4, 6, and 12 hours following surgery. When local anaesthetic plain bupivacaine was combined with 5 mL of magnesium sulphate 10% solution (500 mg), **Elshamaa *et al.*** [13] examined the possible analgesic impact. The scores for postoperative pain were substantially lower. **Ahmed** [14] looked into the effects of combining regular bupivacaine and magnesium sulphate in PECS block, he discovered that it reduced postoperative discomfort. Magnesium sulphate greatly improves the suppression of the compound nerve action potentials generated by regular bupivacaine, according to **Büyükakilli *et al.*** [15].

In order to increase the analgesic effects of regular bupivacaine, magnesium sulphate is added. Magnesium increase the amplitude of compound nerve action potentials from 15.10% to 35.43%. Patients who had TPVB by 0.5% plain bupivacaine with 150 mg magnesium sulphate had considerably longer sensory block periods [16], lower VAS over the postoperative 48

h, and reduced need for postoperative morphine, according to **Ammar *et al.*** [17]. Patients that administered 0.5% pure bupivacaine experienced sensory block durations that were considerably shorter. 90 female patients who were scheduled for modified radical mastectomy were split into two groups for the study by **Hassan *et al.*** [17]. Group (BM) received 150 mg of magnesium sulphate along with plain bupivacaine 0.25% (0.3 ml/kg) in the paravertebral space prior to the induction of general anaesthesia. Group (B) received the same procedure without $MgSO_4$. They discovered that group (BM) had lower VAS scores from 30 minutes to 24 hours, and that group (BM) patients took longer to request their first painkiller and used fewer opioids postoperatively. As shown in the study of **Lee *et al.*** [5] for interscalene nerve blocks, adding magnesium sulphate to a simple bupivacaine-epinephrine solution lessens postoperative discomfort. **Imani *et al.*** [18] in another study looked at the effects of using ropivacaine and magnesium sulphate during an ultrasound-guided transverse abdominis plane block after abdominal hysterectomy. The findings demonstrated that ropivacaine and magnesium sulphate in the TAP block had no impact on the pain brought on the hysterectomy.

In the current investigation, the average postoperative analgesia duration was observed to be substantially greater in group II than in group I. **Al-Refaey *et al.*** [19] studied the impact of combining magnesium sulphate with simple bupivacaine in TAP block for laparoscopic cholecystectomy and it is consistent with this study.

According to **Haghighi *et al.*** study [20], adding magnesium sulphate extended postoperative analgesia's duration, reduced the need for analgesics, and lowered the prevalence of PONV. It was found that compared to the application of lidocaine alone, the addition of magnesium sulphate to lidocaine lengthened the duration of the motor and sensory axillary block in the upper extremities. Patients who received TPVB with 0.5% plain bupivacaine and 150 mg of magnesium sulphate had sensory block and analgesia for noticeably longer times according to **Ammar *et al.*** [16]. A randomised controlled trial was also carried out by **Aguirre-Ospina *et al.*** [21] to evaluate a TAP block's analgesic effectiveness in patients undergoing inguinal hernia surgery, TAP block caused a reduction in opiate use.

CONCLUSION

When patients are getting a transversus abdominis plain block (TAPB) guided by ultrasonography to repair an inguinal hernia, the addition of preemptive magnesium sulphate to plain bupivacaine produced longer time until first need for opioids, decreased demand for opioids and there were no local anaesthetic toxicity issues, hematomas, or severe tissue trauma in patients' injection sites.

DECLARATIONS

- **Consent for Publication:** All writers gave their consent to submit the work.
- **Availability of data and material:** Available
- **Competing interests:** None
- **Funding:** No fund
- **Conflicts of Interest:** The authors asserted that their involvement in the publishing of this paper is free from any conflicts of interest.

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