Original Article

Evaluation Of Ultrasound Guided Transversus Abdominis Plane Block Versus Ilioinguinal/Iliohypogastric Block In Pediatric Inguinal Hernia Repair

Medhat Helaly Allam*, Asmaa Mahdy Mohammed, Osama Helal Ahmed, Mohamed Ali Mahmoud
Department of Anesthesia, Intensive Care, and Pain Management Faculty of Medicine, Al-Azhar University, Assiut, Egypt
*Corresponding Author: Medhat Helaly Allam, Email: medhathelaly@gmail.com
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Abstract

Background: Transversus abdominis plane (TAP) blocks, iliaoinguinal and iliaohypogastric nerve (IIN and IHN) blocks, and inguinal hernia repair (IHR) are among the most frequently done surgical procedures globally. These treatments can offer anesthesia and analgesia of the abdominal wall.

Objective: To compare the effect of ultrasound-guided TAP block versus conventional ilioinguinal/iliohypogastric nerve block for pediatric patients undergoing IHR.

Methods: The present study was carried out on 60 patients, from April 2021 to January 2022 scheduled for elective primary unilateral open IHR in Al-Azhar University Hospital (Assiut). All of the patients had an ASA physical status of I or II and aged between 1-6 years old. Using the sealed envelope technique; patients were randomly divided into two groups (30 sfor each).

Results: As regards patient hemodynamics (MABP, HR, SPO2%) at different intervals showed no statistical difference between both groups. The Comparison between the two studied groups according to Alder Hey Triage Pain Score**,** A significant higher score in group T at 2, 4 and 6 hours after surgery compared to group I.

Conclusion: Ultrasound guided TAP block provides more effective analgesia than conventional IIN/IHN block during pediatric IHR. Less rescue analgesia was used with the use of US-TAP block than with conventional IIN/IHN block.

Keywords: Inguinal hernia; TAP block; Ilioinguinal/iliohypogastric; Pediatrics.

Introduction

Inguinal hernia occurs in 1% to 4% of babies, with the frequency increasing to 30% in preterm infants, depending on gestational age at delivery. Approximately one-third of pediatric hernia cases develop before 6 months of age, with a considerable preponderance in boys, as demonstrated by a male-to-female ratio of 6:1 [(1)]. The selection of an appropriate anesthetic technique remains a topic of debate, necessitating an approach that is straightforward, safe, minimally morbid, and economically viable, while ensuring a painless procedure and a postoperative recovery devoid of adverse effects [(2)].

Effective postoperative pain management is crucial for determining the appropriate timing of a patient's discharge from a surgical facility, significantly impacting their capacity to return to normal daily activities [(3)]. Regional anesthesia is now widely adopted for perioperative analgesia in children, often supplementing general anesthesia [(4)]. Techniques include simple infiltration, single nerve or plexus blocks, and neuraxial blocks such as spinal, paravertebral, and epidural analgesia [(5)].

The anesthesia and analgesia of the abdominal wall can be achieved by TAP blocks, as well as by blocking the ilioinguinal and iliohypogastric nerves (IIN and IHN) [(6)].

Peripheral nerve blocks, employing small-bore needles similar to those used in adults, provide substantial pain relief post pediatric procedures. These blocks require comprehensive anatomical knowledge, appropriate indications, and awareness of potential complications. The integration of ultrasound technology enhances the precision of nerve block placement [(7)]. Increasingly popular for peripheral nerve localization, ultrasound can be used independently or in conjunction with other modalities like nerve stimulation [(8)].

Aim of the Work

The primary outcome is to determine the effectiveness of postoperative pain management. Secondary outcomes include evaluating hemodynamic stability, the time until first additional analgesic is needed, the duration of analgesic effectiveness, and postoperative side effects.

Patients and Methods

The current study was conducted on 60 patients, aged 1 - 6 years old admitted to Al-Azhar University Hospital (Assiut), from April 2021 to January 2022. After permission from the Ethical Committee of Al-Azhar University, Assiut (approval code: M.Sc./AZ.AST. /AIP029/10/194/4/2021). After a thorough description of the study, each patient's parents gave their informed written consent.

All patients were subjected to full medical history taking, full examination, and all needed laboratory investigations. All participants were ASA physical status I and II and were undergoing elective unilateral IHR. All participants were randomly allocated into two equal groups (30 patients each) using sealed envelopes technique. Group T: [US guided TAP block group]: 30 patients received 0.3 ml/kg of 0.25% bupivacaine administered in a TAP block performed with ultrasound guided at same side of the surgery (with maximum dose of bupivacaine 2.5 mg/kg). Group I: [blind IIN/IHN block group]: 30 patients received 0.3 ml/kg of 0.25% bupivacaine administered in an ilioinguinal/iliohypogastric nerves block at the same side of the surgery (with maximum dose of bupivacaine 2.5 mg/kg). Patients with known allergy to local anesthetic agent, skin infection at the site of injection, coagulopathy and Preoperative non-steroidal anti-inflammatory drugs or acetaminophen were excluded from the study.

General anesthesia was administered using 8% sevoflurane (SevoFlo, Egypt) in 100% oxygen via a facemask following the establishment of venous access. Fentanyl (FENTANYL Citrate, Egypt) at a dose of 1 mcg/kg was given intravenously, and A laryngeal mask airway was placed. The anesthesia was maintained with double the minimum alveolar concentration (MAC) of sevoflurane in 100% oxygen. The patient was placed supine using aseptic procedures after standard monitors were installed and spontaneous ventilation was confirmed using the Jackson Rees adaptation of the Ayres T-piece. A portable ultrasound (Mindray Z5, China) was linked to a linear array transducer probe (12 MHz) in multibeam mode. For Group T, the ultrasonic probe was placed on the anterior wall with the medial head at the umbilicus level, then advanced laterally to the anterolateral abdominal wall between the iliac crest and subcostal border. To get a transverse image of the abdominal layers, the probe was oriented perpendicular to a line connecting the anterior superior iliac spine and the inferior rib. Real-time ultrasonography evaluation was used to progress a 40 mm, 22 G short-bevel needle medially to laterally through in-plane insertion. Bupivacaine 0.25% (0.3 ml/kg) was administered with intermittent aspiration once the needle was well positioned. After identifying the second loss-of-resistance when the needle tip crossed the internal oblique muscle aponeurosis, the first dosage was administered to Group I at a needle entry location one-third of the way from the anterior superior iliac spine to the umbilicus. After the initial fascial click, the second dosage of bupivacaine was given, and the needle was inserted one-third of the way from the pubic tubercle to the anterior superior iliac spine.

Vital signs including heart rate, MABP, respiratory rate, and oxygen saturation were meticulously monitored and recorded at several key intervals: immediately post-induction, before and after the block, at skin incision, every 5 minutes until surgery conclusion, and then every 4 hours over the subsequent 24 hours. Postoperatively, pain levels were evaluated using the Alder Hey Triage Pain Score (AHTPS) at 2-hour intervals for the first 8 hours and then every 4 hours for the remaining 16 hours. The time to the first analgesic requirement and total nalbuphine consumption within the first 24 hours post-surgery were documented. Intravenous nalbuphine at a dose of 0.15 mg/kg was administered if the AHTPS exceeded 4. Potential complications, including vomiting, bowel perforation, and hematoma at the injection site, were also evaluated. Parental satisfaction regarding pain management was rated on a four-point scale: Excellent, Good, Fair, and Poor.

Sample size calculation:

The sample size was determined to contain 60 patients, using an alpha value of 0.05 and a beta value of 0.2, based on data from **Alipour et al.** [9] The calculation followed this formula: $n=(Z1-a2+Z1-\beta)2(S21+S22)\ (x®1-x®2)^2$. The SPSS program, version 23.0, was used to analyze the data, employing mean ± SD, frequency, and percentage for descriptive statistics. Data that was regularly distributed were compared between the two groups using the t-test, whereas data that was non-normally distributed (and ranked) were compared using the Mann-Whitney test. To compare the groups over time, repeated measures ANOVA was also used. The p-value was deemed statistically significant if it was less than 0.05.

Statistical analysis:

The statistical analysis was carried out with IBM SPSS software version 20.0. Qualitative data was presented as numbers and percentages. The Kolmogorov-Smirnov test was performed to determine the normality of the distribution. The quantitative data were summarized using range, mean, standard deviation, and median. Statistical significance was established at the 5% level.

Results

The mean age of participants in both Group T and Group I was comparable, with no significant statistical difference. Group T comprised 25 males and 5 females, while Group I had 26 males and 4 females, showing no significant gender differences. The average weight of participants in both groups was similar, with no significant differences. The mean height for both groups was also comparable, and the duration of surgery for both groups showed no significant variation. All parameters between the two studied groups revealed no statistically significant differences (Table 1).

Table (1): Comparison between the two studied groups according to demographic data and duration of surgery.

	Group T		**Group I**		**t**	**P**
	No.= 30 Mean ±SD		**No.= 30 Mean ±SD**			
Age (month)	38.46 ± 12.92		38.0 ± 12.87		0.132	0.896
Weight (kg)	14.57 ± 2.37		14.35 ±2.59		0.343	0.733
Height (cm)	88.78 ± 9.85		87.41 ± 8.86		0.512	0.611
Duration of Surgery (minutes)	23.26 ± 4.45		23.21 ± 4.96		0.030	0.976
Gender	**No.**	**%**	**No.**	**%**	**Test of sig.**	**P**
Male	**25**	**83**	**26**	**87**	χ^2**= 0.166**	**^{FE}p= 1.000**
Female	**5**	**17**	**4**	**13**		

χ^2: Chi square test FE: Fisher Exact t: Student t-test
p: p value for comparing between the two studied groups

The changes in heart rate (beats per minute). For Group T, the mean heart rate just after induction of general anesthesia showed a slight decrease before and after the TAP block. There was an insignificant increase at skin incision, followed by a return to near-baseline levels at 5 and 10 minutes post-incision. The heart rate gradually decreased at intervals post-incision and throughout the 24-hour postoperative period, showing no significant variations at any measured time points (Table 2).

Table (2): Comparison between the two studied groups according to heart rate (beat/min).

	Heart Rate (beat/min.)					
	Group T (n = 30)		**Group I (n = 30)**		**t**	**p**
	Mean ± SD.	**$p_{Imm.}$**	**Mean ± SD.**	**$p_{Imm.}$**		
Immediately after induction	117.28±11.39		116.84±12.25		0.132	0.896
Block						
Before	116.08±11.13	0.233	114.28±11.15	0.096	0.572	0.570
After	116.56±10.53	0.758	114.76±10.57	0.161	0.604	0.549
At skin incision	118.24±8.57	0.275	120.24±8.86	0.108	0.406	0.686
After skin incision						
5 min	117.48±8.49	0.624	117.64±8.49	0.612	0.067	0.947
10 min	118.24±9.59	0.270	116.04±12.95	0.763	0.683	0.498
15 min	115.36±12.12	0.211	114.56±13.82	0.415	0.218	0.828
20 min	114.52±12.09	0.141	114.50±14.59	0.385	0.006	0.996
25 min	111.56±12.56	0.095	111.40±12.67	0.323	0.036	0.972
30 min	110.50±9.0	-	111.17±11.85	-	0.238	0.818
At the end of surgery	115.64±12.17	0.333	113.64±13.86	0.254	0.542	0.590
Postoperative						
4h	114.72±13.34	0.100	115.24±20.11	0.597	0.108	0.915
8h	115.08±14.64	0.213	117.56±15.78	0.991	0.577	0.567
12h	111.48±13.42	0.092	113.40±15.76	0.213	0.464	0.645
16h	116.0±10.11	0.719	116.88±13.32	0.985	0.263	0.793
20h	115.12±10.21	0.571	120.48±9.32	0.214	1.940	0.058
24h	121.0±10.19	0.081	120.76±10.02	0.099	0.084	0.933

t: Student t-test
p: p value for comparing between the two groups

p_{Imm}: p value for Post Hoc Test (LSD) for ANOVA with repeated measures for comparing between Immediately after induction and each other periods

Changes in mean arterial blood pressure (MABP) were observed as follows: In Group T, the mean MABP after induction of general anesthesia showed minor, insignificant fluctuations before and after the TAP block, as well as at skin incision and various time points post-incision. The blood pressure initially decreased slightly, then rose insignificantly at the skin incision and shortly after. Subsequent measurements showed gradual, insignificant decreases and a slight increase at the 30-minute mark post-incision, followed by stable levels at various intervals up to 24 hours post-surgery (Table 3).

Table (3): Comparison between the two studied groups according to MABP (mmHg)

	Blood Pressure (mm Hg)				**t**	**p**
	Group T (n = 30)		**Group I (n = 30)**			
	Mean ± SD.	**$p_{Imm.}$**	**Mean ± SD.**	**$p_{Imm.}$**		
Immediately after induction	74.96±5.75		75.20±5.59		0.150	0.881
Block						
Before	74.68±5.61	0.356	74.96±4.86	0.457	0.189	0.851
After	75.04±5.51	0.897	74.68±4.71	0.275	0.249	0.804
At skin incision	75.56±6.07	0.147	76.32±6.65	0.093	0.422	0.675
After skin incion						
5 min	75.12±5.29	0.597	75.44±5.63	0.533	0.207	0.837
10 min	74.80±5.38	0.590	75.64±5.48	0.361	0.548	0.586
15 min	74.44±5.64	0.097	75.24±6.03	0.953	0.485	0.630
20 min	74.70±5.59	0.162	76.08±5.34	0.231	0.872	0.388
25 min	74.38±5.69	0.068	75.73±6.12	0.714	0.641	0.527
30 min	77.75±4.93	-	73.67±5.93	-	1.136	0.289
At the end of surgery	75.32±5.52	0.257	75.76±5.73	0.325	0.277	0.783
Postoperative						
4h	74.36±5.78	0.192	75.84±6.56	0.335	0.848	0.401
8h	75.16±5.57	0.707	76.08±6.89	0.287	0.520	0.606
12h	75.32±4.87	0.543	76.16±6.65	0.179	0.510	0.612
16h	75.60±6.0	0.271	75.44±5.78	0.636	0.096	0.924
20h	75.36±5.75	0.596	76.04±5.14	0.140	0.442	0.661
24h	75.96±6.08	0.214	75.60±5.52	0.409	0.220	0.827

t: **Student** **t-test**

p: p value for comparing between the two groups

Oxygen saturation (SpO2%) levels remained stable, with no abnormalities detected throughout continuous intraoperative and postoperative monitoring for both groups. There were no significant differences in oxygen saturation between the two groups during the first 24 hours following surgery (Table 4).

Table (4): Comparison between the two studied groups according to oxygen saturation (SpO2%)

	SpO_2 (%)				**T**	**p**
	Group T (n = 30)		**Group I (n = 30)**			
	Mean ± SD.	**$p_{Imm.}$**	**Mean ± SD.**	**$p_{Imm.}$**		
Immediately after induction	99.18±0.81		98.98±0.85		0.862	0.393
Block						
Before	99.22±0.77	0.802	99.14±0.68	0.328	0.395	0.695
After	99.38±0.71	0.307	99.14±0.74	0.405	1.190	0.240
At skin incision	99.26±0.73	0.731	99.06±0.79	0.846	0.934	0.355
After skin incision						
5 min	99.18±0.86	1.000	99.02±0.72	1.000	0.723	0.473
10 min	99.14±0.79	0.885	98.98±0.89	1.000	0.676	0.502
15 min	99.38±0.71	0.409	99.06±0.74	1.000	1.577	0.121
20 min	99.42±0.59	0.265	99.08±0.89	0.747	1.482	0.146
25 min	99.55±0.65	0.068	99.42±0.64	0.082	0.574	0.571
30 min	99.19±0.42	-	99.52±0.56	-	1.195	0.260
At the end of surgery	99.02±0.66	0.382	99.38±0.71	0.133	1.890	0.065
Postoperative						
4h	98.88±0.84	0.283	99.08±0.71	0.788	0.918	0.363
8h	98.86±0.81	0.119	99.06±0.74	0.857	0.921	0.362

12h	99.02±0.83	0.491	99.14±0.79	0.679	0.531	0.598
16h	98.86±0.69	0.161	98.86±0.69	0.543	0.000	1.000
20h	99.14±0.89	0.866	99.48±0.78	0.069	1.538	0.131
24h	98.88±0.84	0.215	99.26±0.73	0.200	1.632	0.109

t: Student t-test p: p value for comparing between the two groups

p_{Imm}: p value for Post Hoc Test (LSD) for ANOVA with repeated measures for comparing between Immediately after induction and each other periods.

Respiratory rates in both groups were monitored over the entire measurement period, revealing no significant statistical differences between the groups (Table 5).

Table (5): Comparison between the two studied groups according to respiratory rate (breath/min)

	Respiratory Rate					
	Group T (n = 30)		**Group I (n = 30)**		**t**	**p**
	Mean ± SD.	**$p_{Imm.}$**	**Mean ± SD.**	**$p_{Imm.}$**		
Immediately after induction	28.60±4.61		30.88±5.09		1.664	0.103
Block						
Before	27.92±4.84	0.221	30.08±4.55	0.160	1.630	0.110
After	28.24±4.48	0.486	30.08±5.29	0.106	1.328	0.191
At skin incision	30.36±4.74	0.123	31.08±4.29	0.564	1.346	0.185
After skin incion						
5 min	28.80±4.65	0.616	30.16±4.71	0.054	1.030	0.308
10 min	27.92±4.92	0.445	30.28±4.55	0.134	1.765	0.084
15 min	28.72±5.29	0.835	30.12±5.29	0.218	0.937	0.353
20 min	27.39±5.49	0.108	30.29±4.54	0.086	1.981	0.054
25 min	28.27±5.92	0.642	30.53±5.89	1.000	0.588	0.561
30 min	30.75±5.33	-	30.67±3.21	-	0.031	0.976
At the end of surgery	28.0±4.98	0.463	30.32±4.75	0.200	1.688	0.098
Postoperative						
4h	30.24±4.59	0.302	30.36±5.12	0.511	0.815	0.419
8h	28.52±4.79	0.866	30.12±3.37	0.052	0.514	0.610
12h	28.44±4.89	1.000	30.64±3.53	0.077	0.995	0.325
16h	30.24±5.41	0.303	31.68±3.51	0.323	1.898	0.065
20h	27.84±5.75	0.382	30.92±3.35	0.168	1.565	0.126
24h	28.40±6.15	0.910	31.16±3.83	0.909	1.908	0.064

t: Student t-test p: p value for comparing between the two groups

Alder Hey Triage Pain Score: Pain scores were assessed using the AHTPS. In Group T, 2 hours post-surgery, most patients had lower scores, indicating less pain compared to Group I, where a greater number of patients reported higher pain scores. This difference was statistically significant. Similarly, at 4 and 6 hours post-surgery, Group T consistently had fewer patients with higher pain scores compared to Group I. By 8 hours post-surgery, the differences in pain scores between the groups were no longer statistically significant (Table 6).

Table (6): Comparison between the two studied groups according to AHTPS postoperative

	AHTPS post-operative					
	Group T (n = 30)		**Group I (n = 30)**		**χ^2**	**P**
	No. (%)	**p_{2h}**	**No. (%)**	**p_{2h}**		
2h						
1	5(17.0%)		3(10.0%)			
2	25(83.0%)		11(37.0%)		21.749*	^{MC}p <0.001*
3	0(0.0%)		16(53.0%)			
4h						
1	0(0.0%)		2(7.0%)			
2	26(87.0%)	0.285	7(23.0%)	NS	31.133*	^{MC}p <0.001*
3	4(13.0%)		21(70.0%)			
6h						
1	0(0.0%)		4(13.0%)			
2	24(80.0%)	0.194	16(53.0%)	NS	6.287*	^{MC}p= 0.031*
3	6(20.0%)		10(34.0%)			
8h						

1	0(0.0%)		0(0.0%)			
2	14(47.0%)	<0.001*	8(27.0%)	NS	3.125	0.077
3	16(53.0%)		22(73.0%)			
12h						
1	0(0.0%)		0(0.0%)			
2	13(43.0%)	<0.001*	10(33.0%)	NS	0.764	0.382
3	17(57.0%)		20(67.0%)			
16h						
1	0(0.0%)		0(0.0%)			
2	19(63.0%)	0.073	12(40.0%)	NS	2.000	0.157
3	11(37.0%)		18(60.0%)			
20h						
1	0(0.0%)		0(0.0%)			
2	13(43.0%)	<0.001*	12(40.0%)	NS	0.082	0.774
3	17(57.0%)		18(60.0%)			
24h						
1	0(0.0%)		0(0.0%)			
2	12(40.0%)	<0.001*	12(40.0%)	NS	0.085	0.771
3	18(60.0%)		18(60.0%)			

χ^2: **Chi square test** MC: **Monte Carlo** FE**: Fisher Exact**
p: p value for comparing between the two studied groups

The duration of analgesia showed a noticeable difference between the two groups. Group T experienced a longer duration of analgesia compared to Group I. This difference was statistically significant, indicating a more prolonged pain relief in Group T (Table 7).

Table (7): Comparison between the two studied groups according to duration of analgesia

Duration of analgesia (min)	Group T (n = 30)	Group I (n = 30)	t	P
Mean ± SD.	187.80 ± 57.63	146.96 ± 52.25	2.433*	0.019*

t: Student t-test p: p value for comparing between the two groups

The total amount of nalbuphine administered within 24 hours post-surgery differed significantly between the two groups. Group T required a lower mean dose of nalbuphine compared to Group I. Statistical analysis indicated that patients in Group I needed a significantly higher amount of nalbuphine for pain management than those in Group T (Table 8).

Table (8): Comparison between the studied cases according to total dose of nalbuphine in 24h postoperative (mg)

Total amount of nabluphine 24h post-operative (mg)	Group T (n = 30)	Group I (n = 30)	t	P
Mean ± SD.	2.58 ± 0.74	3.11 ± 1.04	2.035*	0.048*

t: Student t-test p: p value for comparing between the two groups

Post-operative complications: In Group T, a minor percentage of cases experienced post-operative vomiting. Similarly, in Group I, there was a slightly higher percentage of vomiting cases. Patients were administered ondansetron (Danset 4 mg, Egypt) at a dose of 0.1 mg/kg to manage this complication. Comparison between the two groups revealed no statistically significant difference in the occurrence of vomiting. No additional complications were noted (Table 9).

Table (9): Comparison between the two studied groups according to postoperative vomiting

Post-operative vomiting	Group T (n = 30)	Group I (n = 30)	□□	FEp
No	26(87.0%)	25(83.0%)	0.758	0.667
Yes	4(13.0%)	5(17.0%)		

□², p: □² and p values for Chi square test
FE: Fisher Exact

Parental Satisfaction: Parental satisfaction levels varied between the two groups. In Group T, most parents reported excellent satisfaction, with a significant portion indicating good satisfaction and a smaller segment expressing fair satisfaction. Similarly, in Group I, while a substantial number of parents reported excellent satisfaction, the proportion of good and fair satisfaction differed slightly. However, the comparison between the two groups showed no statistically significant difference in overall parental satisfaction (Table 10).

Table (10): Comparison between the two studied groups according to parental satisfaction

Patient satisfaction	Group T (n = 30)	Group I (n = 30)	□□	p
Fair Good Excellent	4(13.0%) 9(30.0%) 17(57.0%)	10(33.0%) 5(17.0%) 15(50.0%)	□□□□□	0.093

□², p: □² and p values for Chi square test

Discussion

IHR is one of the most common pediatric operations. Most of them that are present at birth or in childhood are indirect inguinal hernias. Inguinal hernias are substantially more prevalent in men than in women [(10)].

Conventional medications were used to manage pain after hernia repair, including pain escape strategies (using maximum dosages of paracetamol, non-steroidal anti-inflammatory drugs, and oral or intravenous opioids). However, this approach has been associated with negative side effects, including sedation, nausea, vomiting, hypotension, decreased lung capacity, and increased cardiac load [(11)].

The current study evaluates ultrasound-guided TAP block against conventional ilioinguinal/iliohypogastric nerve block for pediatric open IHR.

The TAP block, which is used to alleviate pain by blocking sensory neurons by injecting local anesthetics into the neurofascial plane between the transversus abdominis muscles and the internal oblique, was initially reported by **Rafi** [(12)] in 2001. If the needle is not positioned precisely, this blindfolded approach may result in an incorrect block, which can cause catastrophic consequences such liver damage and intestinal puncture. The use of ultrasound guidance for TAP block placement was first presented by **Hebbard et al.** [(13)]. This technique made it possible to identify muscle layers and precisely put the needle and local anesthetic.

The AHTPS is a tool intended to assure validity and excellent inter-rater reliability. It is a rapid and user-friendly observation-based pain score. Comparing the two groups at 2, 4, 6 hours after surgery showed a significantly a smaller number of patients with higher score of AHTPS in group T in comparison to AHTPS in group I and at 8 hours after surgery and after that, comparing the two groups showed no statistical significance.

Single-blinded study involving 273 adult male patients scheduled for elective primary unilateral open IHR under general anesthesia and either traditional IHN blocks or ultrasound-guided TAP blocks, **Aveline et al.** [(14)] discovered that at 4 hours (11 vs. 15, P=0.04), 12 hours (20 vs. 30, P=0.0014), and 24 hours (29 vs. 33, P=0.013), the ultrasound-guided TAP group had reduced median VAS pain levels.

In a comparative study involving 60 children undergoing lower abdominal surgery, **Faried et al.** [(15)] found that There wasn't statistically significant difference in the average pain score (CHEOPS) between the two groups during the study, with the exception of 240 minutes post-operatively, when patients who received US-guided TAP blocks had a significantly lower CHEOPS than those who received US-guided IIN/IHN blocks.

In another comparative study between US-guided TAP blocks and US-guided IIN/IHN blocks, carried out on 50 children scheduled for IHR, **Mohamed and Kamal** [(16)] showed that the average FLACC pain score during hospital stay in patients who received US-guided IIN/IHN blocks was 2 (1–2) compared with 3 (2.25–3.5) [median (interquartile range)] In patients who got US-guided TAP blocks, there was a significant difference between the two groups ($P < 0.001$).

The study found that group T experienced considerably longer durations of analgesia (187.8 ±57.63 min) than in group I (146.96±52.25 min) (p=0.019). In line with our research **Faried et al.** [(15)] discovered that patients who received US-TAP blocks (group T) had a longer average time to first rescue analgesia and analgesia duration (254.5±47.2 minutes) than patients who received US-guided IIN/IHN blocks (group I) (213±45.3 minutes) ($p<0.05$).

Mohamed and Kamal [(16)] showed in their study that US-guided IIN/IHN block provide longer, and better postoperative pain management than TAP block since the first rescue medication was (273±41.7 min) in patients who received US guided IIN/IHN block, in comparison to (209.6±98.4 min) in patients who received US guided TAP block ($P <0.001$).

The present study also showed that the total amount of nalbuphine (Mean ±SD) given to the patients in group T (2.58 ±0.74 mg) was statistically significant less than the total amount of nalbuphine given to the patients in group I (3.11±1.04 mg) (p=0.048).

Aveline et al. [14] revealed that the postoperative morphine needs were decreased within the first 24 hours in the TAP block group in comparison to conventional IIN/IHN block [median (IQR) 60 (20–80) mg vs. 80 (40–140) mg, P<0.001].

In their research of 52 patients having open appendicectomies, **Niraj et al.** [17] shown that, as compared to conventional treatment, ultrasound-guided TAP block significantly decreased postoperative morphine use in the first 24 hours [28±18 vs. 50± 19 mg, P<0.002].

Many studies showed the efficacy of US-TAP block as an effective post-operative analgesic tool, **Shaaban** [18] showed in his randomized control trial carried on 44 children aged 4-16 years prepared for appendectomy that after appendectomy in children, US-TAP block with large volume (0.4ml kg) 0.25% levobupivacaine provided longer postoperative analgesia and decreased analgesic needs compared to local wound infiltration. There are no clinical adverse effects.

In their prospective randomized study carried on 60 adult male scheduled for IHR, and contrasting the traditional technique with US-guided ilioinguinal and iliohypogastric nerve block, **Khedkar et al.** [19] reported that those who got US-guided IIN/IHN block experienced a much earlier onset of sensory block (Group B: 14.03±2.82min) than those who received the traditional approach (Group A: 15.57±1.52min) (p = 0.047).

Furthermore, Group B had motor block earlier (19.40 ± 2.85 min) than Group A (20.67 ± 1.90 min), and it took them longer (7.22 ± 0.97 h) to restore analgesia than Group A (6.80 ± 0.70 h) (p = 0.062). Additionally, with ultrasound-guided block, less medication was needed.

In contrast to our study, **Fredrickson et al.** [20] conducted a prospective randomized study involving 41 children aged 6 months to 12 years undergoing elective inguinal surgery (inguinal herniotomy, hydrocelectomy, orchidopexy). They compared US-guided ilioinguinal blocks with US-guided TAP blocks and found that pain was more frequent (76% vs. 45%, p = 0.040) in the TAP group. However, the two groups' ratings for comfort, contentment, post-discharge ibuprofen usage, morphine use, and recovery room pain were comparable. The ilioinguinal group notably had lower US image quality and longer needle duration under the skin (median [interquartile range] 81 [66–120] vs. 46 [40–51], p < 0.001).

Regarding complications, in the current study, the only observed complication was postoperative vomiting, no other complications were encountered.

In the present study, 4 patients in group T (13%) and 5 patients in group I (17%) experienced vomiting in PACU which was statistically insignificant (P = 0.667). All of them were treated by intravenous ondansetron.

In line with our findings, **Faried et al.** [15] found that only two patients in both groups (T) and (I) reported vomiting and received vomiting rescue medications in a comparative study of US-TAP block versus US guided IIN/IHN block in children undergoing lower abdominal surgery. The difference wasn't significant (P>0.05). There were no further issues reported by either group's participants.

In a comparative study between US guided TAP block and US guided IIN/IHN block which was carried on 50 children scheduled for IHR, **Mohamed and Kamal** [16] showed that no patients received US guided IIN/IHN block developed any complications, but only two patients received US guided TAP block developed postoperative vomiting, that was of no statistical significance, (P=0.59).

The therapeutic efficacy of ultrasound-guided IIN/IHN or TAP blocks for perioperative analgesia in patients having open inguinal surgery was evaluated in a meta -analysis by **Wang et al.** [21]. Four of the 139 articles found during a thorough search of seven databases from the beginning to March 5, 2015, were appropriate for further examination. Randomized controlled trials comparing landmark-based and ultrasound-guided approaches for IIN/IHN and TAP blocks were included in the research.

The findings of the meta -analysis revealed that US-guided blocks significantly reduced the need for additional intraoperative analgesia (OR=0.21; 95% CI: 0.09 to 0.49; p<0.001; I2=0.00%), lowered pain scores during day-stay (SMD=-0.96; 95% CI: -1.68 to -0.24; p<0.001; I2=88.3%), and resulted in significantly less use of rescue medication (OR=0.16; 95% CI: 0.06 to 0.40; p<0.001; I2=10.2%). These results collectively demonstrate that ultrasound-guided IIN/IHN or TAP blocks provide superior perioperative analgesia compared to landmark-based techniques for patients undergoing open inguinal surgery.

Conclusion

Ultrasound guided TAP block provides more effective analgesia than conventional IIN/IHN block during pediatric IHR. Less rescue analgesia was used with the use of US-TAP block than with conventional IIN/IHN block. Both

techniques were associated with a low incidence of vomiting and their use resulted in equal and satisfactory parent satisfaction.

Recommendations

Pre-emptive analgesia should be adopted in all surgical procedures, to allow better pain control in the postoperative period. US guided TAP block should be used as part of multimodal analgesia in pediatric IHR. Future studies should be adopted to assess safety, analgesic efficacy of US guided ilioinguinal/iliohypogastric nerve block in comparison to conventional blind technique. Further research should be conducted to determine the efficacy of various local anesthetics and additives in US guided TAP block as an analgesic aid for lower abdominal surgery.

Author Contributions

MHA designed the experiments, and supervised the research. AMM collected and analyzed the data. OHA conceptualized the study, and supervised the research. MAM gave a critical evaluation of the article in addition to analyzing and interpreting the data. The final draft of the work was approved by all authors.

References

1. Nordin P. (2013): Anesthesia In: Kingsnorth A, LeBlanc KA (eds). Management of abdominal hernias. New York: Springer Science & Business Media; 159-70.
2. Kehlet H. and Dahl JB. (2003): Anaesthesia surgery and challenges in postoperative recovery. Lancet 2003; 362: 1921– 8.
3. White PF. (2002): The role of non-opioid analgesic techniques in the management of pain after ambulatory surgery. Anesth Analg; 94: 577– 85.
4. Verghese S. and Hannallah R. (2010): Acute pain management in children Journal of Pain Research 3 105–123
5. Walker S. (2014): Neonatal pain Pediatric Anesthesia 24 (1) 39–48
6. Côté AV., Vachon CA., Horlocker TT. and Bacon DR. (2003): From victor pauchet to gaston labat: The transformation of regional anesthesia from a surgeon's practice to the physician anesthesiologist. Anesth Analg; 96: 1193-200.
7. Ivani G. and Mossetti V. (2010): Continuous central and perineural infusions for postoperative pain control in children Current Opinion in Anaesthesiology 23 (5) 637–642
8. Marhofer P., Greher M. and Kapral S. (2005): Ultrasound guidance in regional anaesthesia. Br J Anaesth; 94(1): 7-17.
9. Alipour M., Karimi K., and Rostamy D. (2011): Modified Variational Iteration Method for the Multi-pantograph Equation with Convergence Analysis. Australian Journal of Basic and Applied Sciences; 5(5) 886-893.
10. Lloyd DA. and Rintal RJ. (1998): Inguinal hernia and hydrocele. In: O'Neill JA, Rowe MI, Grosfeld JL, Fonkalsrud EW, Coran AG, (eds). Pediatric Surgery. 5th ed. St Louis: Mosby; 1071–86.
11. Tilleul P., Aissou M., Bocquet F., Thiriat N., le Grelle O., Burke MJ., Hutton J. and Beaussier M. (2012): Cost effectiveness analysis comparing epidural, patient-controlled intravenous morphine, and continuous wound infiltration for postoperative pain management after open abdominal surgery. Br J Anaesth; 108(6):998-1005.
12. Rafi AN. (2001): Abdominal field block: a new approach via the lumbar triangle. Anaesthesia 56: 1024-6.
13. Hebbard P, Fujiwara Y, Shibata Y et al. (2007): Ultrasound-guided transversus abdominis plane (TAP) block. Anaesth Intensive Care; 35(4):616-7.
14. Aveline C., Le Hetet H., Le Roux A., Vautier P., Cognet F. and Vinet E. (2011): Comparison between ultrasound-guided transversus abdominis plane and conventional ilioinguinal/iliohypogastric nerve blocks for day-case open inguinal hernia repair. Br J Anaesth; 106(3):380-6.
15. Faried AM., Lahloub FMF. and Elzehery MM. (2015): Ultrasound guided Transverses Abdominal Plane Block versus Ilioinguinal/iliohypogastric Nerve Blocks for Postoperative Analgesia in children Undergoing Lower Abdominal Surgery. Enliven J Anesthesiol Crit Care Med; 2(1):001.
16. Mohamed MH. and Kamal MM. (2015): Comparison of postoperative analgesia of ultra sound-guided ilioinguonal/iliohypogastric nerve block versus ultrasound-guided TAP block for pediatric inguinal hernia repair. Ain Shams J Anesthesiol 8:658-63.
17. Niraj G., Kelkar A., Jeyapalan I., Graff-Baker P., Williams O. and Darbar A. (2011): Comparison of analgesic efficacy of subcostal transversus abdominus plane blocks with epidural analgesia following upper abdominal surgery. Anaesthesia 66:465-71.
18. Shaaban AR. (2014): Ultrasound guided transversus abdominis plane block versus local wound infiltration in children undergoing appendectomy: A randomized controlled trial. Egyptian J Anaeth; 30(4): 377.
19. Khedkar SM., Bahlerao PM., Yemul-Golhar SR. and Kelkar KV. (2015): Ultrasound-guided ilioinguinaland iliohypogastric nerve block, a comparison with the conventional technique: An observational study. Saudi J Anaesth; 9(3):293-7.
20. Fredrickson MJ., Paine C. and Hamill J. (2010): Improved analgesia with the ilioinguinal block compared to the transversus abdominis plane block after pediatric inguinal surgery: A prospective randomized trial. Paediatric Anaesth; 20(11): 1022-7.
21. Wang Y., Wu T., Terry MJ., Eldrige JS., Tong Q. and Erwin PJ. (2015): Improved Perioperative Analgesia with Ultrasound-Guided Ilioinguinal/iliohypogastric Nerve or Transversus Abdominis Plane Block for Open Inguinal Surgery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Phys Med Rehabil Int 2(6): 1055.