Open versus Laparoscopic Pyloromyotomy for Infantile Hypertrophic Pyloric Stenosis

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Introduction: Infantile hypertrophic pyloric stenosis (IHPS) is the most common surgical cause of vomiting in infancy which can be treated by pyloromyotomy after correction of pH and electrolytes imbalance. Infantile hypertrophic pyloric stenosis (IHPS) is the most common surgical cause of vomiting in infancy which can be treated by pyloromyotomy after correction of pH and electrolytes imbalance.

Aim of work: To Compare between laparoscopic and open (Right upper quadrant incision) approach for pyloromyotomy in the management of infants with infantile hypertrophic pyloric stenosis regard their operative time, hospital stay, postoperative complications and cosmoses.

Patients and methods: A prospective study of 40 patients with IHPS was done. (20 by laparoscopy and 20 by open approach) To Compare between laparoscopic and open (Right upper quadrant incision) approach in pyloromyotomy in infants with infantile hypertrophic pyloric stenosis regard their operative time, hospital stay, postoperative complications and cosmoses.

Results: This study was conducted on 40 patients with infantile hypertrophic pyloric stenosis (IHPS) randomly divided into two groups, A and B. Laparoscopic pyloromyotomy was performed on group A while Group B underwent open pyloromyotomy through a transverse right upper quadrant incision. Throughout the study, 31 (77.5%) male babies were diagnosed with IHPS, while only 9 (22.5%) female babies were diagnosed during the study with 3.4:1 male to female Ratio. Open pyloromyotomy needed less operative time (mean 28.6 mins), while laparoscopic pyloromyotomy took more time (Mean 36.8 mins) intraoperatively and needs more experience for the surgeon in dealing with laparoscopic tools. According to the study, Patients underwent open pyloromyotomy needed more hospital stay (Mean 2.9 days) till achievement of full feeding than laparoscopic pyloromyotomy (mean 1.7 days). Through the study, we addressed cosmetic results according to patient's parent or guardian satisfaction to cosmetic results. 4 cases' (20% of the total group) Parents in group A complained of the shape of the scar and wished if it was better (Shown in the next picture), while parents in Group B was satisfied with the post operative scar which was mostly unnoticed.

Conclusion: The study revealed that laparoscopic pyloromyotomy has excellent cosmesis, less hospital stay, with operative time and complications comparable rates to open approach, so it can be considered as a standard technique for treatment of IHPS.

Key words: Infantile hypertrophic pyloric stenosis, pyloric stenosis, pyloromyotomy, open, laparoscopy.

Introduction

Infantile hypertrophic pyloric stenosis (IHPS) is the most common surgical cause of vomiting in infancy, with an incidence of approximately 1 in every 400 live births. Males are four times more likely to have IHPS than females, and most often occurs in neonates and infants aged 1-10 weeks (mean, 5 weeks; range, 5 days to 5 months).[1]

IHPS is characterized by forceful non-bilious vomiting in young infants. This is caused by hypertrophy of the pylorus, which can progress to near-complete obstruction of the gastric outlet.

Numerous theories in the pathogenesis of pyloric stenosis have been proposed, but none of them has achieved general acceptance. These theories fall into three main categories; compensatory work muscle hypertrophy, neurologic degeneration or immaturity and abnormal endocrine or growth factor signals.[2]

Adequate fluid resuscitation followed by pyloromyotomy is the standard curative treatment.[3]

The Ramstedt extra mucosal pyloromyotomy in the longitudinal axis of the pylorus has been long described as the classic surgical approach to IHPS. Numerous approaches have been described to gain access to the pylorus: Upper midline laparotomy (Fredet), right upper quadrant muscle cutting, right-upper quadrant transverse muscle-splitting (Robertson "gridiron") or muscle-sparing (Rickham) incision, and circumumbilical (Tan and Bianchi) or trans-umbilical laparoscopic incision.[4]

There is an ongoing debate about whether laparoscopic pyloromyotomy or open pyloromyotomy is the best option for treating hypertrophic pyloric stenosis. Both surgical modalities have gained wide acceptance although minimal access approaches are now increasingly preferred in the western world.

DOI: 10.21608/ASJS.2024.336998

Aim of work

To Compare between laparoscopic and open (Right upper quadrant incision) approach for pyloromyotomy in the management of infants with infantile hypertrophic pyloric stenosis regard their operative time, hospital stay, postoperative complications and cosmoses.

Patients and methods

We conducted a prospective study on 40 patients diagnosed with infantile hypertrophic pyloric stenosis. We randomly allocated the patients into two groups, A and B. We used two cards from which the baby or the parent chose one card. Each card carried the letter A or B on the back.

We performed laparoscopic pyloromyotomy on group A. Group B underwent open pyloromyotomy through a transverse right upper quadrant incision. We conducted the study at the pediatric surgery department in Ain Shams, Ghamra and Maadi Military hospitals, during the period from September 2022. In every case an informed preoperative consent was obtained from the parents or the guardians as shown in page (53).

Preoperative assessment: We confirmed the diagnosis of hypertrophic pyloric stenosis through the following steps:

Clinical assessment: Careful history talking (When vomiting started, color, projectile or not?). General examination (Dehydrated or not? weight gain). Local examination (Presence of a palpable olive mass).

Pre-operative investigation: Labs: CBC, bleeding profile, ABG, K, Cl, and Na. Ultrasound findings: Length and thickness of the pyloric channel. Heart and chest condition.

Inclusion Criteria: Age: 2 weeks to 3 months. Infants diagnosed as IHPS (By history, positive ultrasound finding and metabolic alkalosis)

Exclusion criteria: Age older than 3 months. Patient with co-morbidity leading to associated risk to laparoscopy Infants complaining of vomiting due to other causes e.g., severe Gastroesophageal reflux

Operative technique

Staff members of the department of pediatric surgery of Ain Shams, Ghamra and Maadi hospitals do perform the both types of procedures. In laparoscopic procedure the patient is placed in the supine position across the end of the operating table. The video monitor is placed to the right of the table, and the surgeon stands opposite the monitor on the left side of the table with the assistant to the patient's right side (Puri Prem & Michael Hollworth, 2006).

The abdomen is scrubbed and draped in a sterile fashion. Attention must be paid to ensure the appropriate preparation of the umbilicus. The access sites are injected with local anesthetic (0.25% bupivacaine) with epinephrine to reduce the post-

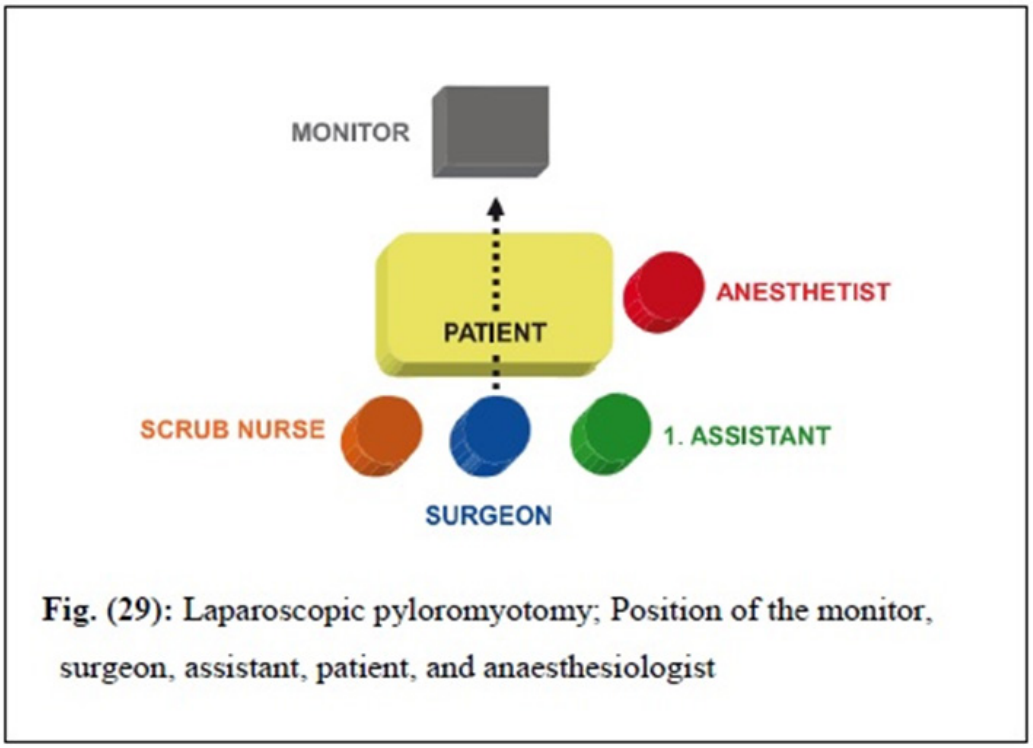

Fig. (29): Laparoscopic pyloromyotomy; Position of the monitor, surgeon, assistant, patient, and anaesthesiologist

Fig 1: Laparoscopic pyloromyotomy, Position of the monitor, surgeon, assistant, patient, and anaesthesiologist.

operative pain and reduce the risk of bleeding from the stab wound.

An open procedure for insertion of the primary port is undertaken. A 4.0-5.0-mm curvilinear supra-umbilical incision is made down to the peritoneal cavity. At the level of umbilical fascia, 4/0 absorbable suture material is placed circumferentially to anchor the port during procedure and to use for closure of the peritoneal cavity when we are done.

5 mm 30-degree laparoscope is introduced in the trocar placed the curvilinear supra-umbilical incision. Intra-abdominal pressure is maintained at 8 mmHg, and insufflation rate is set at 0.5 l/min. In the mid-clavicular line just below the costal margin (just above the liver edge),

A no.11 scalpel blade is used to make a 2- to 3-mm stab incision under direct vision on the right and left sides in a mirror image position. 3-mm atraumatic grasper is placed directly through the right upper quadrant stab wound (port less) and is used to retract the inferior border of the liver superiorly and expose the hypertrophic pylorus. A 3-mm retractable myotomy knife is inserted directly through the left stab wound. Working ports are usually not used and instruments are directly introduced through the stab wounds. The working instruments are used to assess the extent of the hypertrophied pylorus. The duodenum is then grasped just distal to the pyloric vein (pyloroduodenal junction) and retracted in lateral and slightly anterocephalad direction using the atraumatic grasper to expose the avascular surface of hypertrophic pylorus. This maneuver also exposes the proximal margin of hypertrophied muscle that is seen as a deep fold in the wall of stomach.[5]

A seromuscular incision is made over the hypertrophic pylorus with retractable myotomy knife starting at 1–2 mm proximal to the pyloroduodenal junction extending to the gastric antrum. The incision should go far enough onto antrum at least 0.5-1.0 cm proximal to antropyloric junction. Care must be taken at this stage that this incision is deep enough to allow the insertion of the pyloric spreader blades and must penetrate the pyloric muscle somewhat deeper than is usual with the conventional open procedure. After the muscle is incised, the blade is then retracted and the sheath of the knife is used to further split the hypertrophied muscle fibers.

The retractable myotomy knife is removed and a laparoscopic pyloromyotomy spreader is introduced into abdominal cavity directly through the left stab wound to complete the pyloromyotomy. The spreader is placed in the midpoint of the seromuscular incision line and the muscle is spread perpendicularly. Once the initial spread reaches the mucosa, spreading must be continued proximally and distally. Pushing the spreader towards the mucosa or rapid spreading can result in mucosal tear. In order to avoid the mucosal tear, the spreader should not be placed at the proximal and distal edges of the incisional (Myotomy) line.

To test for the mucosal injury, the stomach is inflated through the nasogastric tube (160–180ml) as is usually done in open techniques. Bulging of the mucosal layer with no evidence of defect should be confirmed. Greenish or yellowish fluid at the myotomy area is a sign of mucosal tear.[5]

After the successful myotomy, the instruments are withdrawn under direct vision and the pneumoperitoneum is evacuated. The umbilical fascia is reapproximated with 4/0 absorbable suture material, which is already in place, and the skin of all the wound is reapproximated with skin adhesive

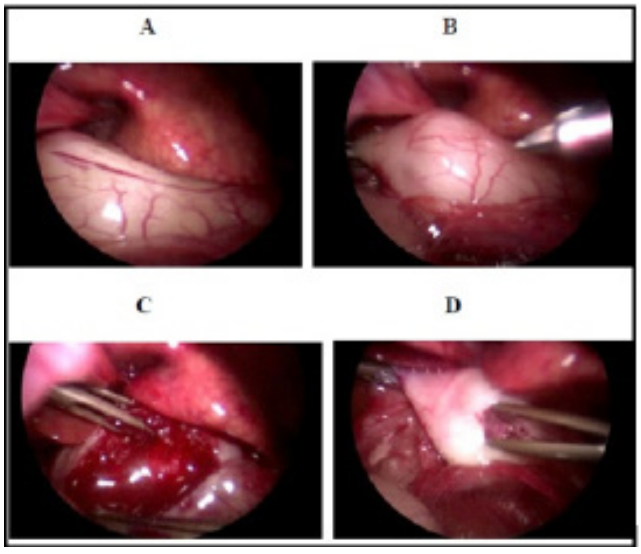

Fig 2: Laparoscopic Pyloromyotomy technique; A, Atraumatic grasper is used to grasp the duodenum just distal to the mass. B, Incision is made with myotomy knife in an avascular plane. C, Spreader is used to split the muscle. D, Spreading the muscle until intact mucosa bulges freely from the myotomy.

tapes or running subcuticular sutures to close the wounds.[5]

In open Ramstedt's pyloromyotomy; the patient is placed in the supine position. After induction of anesthesia and endotracheal intubation, careful abdominal palpation for the pyloric tumor is done.

A 2.5 to 3 cm long transverse incision is made lateral to the lateral border of the rectus muscle in the upper right quadrant. The incision is deepened through the subcutaneous tissue then the underlying external oblique, internal oblique and transverse muscles are split. The peritoneum is opened transversely in the line of the incision.

The stomach is identified and is grasped proximal to the pylorus with non-crushing clamp (Babcock or ovum forceps) and brought through the wound. Then, the greater curvature of the stomach can be held in a moist gauze swab (That is more non-traumatic), and with traction inferiorly and laterally, the pylorus can be delivered through the wound. Grasping the duodenum or pyloric tumor directly by forceps should not be attempted as often results in serosal laceration, bleeding or perforation.

The pylorus is held between the thumb and forefinger to stabilize and assess the exact extent of hypertrophied muscle. A seromuscular incision is made over the avascular area of pylorus with a scalpel at the longitudinal axis of the pylorus, commencing 1-2 mm proximal to the prepyloric vein along the gastric antrum. The incision goes far enough onto the gastric antrum at least 0.5-1.0 cm from the antropyloric junction where the muscle is thin. The scalpel handle (blunt, wider tip and safer), or mosquito with its tip directed upwards, is used to further split the hypertrophied muscle down to the submucosal layer.[5]

Pyloric muscle is spread widely. Spreader is placed at the midpoint of incision line and muscle is spread perpendicularly and spreading must be continued proximally and distally. Gentle spreading is required till the intact mucosa bulges as evidence of a satisfactory myotomy. Mucosal tears are most common at the pyloroduodenal junction because of the attempt to split all remaining muscle fibers. Care should be taken when spreading pyloric muscle fibers at the duodenal end, in order to reduce the risk of mucosal tear.

The stomach is inflated through the nasogastric tube, and passage of air through the pylorus to duodenum is confirmed. Then the pylorus is returned back into the abdomen. Bleeding from the myotomy edge or submucosal surface is frequently seen; however, it is generally venous and always stops after returning the pylorus to the abdominal cavity.

Posterior rectus fascia and peritoneum is approximated with a running 4/0 absorbable suture material and anterior fascia is closed with 5/0 absorbable suture material.

Oral feeding was started regularly for all patients 6 hours postoperatively according to the following regimen 5 ml distilled water / 20 min for 2 hours, if tolerated, then 15 ml glucose water/hour for 2 hours, 30 ml one half strength formula every 2 hours' x 2 meals, 45 mL full strength formula every 2 hours, then as needed.[5]

Results

Postoperative vomiting

Was encountered in one of the cases that underwent laparoscopic pyloromyotomy, inadequate pyloromyotomy was diagnosed by delayed emptying in upper gastrointestinal tract contrast imaging series that was done 4 days after operation due to intolerance to feeds for more than 72 hours postoperatively and open redo-pyloromyotomy was done through transverse RUQ incision like the conventional open approach described formerly in the methodology.

Mucosal perforation

Was encountered in another case of group A undergoing the laparoscopic technique. Perforation was detected by air leak during stomach inflation through the NG tube and we converted to open approach, mucosal perforation and myotomy were repaired and another myotomy was performed.

Cosmetic results;

We addressed cosmetic results according to patient's parent or guardian satisfaction to cosmetic results.

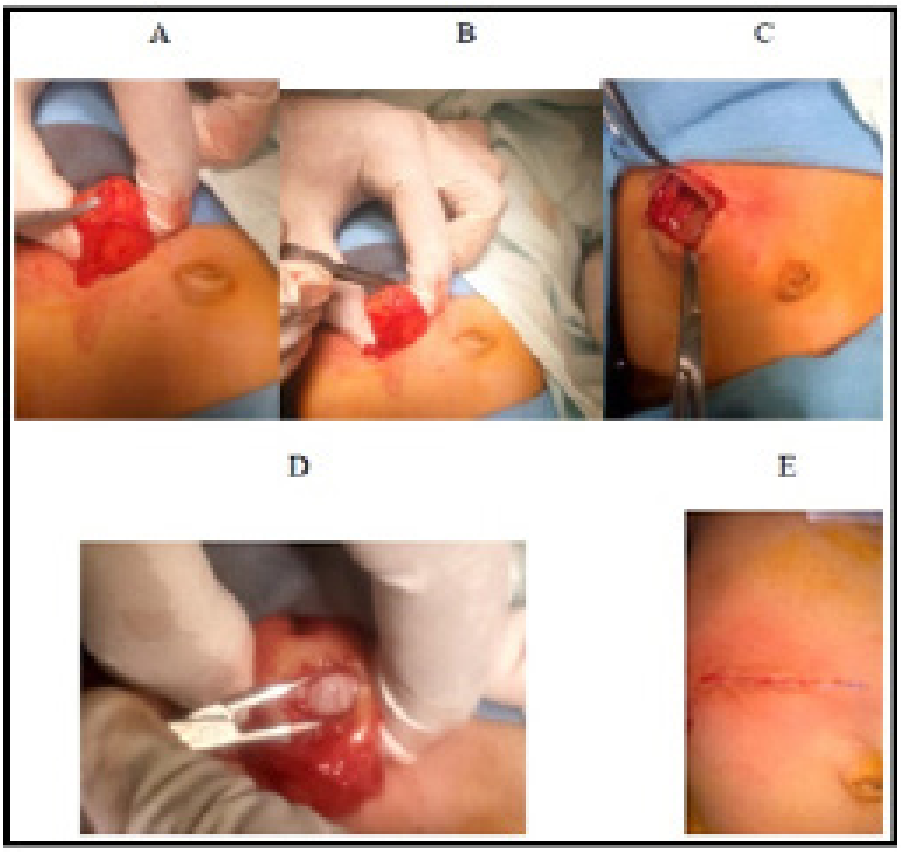

Fig 3: Pyloric stenosis, operative technique. A, Incision. B, Pylorus delivered from peritoneal cavity and stabilized between surgeon's index and thumb fingers then serosal incision outlined and begun. C, The back of a scalpel handle or mosquito tip directed upwards being used to split the hypertrophied muscle down to the submucosa. D, Completed myotomy showing submucosa bulging through the divided muscle. E, Postoperative RUQ wound picture.

Fig 4: Post operative follow up after 2 months of a case of laparoscopic pyloromyotomy.

Fig 5: Post operative follow up after 2 months of a case of open pyloromyotomy.

Table 1: Shows descriptive analysis

		N / Mean	% / SD	Median (IQR)	Range
Group	Group A	20	50.0%		
	Group B	20	50.0%		
Age (weeks)		4.70	1.54	4.5 (3.25 - 6)	(2.5 - 8)
Sex	Male	31	77.5%		
	Female	9	22.5%		
Weight (kg)		2.97	0.42	2.8 (2.65 - 3.25)	(2.3 - 3.8)

Table 2: Shows descriptive analysis (Symptoms)

		N / Mean	% / SD	Median (IQR)	Range
Onset of vomiting (weeks)		3.10	1.16	3 (2 - 4)	(1.5 - 5.5)
Non bilious vomiting	No	0	0.0%		
	Yes	40	100.0%		
Projectile	No	0	0.0%		
	Yes	40	100.0%		
Dehydration	No	16	40.0%		
	Yes	24	60.0%		
Palpable mass	No	12	30.0%		
	Yes	28	70.0%		

Table 3: Shows age distribution

Age	Group A	Group B	Total	%
< 2weeks	0	0	0	0
2-4	7	11	18	45%
4-8	13	9	22	55%
> 8 weeks	0	0	0	0

Table 4: Shows patient's sex distribution

Sex	Group A	Group B	Total
Males	16 (80%)	15 (75%)	31 (77.5%)
Females	4 (20%)	5 (25%)	9 (22.5%)
Total	20(50%)	20(50%)	40(100%)

Table 5: Shows clinical assessment of the patients

Symptoms & signs	Number of cases	%
Vomiting (non-bilious)	40	100%
Dehydration	24	60%
Palpable mass	28	70%

Table 6: Shows clinical assessment of the patients

		N / Mean	% / SD	Median (IQR)	Range
Onset of vomiting (weeks)		3.10	1.16	3 (2 - 4)	(1.5 - 5.5)
Non bilious vomiting	No	0	0.0%		
	Yes	40	100.0%		
Projectile	No	0	0.0%		
	Yes	40	100.0%		
Dehydration	No	16	40.0%		
	Yes	24	60.0%		
Palpable mass	No	12	30.0%		
	Yes	28	70.0%		

Table 7: Shows laboratory findings of the patients

	Mean	SD	Median (IQR)	Range
Hb	11.88	1.09	11.65 (10.95 - 12.8)	(10.1 - 14.1)
TLC	7.56	2.43	7.7 (5.65 - 9.25)	(3.6 - 12.5)
INR	1.13	0.09	1.13 (1.06 - 1.19)	(1 - 1.39)
Na	128.23	4.17	128 (126 - 130.5)	(121 - 139)
K	3.07	0.46	2.9 (2.8 - 3.35)	(2.5 - 4.8)
Cl (mEq/L)	87.90	9.70	88 (80 - 96.5)	(64 - 102)
PH on admission	7.56	0.07	7.56 (7.5 - 7.61)	(7.45 - 7.7)

Table 8: Shows laboratory findings among patients

Laboratory findings	Number of cases	Percentage
Hb.		
< 11	10	25%
11 – 13	24	60%
> 13	6	15%
Na		
< 135	37	92%
135-145	3	8%
> 145	0	0%
K		
< 3.5	33	82.5%
3.5-5.5	7	17.5%
> 5.5	0	0%
ABG		
< 7.35	0	0%
7.35 – 7.45	1	2.5%
> 7.45	39	97.5%

Table 9: Shows Radiological findings of the patients

	N / Mean	% / SD	Median (IQR)	Range
Canal length (mm)	17.02	2.09	16.5 (15.65 - 18.75)	(14 - 22)
Muscle thickness (mm)	6.00	1.30	6 (5 - 6.7)	(3.8 - 9)

Table 10: Shows radiological findings of the patients

U/S findings	No. of cases	%
Thickness of pyloric canal	40	100
> 3 mm	40	100
< 3mm	0	0
Length of pyloric canal	40	100
> 14 mm	40	100
< 14 mm	0	0

Table 11: Shows operative details

		N / Mean	% / SD	Median (IQR)	Range
Operative time (min)		32.70	4.87	33 (29 - 36)	(25 - 43)
Mucosal perforation	No	38	95.0%		
	Yes	2	5.0%		

Table 12: Shows operative time

Operative time	Group A	Group B	P value
Mean	28.6 mins	36.8 mins	<0.001
Std. deviation	2.06	3.02	
Minimum	25 mins	33 mins	
Maximum	33 mins	43 mins	

(T) Student t-test of significance.

Table 13: Shows post operative follow up till recovery of the patients

	N / Mean	% / SD	Median (IQR)	Range
Time to achieve full feeds (days)	2.30	1.02	2 (2 - 3)	(1 - 5)
Hospital stay (days)	2.98	1.00	3 (2 - 3.5)	(2 - 6)
PH on discharge	7.42	0.02	7.42 (7.41 - 7.43)	(7.37 - 7.46)

Table 14: Shows Time to achieve full feeding difference between the two groups

Time to achieve full feeds (days)	Group A	Group B	P value
Mean	2.9	1.7	<0.001(T)
Std. deviation	0.85	0.8	
Minimum	2	1	
Maximum	5	4	

(T) Student t-test of significance.

Table 15: Shows incidence of complications throughout the study

		N / Mean	% / SD	Median (IQR)	Range
Mucosal perforation	No	38	95.0%		
	Yes	2	5.0%		
Recurrence of vomiting	No	40	100%		
	Yes (more than 72 hrs.)	0	0%		
Wound infection	No	39	97.5%		
	Yes	1	2.5%		
Ugly scar	No	36	90%		
	Yes	4	10%		

Table 16: Shows incidence of complications throughout the study

Complications	Group A	Group B	% of total	P value
Recurrence of vomiting	0	0	0%	_____
Mucosal perforation	1	1	5%	1.00(F)
Wound infection	1	0	2.5%	1.00(F)
Burst abdomen	0	0	0 %	_____
Ugly scar	4	0	10 %	0.106(F)

(F) Fisher's Exact test of significance.

Discussion

We conducted the study at the pediatric surgery department in Ain Shams, Ghamra and Maadi Military hospitals during the period from September 2022 to June 2023.

- **Age**

The age of the studied patients ranged between 20 days and 56 days with peak age (Mean ± 1SD) of 22 to 44 days.

Jia et al. studied 492 patients in 2011 in a meta-analysis of three studies that were conducted by Peter et al. from USA, LeClair et al. from France and Hall et al. from UK. Their ages ranged between 18 to 60 days with peak age of (Mean ± 1SD) 27 to 39 days.[6]

This reveals that our results run parallel with that mentioned by Jia W.Q et al, however slightly higher ages at presentation may reflect somehow a delay in the diagnosis by the referring primary care units.

- **Sex**

In our study the male to female ratio was 3.4:1 (P value = 1) while the ratio in the study done by O'Donoghue et al., (1993)[7] was 2:1, in the study done by Mason PF was 5:1 and in a study of 101 cases published by Handu[8] the ratio was 7.4:1 with male predominance[7-9]

Preoperative

The use of preoperative antibiotics has become standard practice. Since 1998 several studies reported a lower incidence of wound, infection with prophylactic antibiotic use.[10]

In this study, the 1st line antibiotic (Claforan "Cefotaxime" 100mg/Kg/day) was used in all patients because these patients may be immunocompromised due to preoperative vomiting (Relative starvation). Wound dehiscence and burst abdomen as postoperative complications were encountered in none of this study patients but one patient in the open pyloromyotomy group had wound site infection (2.5%).

Jia et al. studied the incidence of wound site infection in his meta- analysis of 3 studies. 2 studies used prophylactic anti- biotics and another did not use prophylactic antibiotics and analysis indicated that there were no significant differences between the 2 groups.[6]

Operative data

In this study, the mean operative time of laparoscopic pyloromyotomy was 36.8 ± 3.02 minutes (Range 33 - 43 minutes) while the mean operative time of the open approach was 28.6 ± 2.06 minutes (Range 25 - 33 minutes) with the P value = <0.001. This is attributed to operator dependent expertise in laparoscopic skills and as the operator reaches the end of the learning curve his minimum times in laparoscopic approach can be shorter than those in open approach.

In the study published by Handu; mean operative time was 45.7 ± 17.4 minutes (Range 15 to 105 minutes). The time was reduced from 49.7 minutes to 43.0 minutes in the latter half of their experience. This difference was found to be statistically significant (P value = 0.015). The operative time of their four senior surgeons decreased from 49.2 ± 12.3 minutes (Range 20 - 75 minutes) to 37.0 ± 17.6 minutes (Range 15 - 75 minutes) (Handu et al., 2014).

Accordingly, the operative time of our study is comparable to the previously mentioned studies.

Early comparative studies of laparoscopic and open pyloromyotomy reported a higher complication rate with laparoscopic pyloromyotomy leading to the conclusion that the operation is equal to the open approach only after the surgeon has incurred substantial experience.

This conclusion resulted in the argument that the technical ability of performing a laparoscopic pyloromyotomy requires a period of learning and that this period should be respected prior to considering the laparoscopic approach to be as safe as the traditional open technique.

Attempts to quantify this period of learning have estimated it to be about 30 cases.

- **Mucosal perforation**

In our study mucosal perforation was encountered twice (One was with the open technique while the other was with laparoscopic technique which was converted to open technique) with incidence of 5% within the whole study of 40 with the P value = 1.00

This may be attributed to having many cases done by junior staff members at the beginning of their learning curve. While more experienced surgeons didn't face such a complication with the open or the laparoscopic technique which leads to a conclusion that both operations are safe with good experience.

In the 101 cases study done by Handu (69 cases done by senior surgeons and 32 others done by junior surgeons), four patients (3.9%) had mucosal perforation of which one was managed successfully laparoscopically while the remaining three were converted to open (Handu et al., 2014).

- **Incomplete pyloromyotomy**

In our study incomplete pyloromyotomy was not encountered in both groups with incidence of 0% within the whole study of 40 with the P value = 1.00. This was due the progression of surgeon's operative skills.

In the study published by Jia W.Q et al. there were four cases of incomplete pyloromyotomy in 137 cases that have had laparoscopic pyloromyotomy with an incidence of 4.3 % compared to zero cases among the open approach cases.[6]

Thus, in our study, the incidence of incomplete pyloromyotomy was even better than that published by Handu and Jia et al.

Using the laparoscopic approach provides pediatric surgery fellows with valuable laparoscopic experience at a time when minimally invasive surgery is being used for an increasing number of abdominal operations.

- **Postoperative data**

Hospital stay & time to achieve full feeding:

In our study, Oral feeding was started regularly for all patients 12 hours postoperatively according to the following regimen 5 ml distilled water / 20 min for 2 hours, if tolerated, then 15 ml glucose water/ hour for 2 hours, 30 ml one half strength formula every 2 hours x 2 meals, 45 mL full strength formula every 2 hours, then as needed.

Infants achieved full feeding within 1 to 4 days with a mean of 40 ± 19 hours for the laparoscopic approach and within 2 to 5 days with a mean of 69 ± 20 hours for the open approach which supposes faster postoperative feeding tolerance with the laparoscopic approach and thus shorter postoperative hospital stay.

In the study published by Jia et al. procedures appear to be equal in terms of time-to full feeds and length of stay after surgery. However, there was a trend in the laparoscopic group towards shorter times.[6]

Several studies have investigated postoperative feeding regimens for IHPS patients with respect to time of reintroduction of feeding and speed of advancement in an attempt to declare the safest and most effective regimen. However, a review of results does not provide any single best regimen; however, these studies do appear to support the contention that a more liberal feeding regimen probably does no harm.

Turnock and Rangecroft, evaluated early (4 hour) versus late (18 hour) reintroduction of feeding. Although there was more vomiting in the early group, there was no difference in the time required to achieve full feedings. Georgeson et al. compared cautious and accelerated regimens and found that starting feedings 6 hours after pyloromyotomy with accelerated feeding advancement every 2 hours transiently increased vomiting, but resulted in significantly shorter hospital stays compared with more cautious strategies. Wheeler et al.,[11] studied gradual reintroduction of feedings over 16 or 48 hours versus starvation for 24 hours followed by full feedings. This study found vomiting to be self-limited and independent of the timetable or composition of the postoperative feeding regimen. Of note, the patients in this study were discharged at an average of 48 to 59 hours after surgery, which is longer by today's standards.[11-13]

Recurrence of vomiting

Post operative emesis was recorded in 5% of patients within the first 48 hours postoperatively only and was subsided without the need of doing redo-pyloromyotomy. while in the study done by Handu, five infants (4.9%) had inadequate pyloromyotomy requiring re-do surgery. Two re-do surgeries were performed laparoscopically with a smooth post-operative recovery. Another was attempted laparoscopically but had to be converted to open. Two re-dos were performed by the open technique.[8]

Follow up & cosmesis

Laparoscopic pyloromyotomy found to be cosmetically superior to open pyloromyotomy approach as the incision for the camera port is hidden in the umbilicus leaving no visible scar and the other 2 stab incisions used for the working

instruments are too small to be noticed, also laparoscopic pyloromyotomy avoids the transverse right upper quadrant incision which leaves a scar that enlarges as the child grows up in the open technique.

Through the study, we addressed cosmetic results according to patient's parent or guardian satisfaction to cosmetic results. 4 (20% of the total group) Parents in group A complained of the shape of the scar and wished if it was better (Shown in the next picture), while parents in Group B was satisfied with the post operative scar which was mostly unnoticed.

Conclusion

The study revealed that laparoscopic pyloromyotomy has excellent cosmesis, less hospital stay, with operative time and complications comparable rates to open approach, so it can be considered as a standard technique for treatment of IHPS. With more experience, this approach may consume a shorter operative time and, subsequently, the potential for decreased operative and hospital stay costs in comparison with the open approach.

References

1. O'Neill JA, Grosfeld JL, Fonkalsrud EW, et al: (Editors): Principles of pediatric surgery, 2nd Edition. ***Hypertrophic Pyloric Stenosis.*** 2006.
2. Ziegler MM, Azizkhan RG, Von Allmen D, Weber TR: Operative pediatric surgery. ***Hypertrophic Pyloric Stenosis.*** 2014.
3. Siddiqui S, Heidel RE, Angel CA, Kennedy AP: Pyloromyotomy: Randomized control trial of laparoscopic vs open technique. ***Journal of Pediatric Surgery.*** 2012; 47(1): 93-8.
4. Sola JE, Neville HL: Laparoscopic vs. open pyloromyotomy: A systematic review and meta-analysis. ***J Pediatric Surg.*** 2009; 44: 1631–1637.
5. Prem Puri, Michael Hollworth: Pediatric surgery, pyloric stenosis, 2006; 18: 171-180.
6. Jia WQ, Tian JH, Yang KH, et al: Open versus laparoscopic pyloromyotomy for pyloric stenosis: A meta- analysis of randomized controlledt trials. ***European Journal of Pediatric Surgery.*** 2011; 2:1: 77-81.
7. O'Donoghue JM, Connolly KD, Gallagher MM, O'Hanlon D, Doyle J, Flynn JR: The increasing incidence of infantile hypertrophic pyloric stenosis. ***Irish Journal of Medical Science.*** 1993; 162: 175-6.
8. Handu AT, Jadhav V, Deepak J, Aihole JS, Narendrababu M, Ramesh S, Srimurthy KR: Laparoscopic pyloromyotomy: Lessons learnt in our first 101 cases. ***Journal of Indian Association of Pediatric Surgeons.*** 2014; 19(4): 213.
9. Mason PF: Increasing infantile hypertrophic pyloric stenosis? Experience in an overseas military hospital. ***Journal of the Royal College of Surgeons of Edinburgh.*** 1991; 36(5): 293-4.
10. Nour S, MacKinnon AE, Dickson JA, Walker J: Antibiotic prophylaxis for infantile pyloromyotomy. ***Journal of the Royal College of Surgeons of Edinburgh.*** 1996; 41(3): 178-80.
11. Wheeler RA, Najmaldin AS, Stoodley N, Griffiths DM, Burge DM, Atwell JD: Feeding regimens after pyloromyotomy. ***British Journal of Surgery.*** 1990; 77(9): 1018-9.
12. Turnock RR and Rangecroft L: Comparison of postpyloromyotomy feeding regimens in infantile hypertrophic pyloric stenosis. ***Journal of the Royal College of Surgeons of Edinburgh.*** 1991; 36(3): 164-5.
13. Georgeson KE, Corbin TJ, Griffen JW, Breaux CW: An analysis of feeding regimens after pyloromyotomy for hypertrophic pyloric stenosis. ***Journal of pediatric Surgery.*** 1993; 28(11): 1478-80.