



**A COMPARATIVE STUDY TO ASSESS THE IMPACT OF
LOW PRESSURE VERSUS STANDARD PRESSURE
PNEUMOPERITONEUM ON SHOULDER TIP PAIN AFTER
LAPAROSCOPIC SURGERY**

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Abstract:

Background: In an effort to lessen the effect of pneumoperitoneum on human physiology while still giving appropriate working space, a new trend has been the use of low pressures for pneumoperitoneum in the range of 7–10 mm Hg. The advantages of low pressures during pneumoperitoneum appear to be a lower incidence of shoulder tip pain in the postoperative period and also better quality of life in the week following surgery. *Objectives* 1.To study the advantages of low-pressure pneumoperitoneum and its impact on decreasing postoperative complications, especially shoulder tip pain.2.Correlating the duration of laparoscopic surgery and its impact on shoulder tip pain. *Methods:* This is a prospective comparative study of patients undergoing laparoscopic surgeries in B.L.D.E.(D.U)’S Shri B.M.Patil Medical College and Hospital with a sample size of 90. *Results:* Postoperative shoulder tip pain scores were significantly low in the low pneumoperitoneal pressure group, according to our study, with a p-value of < 0.00. The duration of surgery also had a significant impact on shoulder tip

pain. Procedures that exceeded more than 1 hour were associated with more shoulder tip pain (p-value of <0.00). The analgesic requirement and duration of stay in hospital was also less in the low pneumoperitoneal pressure group.

Keywords: Intraabdominal Pressure, Shoulder Tip Pain, Pneumoperitoneal Pressure.

Introduction:

Primum non-nocere. Possibly, the Hippocratic impulse underlying the demand for moral action on the part of doctors was one of the many factors responsible for the introduction of minimally invasive surgery as we know it today. The cause of post-MIS STP, which is thought to be complex and possibly referred to as pain, is not entirely understood. There are at least three probable explained theories.

1. According to the first theory, the generation of carbonic acid lowers the pH of the peritoneal fluid, which damages and irritates the peritoneal and diaphragmatic nerves and causes STP. The conversion of carbon dioxide (CO₂) gas to carbonic acid by carbonic anhydrase, which takes place in the wet surface of the peritoneum and diaphragm, is what causes the irritation caused by carbonic acid on the peritoneum and diaphragm. Although similar results are not always replicated by other investigations, the use of carbonic anhydrase inhibitor acetazolamide in the substantial lowering of STP supports additional evidence.[1]

2. The second theory—also known as visceral ligament traction—i.e. the presence of CO₂ gas pockets between the liver and diaphragm, which results in loss of negative pressure in the peritoneal cavity and, consequently, the loss of suction support of the liver and diaphragm, allowing traction on the triangular and coronary ligaments of the liver, leading to sub-diaphragmatic pain and STP.[1]

3. The tissue trauma theory is the final (also called neuropraxia theory). Pneumoperitoneum causes the peritoneum and diaphragm to extend and/or get injured, which causes blood vessels to leak, nerves to become compressed (such as the phrenic nerve), and the production of inflammatory mediators that cause pain to radiate to the shoulder. The relationship between stretching and the severity of STP has already been documented.[1]

Features of an ideal gas for insufflation in laparoscopy are it should be fireproof, antiknock, have limited ability resorption, have limited physiological effects on the body after absorption, rapid excretion from the body after absorption, does not support the occurrence of burns, little physiological effects in the case of intravascular embolization, very soluble in blood, colourless. The body naturally produces CO₂, which is an inert gas that is very affordable, more widely used, and more practical than nitrous oxide. Since gas is naturally eliminated from the body through the lungs, neither its diffusion nor decomposition within the body present a concern to the patient nor a risk of embolism. Since CO₂ is not flammable, electrocoagulation is allowed.[2,3]

In some cases, carbon dioxide may cause peritoneal irritation and postoperative pain during prolonged laparoscopic procedures. It can occasionally cause laparoscopic acidosis after being absorbed from the stomach, which could result in cardiac arrhythmias. Some surgeons use nitrous oxide (N₂O) for quick laparoscopic surgeries since it does not cause peritoneal irritation, resorption, or acidosis. It should be highlighted that additional nitrous oxide is not blood soluble and, theoretically, poses a very high danger of gas embolism. Due to the flammability of the gas, electrocautery is associated with a risk of burns during N₂O-pneumoperitoneum. Although they are suited for insufflation due to their characteristics, other gases like helium, argon, xenon, and krypton were not used in routine laparoscopic

procedures due to their high cost. Table 1 compares the gases used for PNP during laparoscopy.[2,3]

There are various methods of creating pneumoperitoneum such as the Veress needle insertion method, Direct trocar insertion method, Hassan's method, and Optical trocar.

Pneumoperitoneum is created during laparoscopic surgery by introducing a gas, typically carbon dioxide, into the abdominal cavity. This raises the pressure inside the abdomen (IAP). A pressure of 10–20 mm Hg of carbon dioxide is insufflated into the peritoneal cavity at a rate of 4–6 litres per minute. A steady gas flow of 200–400 ml/min keeps the pneumoperitoneum in place.[2,3,4]

Materials and Methods:

This study was approved by the research ethics committee of Shri B. M Patil Medical College and Research Hospital, Vijayapur and all participants signed written consent forms.

This study was approved by the research ethics committee of Shri B. M Patil Medical College and Research Hospital, Vijayapur and all participants signed written consent forms.

Source of data: All patients admitted in the Department of surgery at Shri B.M.Patil Medical College, Hospital and Research centre, Vijayapur between October 2020 to November 2022 and underwent laparoscopic surgeries for different surgical ailments. This is a prospective comparative study of patients undergoing laparoscopic surgeries in B.L.D.E.(D.U)'S Shri B.M.Patil Medical College Hospital. All patients in IPD undergoing laparoscopic surgery were included in the study. A pretested structural proforma was used to collect relevant information for each individual patient selected. Patients were divided into two groups;

Group A included patients in whom the intra peritoneal pressure is above 10 mm of HG (i.e)standard pressure pneumoperitoneum group, and **Group B** included patients in whom the intraperitoneal pressure is less than 10 mm of HG (i.e) low pressure pneumoperitoneum ,each group were then subdivided into two sub-groups depending on the duration of surgery. In the first subgroup the duration of surgery was less than one hour. In the next subgroup included patients where the duration of surgery is more than one hour. Presence or absence of shoulder Tip pain was recorded within four hours, 12 hours ,24 hours and 48 hours. Visual analogue pain scores of each individual patient selected were included. All routine investigations were done. Written informed consent was obtained from all the patients with detailed explanation of the procedure going to be performed on them, the risk factors and complications involved and the advantages and disadvantages of the same. The duration of stay of each individual patient post operation is mentioned in the study. Cases were selected consequently following the inclusion and exclusion criteria. **Exclusion criteria:** Patients with Endocrine, Renal, Hepatic or Immunological disease, Pregnant patients and Gynaecological surgeries, patients undergoing open conversion of a Laparoscopic surgery.

SAMPLE SIZE: 90

Statistical Analysis:

Descriptive statistics were used with an evaluation of the mean, median and standard deviation employing the paired t-test with an alpha error of 5% (p-value < 0.05) being considered statistically significant.

Results:

In this prospective study, in comparison to assess the impact of low-pressure versus standard-pressure pneumoperitoneum on shoulder tip pain after Laparoscopic surgery various parameters were evaluated. Basic objectives such as advantages of low-pressure

pneumoperitoneum and its impact on decreasing post-operative complications especially shoulder tip pain, correlating the duration of Laparoscopic surgery and its impact on shoulder tip pain., a visual analogue scale for the measurement of shoulder tip pain post-procedure, faster recovery and the duration of stay in the hospital were studied. In this study total population included was 90 with which the maximum age of the patient being 72 years, and the minimum age being 9 years. The mean age of the population was 34 years.(table 1). The majority of the study population was in the age group of 21 - 30 years which accounts for around 42.2%, next common group were 11-20 years constituting 21.1 %. In our study of a total population of 90, male patients were more compared to females, with males being 54.4%, and Females being 46.4 %. The most common laparoscopic procedure was cholecystectomy i.e 43%, followed by appendicectomy i.e 29 %. Laparoscopic hernia repair accounted for 12 % of all the procedures performed.(table 2) Shoulder tip pain was assessed using a visual analogue score and the average of the scores was calculated.

In our study, with a total population of 90, 45 patients underwent surgery with low pneumoperitoneal pressure (i.e 45 %) and the remaining 45 % of patients underwent surgical procedures with pneumoperitoneal pressure above 10.

The population were randomized into two groups of 45 patients in group A and 45 in group B. Patients in group A had a pneumoperitoneal pressure of more than 10 and patients in group B had a pneumoperitoneal pressure of less than or equal to 10. The average of the shoulder tip pain scores was calculated and it was seen that patients in Group A had more shoulder tip pain compared to the patients in Group B. The average shoulder tip pain scores were significantly higher in cholecystectomy and inguinal hernia repair patients.(Figure 1)

In our study, it was noted that patients in Group B had lower STP scores compared to patients in Group A with a significant p-value of 0.000 and a chi square value of 25.1999.(Figure 2)

The study population were further subdivided into two groups depending on the duration of the procedure. (i.e less than 60 mins and more than 60 mins). Patients in the standard pneumoperitoneal group with procedures lasting more than 1 hour had more shoulder tip pain compared to the patients in the low pneumoperitoneal group and it was statistically significant.(Figure 3) The pain scores were more in Cholecystectomy followed by Appendectomy and Hernia repair In the present study, the subdivided groups were further compared with the duration of stay in the hospital. (Figure 4) It was noted that the average duration of stay in the hospital for group A patients was higher compared to Group B Patients. The average duration of stay of group A patients was 3-4 days, whereas in the average duration of stay for group B patients was 2-3 days. In our study, comparison of analgesic (opioids) requirement in the postoperative period was compared with the standard and low pneumoperitoneal pressure group. It was noted that 66.6% population in Group A needed additional analgesics whereas only 33.3 % of Group B patients needed analgesics for pain management. In our study, out of the total population, it was noted that About 54.4 % of the patients need opioid analgesics when the duration of the procedure exceeded 1 hour with a p-value of 0.000.

The following table (table 4) summarises the variables that were studied and their association and level of significance.

1.Comparison of PNP Pressure with shoulder tip pain score yielded a spearman's rho value of 0.551 indicating strong association with a p value of 0.00, stating that it is statistically significant. 2.Comparison of PNP Pressure with Duration of procedure yielded a spearman's rho value of 0.654 indicating strong association with a p value of 0.00, stating that it is statistically significant. 3.Comparison of Shoulder tip pain score with Duration of procedure

yielded a spearman's rho value of 0.551 indicating strong association with a p value of 0.00, stating that it is statistically significant.

Discussion:

Nasir et al 2011, in which 100 patients were studied, which majority of the study population was 30-40 years and the majority of the study population was females(63%) and the indication for surgery was Cholelithiasis.(Table 5) In a study done by Sarli et al in 2017, in which 90 patients were studied, which majority of the study population was 40-50 years and the majority of the study population was females(70%) and the indication for surgery was Cholelithiasis.[4] In a study done by Guruswamy et al in 2021, in which 1092 patients were studied, which majority of the study population were females(60%) and the indication for surgery was Cholelithiasis.[5]

In our study, it was noted that patients in Group B had lower Shoulder tip pain scores compared to patients in Group A with a p-value of 0.000 and chi-square value of 25.1999. The pain scores were more in Cholecystectomy followed by appendicectomy and hernia repair. In our study it was noted that high shoulder tip pain scores were noted in patients where the duration of the procedure lasted more than 60 min with a chi-square value of 13.187, indicating that there is a positive association between the two variables.

In a study done by Nasir et al 2011, Patients in Group A had higher scores compared to patients in Group B. The scores were initially higher post-procedure at 4hr, and 12 hr and gradually decreased over a period of time. The mean operative time was more in Group A compared to Group B. In the study conducted by Sarli et al 2017, Patients in Group A had higher scores compared to patients in Group B. The frequency was significantly lower in

patients who underwent laparoscopic cholecystectomy with low-pressure pneumoperitoneum as compared to patients with standard-pressure pneumoperitoneum with a p-value of 0.05.

In the study conducted by Guruswamy et al 2021, Patients in Group A had higher scores compared to patients in Group B. The frequency was significantly lower in patients who underwent laparoscopic cholecystectomy with low-pressure pneumoperitoneum as compared to patients with standard-pressure pneumoperitoneum with a p-value of 0.01.⁴⁵

In the study conducted by Monica ortezi et al 2022, Patients in Group A had higher scores compared to patients in Group B. The frequency was significantly lower in patients who underwent laparoscopic cholecystectomy with low-pressure pneumoperitoneum as compared to patients with standard-pressure pneumoperitoneum with a p-value of 0.001.[6]

In our study, comparison of analgesic (opioids) requirement in the postoperative period was compared with the standard and low pneumoperitoneal pressure group. It was noted that 66.6% population in Group A needed additional analgesics whereas only 33.3 % of Group B patients needed analgesics for pain management.

In our study, out of the total population, it was noted that About 54.4 % of the patients need opioid analgesics when the duration of the procedure exceeded 1 hour with a p-value of 0.000. The average duration of stay of group A patients was 3-4 days, whereas the average duration of stay for group B patients was 2-3 days.

In a study by Nasir et al in 2011, the analgesic requirement in the postoperative period was more in group A patients compared to Group B patients. About 60% of Group A patients required post-operative analgesics, whereas only 40 % of Group B patients needed additional analgesics. The average duration of stay of group A patients was 2-3days, whereas the average duration of stay for group B patients was 1-2 days.(Table 6)

In a study by Sarli et al in 2017, analgesic requirement in the postoperative period was more in group A patients compared to Group B patients. About 69% of Group A patients required post-operative analgesics, whereas only 31 % of Group B patients needed additional analgesics.⁴⁴

In a study by Guruswamy et al in 2021, the analgesic requirement in the post-operative period was more in group A patients compared to Group B patients. The average duration of stay of group A patients was more compared to patients in Group B.⁴⁵

In a study by Monica ortezi et al in 2022, the analgesic requirement in the postoperative period was more in group A patients compared to Group B patients. About 56% of Group A patients required post-operative analgesics, whereas only 44 % of Group B patients needed additional analgesics. The average duration of stay of group A patients was 1-2days, whereas the average duration of stay for group B patients was 2-3 days.[7,8]

Conclusion:

The prospective comparative study of low pneumoperitoneal pressure versus standard pneumoperitoneal pressure showed significant low shoulder tip pain post-procedure in the low PNP group compared to the standard PNP group. The Duration of surgery also had an impact on shoulder tip scores, when the procedure exceeded more than 60 mins pain scores were high as compared to procedures which lasted less than 60 mins. The analgesic requirement in the postoperative period was also more in the standard PNP group compared to the Low PNP group. Thus we would like to conclude that patients with low

pneumoperitoneal pressure during laparoscopic surgeries had fewer complications especially lower shoulder tip pain scores and better quality of life post-procedure.

Take home message /Learning points:

Shoulder tip pain is one of the most common complication post laparoscopic surgery and should not be neglected .The pain is influenced by many factors mainly intraoperative pneumoperitoneal pressure, duration of procedure and type of procedure.Hence its important to segregate the cause for Shoulder tip pain and manage it accordingly to provide pain free and better post operative outcome.

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FIGURE 1: Comparison of STP with PNP.

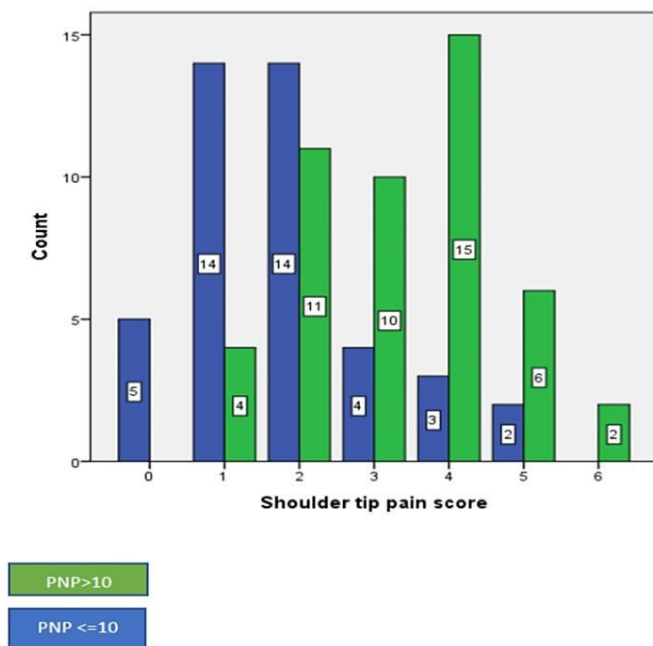


FIGURE 2: Comparison of STP with Type and Duration of Procedure.

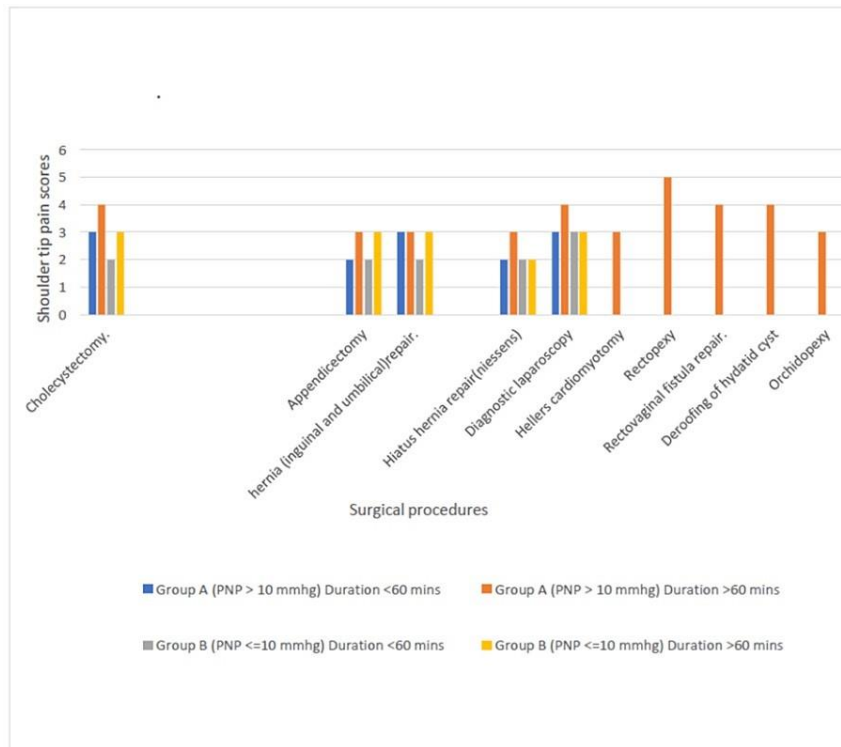
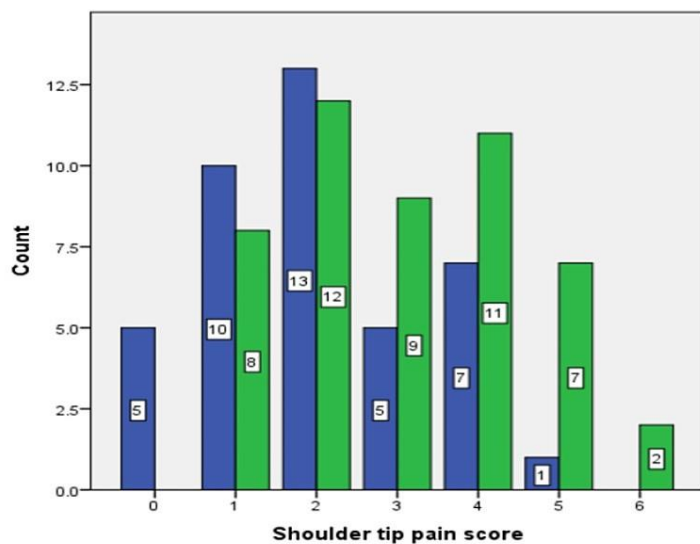
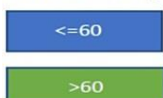


FIGURE 2: Comparison of STP with Type and Duration of Procedure.

FIGURE 3: Comparison of STP with Duration of procedure.



Duration of procedure (mins)



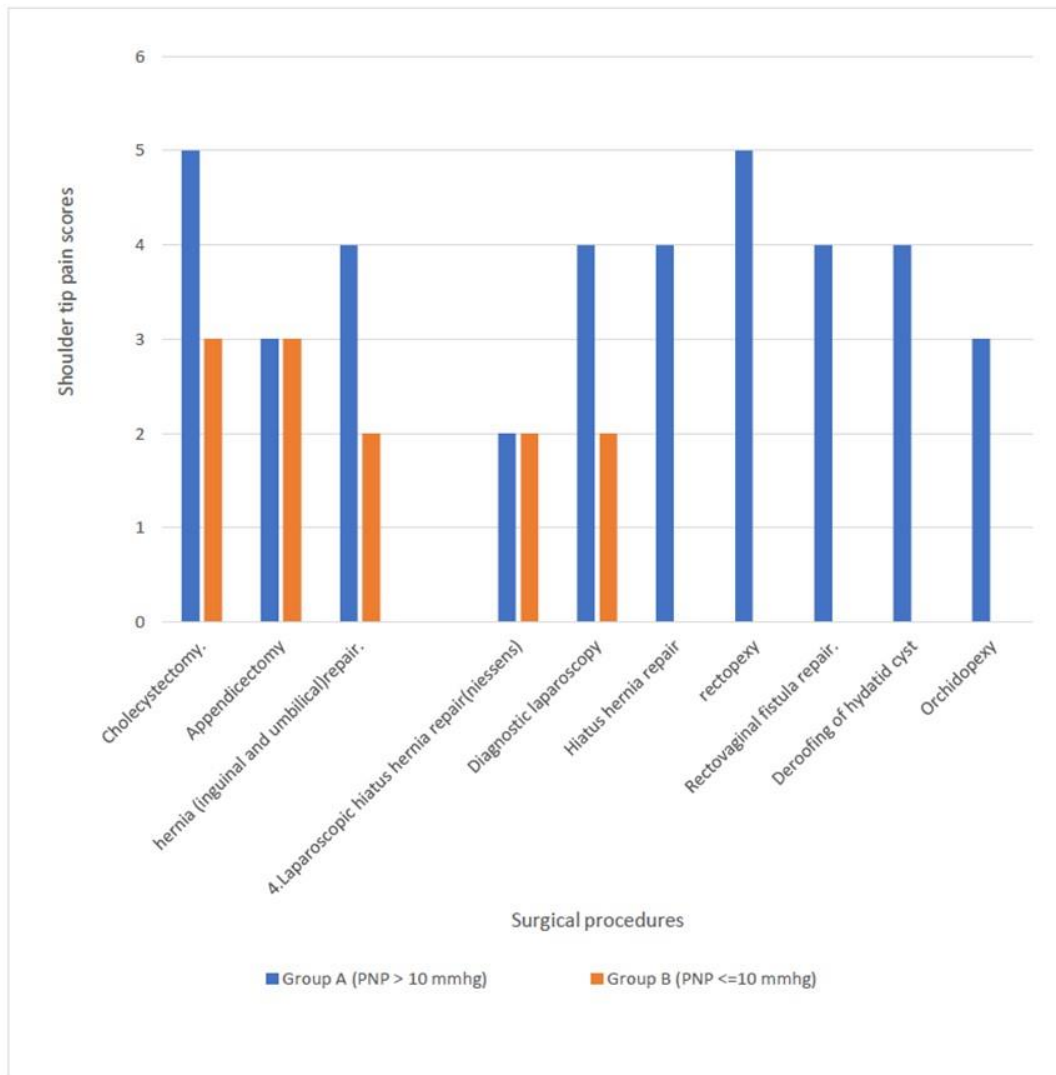


FIGURE 4: Comparison of STP with Type of Surgery.

AGE(In years)	No of patient	Percentage (%)
<10 years	1	1.1
10-20	19	21.1
21-30	38	42.2
31-40	14	15.5
41-50	11	12.2
>50 years	7	7.8

TABLE 2: Distribution according to the type of surgical procedure performed.

Surgical procedure	Number
1.Laparoscopic Cholecystectomy.	39
2.Laparoscopic Appendicectomy	27
3.Laparoscopic hernia (inguinal and umbilical)repair.	12
4.Laparoscopic hiatus hernia repair(niessens)	5
5.Diagnostic laparoscopy	2
6.Laparoscopic hellers cardiomyotomy	1
7.Laparoscopic rectopexy	1
8.Laparoscopic rectovaginal fistula repair.	1
9.laparoscopic deroofing of hydatid cyst	1
10.Laparoscopic orchidopexy	1

			cpressure		Chi-square Value	p-value
			≤10(Group B)	> 10(Group A)		
Shoulder tip pain score	0	Count	5	0	25.199 9	0.000
		% within Shoulder tip pain score	100.0%	0.0%		
	1	Count	14	4		
		% within Shoulder tip pain score	77.8%	22.2%		
	2	Count	14	11		
		% within Shoulder tip pain score	56.0%	44.0%		
	3	Count	4	10		
		% within Shoulder tip pain score	28.6%	71.4%		
	4	Count	3	15		
		% within Shoulder tip pain score	16.7%	83.3%		
	5	Count	2	6		
		% within Shoulder tip pain score	25.0%	75.0%		
	6	Count	0	2		
		% within Shoulder tip pain score	0.0%	100.0%		
Total	Count	42	48			
	% within Shoulder tip pain score	46.7%	53.3%			

TABLE 3: Comparison with shoulder tip pain score and pressure

Variables	Spearman's rho Correlation value	p-value
Pressure v/s Pain Score	0.551	0.00
Pressure v/s Duration	0.654	0.00
Pain score v/s Duration	0.523	0.00

TABLE 4: Non Parametric Correlations.

SL NO	Name of study	Study Population(years)	Indication
1.	Nasir et al	30-40	Cholelithiasis
2.	Sarli et al	40-50	Cholelithiasis
3.	Guruswamy et al	30-40	Cholelithiasis
4.	Monica ortezi et al	30-40	Cholelithiasis
5.	Present study	21-30	Cholelithiasis >Appendicectomy>Hernia repair

TABLE 5: Comparison with other studies(1)

Study	Analgesic Req in low PNP group	Duration of stay(days) Group A	Duration of stay Group B(days)
Nasir et al	40%	2-3	1-2
Sarli et al	31%	NA	NA
Guruswamy et al	less	More compared to group b	More compared to group A
Monica ortezi et al	less	1-2	2-3
Present Study	33.3%	3-4	2-3

TABLE 6: Comparison with other studies (2)