A Comparative Study of Low Versus Standard Intraperitoneal Pressures in Gynaecological Laparoscopic Surgery

Anup R. Patil a≡, Deepika Dewani a≡*, Kalyani Mahajan aœ, Neema Acharya a#
Arpita Jaiswal a†, Saunitra A. Inamdar a† and Sparsh Madaan a‡

a Department of Obstetrics and Gynecology, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Science (Deemed to be university), Wardha, Maharashtra, India.

Authors’ contributions
This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

ABSTRACT

Background: Minimal access surgery in contrast to open surgery has quicker recovery during the postoperative period as well as reduced scores of pain. As a result of increased pressure in the abdominal cavity, laparoscopic surgery has many implications over a range of organ systems as well as their functioning. Laparoscopic surgery due to increased intraabdominal pressure also has many implications on various organ systems and their functioning. To overcome the consequences of increased intrabdominal pressure, a number of trials have been formulated to compare low-versus standard-pressure pneumoperitoneum.

Aim: The aim of this study was to assess the effectivity of low intraperitoneal pressures v/s standard intraperitoneal pressure during laparoscopic hysterectomies.

Study Design: Experimental study

Materials and Methods: 40 cases with uncomplicated symptomatic benign uterine pathologies who were posted for laparoscopic hysterectomy were selected out of which 20-20 cases were...
randomized into low and standard pneumoperitoneum groups.

**Results:** In patients in whom low pressure pneumoperitoneum is employed are better recovered in terms of pain than standard pressure pneumoperitoneum. This means hospital stay can be shortened in low pressure pneumoperitoneum groups which will be more economical and comfortable for patients.

**Conclusion:** Laparoscopic hysterectomy can be done at 10 mmhg with the benefits of:
- Optimum visualization with low pressure
- Reduction in post operative pain helping the patient for early ambulation so that patient will get back to routine work and normal life earlier, it is the main purpose of minimal invasive surgery.

**Keywords:** Laparoscopy; pneumoperitoneum; hysterectomy.

**1. INTRODUCTION**

For laparoscopic surgery, the most suitable intraperitoneal pressure during laparoscopy is still debatable. There have been a few studies which have emphasized on the convenience of using lower pressures, but the effectiveness of performing abdominal surgery with low peritoneal pressures needs further evaluation. This study compares low with standard pneumoperitoneum during the process of gynecological laparoscopy.

Intraperitoneal pressures at or above the value of 12 mm Hg are most commonly used while performing laparoscopic procedures of the abdomen [1,2]. Studies done by various authors have concluded that by using low pressures for pneumoperitoneum there could be resultant less pain during the postoperative period and reduced risk of complications which are related to laparoscopy including pneumothorax, pneumomediastinum, air embolism, arrhythmias and respiratory implications [3–8]. However, with low pressure pneumoperitoneum improper operative field of vision is a major concern [9] which can result in various complications. Proper visualization may be achieved with optimal pressure of pneumoperitoneum which in turn reduces the complications during post-operative period [1]. The above mentioned findings may vary from one case to another as a result of the differences in positioning provided to the patient (Trendelenburg vs Fowler) as well as the nature of gynecologic laparoscopy [10-12].

However, sparsity of data exists about the possibility of endoscopic abdominal surgeries with less than 12 mm of Hg of peritoneal pressures [13,14]. Hence the purpose of this study to compare the gynaecologic laparoscopies done with low and standard Intraperitoneal pressure.

**1.1 Objectives**

To compare the effectiveness of low intraperitoneal pressure with standard intraperitoneal pressure in terms of duration of operating time related to adequate exposure. Intraoperative haemodynamic changes Postoperative pain.

**2. METHODS**

**2.1 Study Type**

Experimental study.

**2.2 Sample Size**

Out of total 40 cases, in which 20 were randomised in to low pneumoperitoneum pressure group and 20 patients were randomized in to standard pressure group.

**2.3 Inclusion Criteria**

All consecutive patients with uncomplicated symptomatic benign uterine pathologies posted for laparoscopic hysterectomies who gave consent for study

**2.4 Exclusion Criteria**

- Patients with complicated uterine pathologies, with large size masses (more than 20 weeks size), and with cancer.
- Cases with medical and surgical problems.
- Cases with acute abdomen

- Patients were randomized into two groups. One group with patients undergoing laparoscopic hysterectomy with standard pressure pneumoperitoneum at 14 mm Hg while the other group with patients undergoing laparoscopic hysterectomy with low pressure pneumoperitoneum at 10 mm Hg
- A standard laparoscopic hysterectomy was performed with the insertion of four ports at the start of surgery.
- At admission, the patient’s blood pressure and heart rate was noted.
- Intraoperative blood pressure and heart rate was noted. The difference between the readings at admission and those taken intraoperatively was calculated.
- Postoperative analgesia was administered in the form of diclofenac 12 hourly with additional doses where necessary. Postoperative pain was assessed at 6, 12 and 24 hours using a visual analogue scale.
- Need for additional analgesia over and above the 12 hourly diclofenac and incidence of shoulder tip pain was also noted.

3. RESULTS

- Standard pressure pneumoperitoneum took an average of 139.2 ± 6.9 minutes whereas low pressure pneumoperitoneum took an average of 147.3 ± 5.7 minutes for completion of laparoscopic hysterectomy.
- While doing laparoscopic hysterectomies under low pressure pneumoperitoneum, it took on average eight minutes more when compared to the laparoscopic hysterectomy done using standard pressure for pneumoperitoneum. The difference in time duration was not statistically significant (p = 0.1).
- In patients who underwent low pressure laparoscopic hysterectomy, the average change in systolic BP was an increase of 0.96 ± 6.27 mm Hg with a maximum rise of 13 mm Hg and a maximum fall of 7 mm Hg. Whereas, the average change in diastolic BP in patients who underwent standard pressure laparoscopic hysterectomy was an increase of 2.8 ± 4.2 mm Hg with a maximum rise of 10 mm Hg and a maximum fall of 7 mm Hg. This difference was not statistically significant.
  - The variation of heart rate in patients who underwent low pressure laparoscopic hysterectomy was a decrease of 0.5 ± 5.28 beats per minute, whereas in patients who underwent standard pressure laparoscopic hysterectomy there was an increase of 1.5 ± 6.02 beats per minute.
  - The difference in heart rate in both groups of patients was not statistically significant.
  - At 6 hours post surgery, the average pain score was 62.2 and 59.1 for patients who underwent low pressure laparoscopic hysterectomy and standard pressure laparoscopic hysterectomy respectively and the difference was not statistically significant (p = 0.4).
  - After 12 hours of the surgery, the average pain score was 54.2 and 62.2 for patients who underwent low pressure laparoscopic hysterectomy and standard pressure laparoscopic hysterectomy respectively and the difference in both the groups was statistically significant (p = 0.04).
  - At completion of 24 hours of the postoperative period the average pain score was 4.6 and 5.2 for patients who underwent low pressure laparoscopic hysterectomy and standard pressure laparoscopic hysterectomy respectively. This difference was not statistically significant.
  - One (5.8%) of the 17 patients who underwent low pressure laparoscopic hysterectomy and two (11.11%) of the 18 patients who underwent standard pressure laparoscopic hysterectomy had postoperative pain referred to the tip of the right shoulder. This difference was not statistically significant (p = 1.0).

Table 1. Time required while using standard pressure v/s low pressure pneumoperitoneum

|                     | Standard pressure | Low pressure |
|---------------------|-------------------|--------------|
| Average time required | 139.2             | 147.3        |
| Minimum time required | 105               | 120          |
| Maximum time required | 195               | 180          |
Table 2. Changes in blood pressure while using standard pressure v/s low pressure pneumoperitoneum

| Average change in Blood Pressure | Standard pressure | Low pressure |
|---------------------------------|-------------------|-------------|
| Systolic Bp                     | 0.8 + 8.9 mm Hg   | 0.96 + 6.27 mm Hg |
| Diastolic Bp                    | 2.8 ± 4.2 mm Hg   | 1.8 ± 5.2 mm Hg |

Table 3. Changes in heart rate while using standard pressure v/s low pressure pneumoperitoneum

| Standard pressure | Low pressure |
|-------------------|-------------|
| Average change in heart rate | 1.5 ± 6.02 beats per minute | 0.5 ± 5.28 beats per minute |

Table 4. Pain Score noted while using standard pressure v/s low pressure pneumoperitoneum

| Average pain score at time interval | Standard pressure | Low pressure |
|-------------------------------------|-------------------|-------------|
| 6 hours                             | 59.1              | 62.2        |
| 12 hours                            | 62.2              | 54.2        |
| 24 hours                            | 5.2               | 4.6         |

Table 5. Shoulder tip pain noted while using standard pressure v/s low pressure pneumoperitoneum

| Standard pressure | Low pressure |
|-------------------|-------------|
| No. of cases      | 18          | 17          |
| Shoulder tip pain present | 2(11.1%) | 1(5.8%) |
| Shoulder tip pain absent    | 16(88.8%) | 16(94.2%) |
4. DISCUSSION

For laparoscopic surgery CO₂ is the insufflation gas of choice. As air insufflation affects the systemic and peritoneal response more in comparison to CO₂, therefore CO₂ is preferred over air insufflations [15]. The advantages of using CO₂ are: that it is, non-inflammable, dissolvable in the blood as well as transparent. However, the usage of carbon dioxide comes with certain disadvantages as increase in intra-abdominal pressure leads to an increase in the absorption of Carbon dioxide, which results in hypercapnia and acidosis, which has to be countered through carbon dioxide washout in the form of hyperventilation [16]. The use of CO₂ increases the peak airway pressure [17,18] as it pushes the diaphragm upwards and thereby decreasing the pulmonary compliance [16,17].

With creation of pneumoperitoneum there also occurs rise in systemic vascular resistance [18,19] as well as pulmonary vascular resistance [18]. CO₂ insufflation also predisposes the patient to cardiac arrhythmias [20]. Cardiac output decreases during the early phase of pneumoperitoneum [17,18] as there is a reduction in the venous return [21]. Healthy adults with adequate cardiopulmonary reserve may easily tolerate these cardiorespiratory changes however people with underlying cardiopulmonary disease may not be able to cope up with these changes. Laparolift [20] or Laparo-tensor [17], is a special device used for abdominal wall lift, is introduced through a port in the abdominal wall and is applied to decrease the cardiopulmonary changes [22].

The data from a few randomized clinical trials shows that by incorporating low pressures for pneumoperitoneum the is lesser degree of changes seen with cardiorespiratory system, [23] patients also have low pain score postoperatively [24] with less no of patients complaining of shoulder tip pain [25] and fewer requiring analgesia [24-27]. When creating pneumoperitoneum with lower pressures of CO₂, the risk of mortality because of CO₂ embolism is also prevented [28]. In a study done by Schwarte et al. [28], it was also seen that with rise in intra-abdominal pressure there is decreased gastric mucosal oxygen saturation. Use of lowest intra-abdominal pressure instead of routine pressure(14 mmHg) for adequate visualization of the operative field is also recommended by The European Association for Endoscopic Surgery (EAES) and is one of the practice recommendation in their guideline [21].

5. CONCLUSION

Both groups are equally comparable in almost all above parameters. There is no significant differences in both groups, this means low pressure pneumoperitoneum can be used as effectively as standard pressure pneumoperitoneum.

In patients in whom low pressure pneumoperitoneum is employed are better recovered in terms of pain than standard pressure pneumoperitoneum. This means hospital stay can be shortened in low pressure pneumoperitoneum groups which will be more economical and comfortable for patients.

Impact of low pressure pneumoperitoneum on intra-operative hemodynamics is not significant. This needs to be examined through a more complex set up and probably a bigger sample size that includes a larger numbers of patients with cardiovascular comorbid conditions.

CONSENT

As per international standard or university standard, patient’s written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Neudecker J, Sauerland S, Neugebauer E, Bergamaschi R,Bonjer HJ, Cuschieri A, et al. The European Association for Endoscopic Surgery clinical practice guideline on the pneumoperitoneum for laparoscopic surgery. Surg Endosc. 2002;16(7):1121–1143. DOI:10.1007/s00464–001-9166–7.
2. laChapelle CF, Bemelman WA, Rademaker BM, van Barneveld TA,
C. What is the \textit{aparoscopic} erling TM, Rauh R, \textit{aparoscopic} – 87(9):1161.

3. Galizia G, Prizio G, Lieto E, Castellano P, Pelosi L, Imperatore V, et al. Hemodynamic and pulmonary changes during open, carbon dioxide pneumoperitoneum and abdominal walllifting cholecystectomy. A prospective, randomized study. \textit{Surg Endosc}. 2001;15(5):477–483.

4. Leonard IE, Cunningham AJ. Anaesthetic considerations for laparoscopic cholecystectomy. \textit{Best Pract Res Clin Anaesthesiol}. 2002;16(1):1–20.

5. Henny CP, Hofland J. Laparoscopic surgery: pitfalls due to anesthesia, positioning, and pneumoperitoneum. \textit{Surg Endosc}. 2005;19(9):1163–1171. DOI:10.1007/s00464–004-2250-z.

6. Wallace DH, Serpell MG, Baxter JN, O'Dwyer PJ. Randomized trial of different insufflation pressures for laparoscopic cholecystectomy. \textit{Br J Surg}. 1997;84(4):455–458.

7. Sarli L, Costi R, Sansebastiano G, Trivelli M, Roncoroni L. Prospective randomized trial of low-pressure pneumoperitoneum for reduction of shoulder-tip pain following laparoscopy. \textit{Br J Surg}. 2000;87(9):1161–1165. DOI:10.1046/j.1365–2168.2000.01507.x.

8. Chok KS, Yuen WK, Lau H, Fan ST. Prospective randomized trial on low-pressure versus standard pressure pneumoperitoneum in outpatient laparoscopic cholecystectomy. \textit{Surg Laparosc Endosc Percutan Tech}. 2006;16(6):383–386. DOI:10.1097/01.sle.0000213748.00525.1e

9. Angioli R, Terranova C, Ploiti F, Cafa EV, Gennari P, Ricciardi R, et al. Influence of pneumoperitoneum pressure on surgical field during robotic and laparoscopic surgery: a comparative study. \textit{Arch Gynecol Obstet}. 2015;291(4):865–868. DOI:10.1007/s00404–014-3494-z.

10. Hirvonen EA, Nuutinen LS, Kauko M. Hemodynamic changes due to Trendelenburg positioning and pneumoperitoneum during laparoscopic hysterectomy. \textit{Acta Anaesthesiologica Scandinavica}. 1995;39(7):949–955.

11. Hirvonen EA, Poikolainen EO, Paakkonen ME, Nuutinen LS. The adverse hemodynamic effects of anesthesia, head-up tilt, and carbon dioxide pneumoperitoneum during laparoscopic cholecystectomy. \textit{Surg Endosc}. 2000;14(3):272–277.

12. Rist M, Hemmerling TM, Rauh R, Siebzehnrubl E, Jacobi KE. Influence of pneumoperitoneum and patient positioning on preload and splanchnic blood volume in laparoscopic surgery of thelower abdomen. \textit{J Clin Anesth}. 2001;13(4):244–249.

13. Gurusamy KS, Vaughan J, Davidson BR. Low pressure versus standard pressure pneumoperitoneum in laparoscopic cholecystectomy. Cochrane Database Syst Rev. 2014;3:CD006930. DOI:10.1002/14651858.CD006930.pub3.

14. Ozdemir-van Brunschot DM, van Laarhoven KC, Scheffer GJ, Pouwels S, Wever KE, Warle MC. What is the evidence for the use of low-pressure pneumoperitoneum? A systematic review. \textit{Surg Endosc}; 2015. DOI:10.1007/s00464–015-4454–9.

15. Watson RW, Redmond HP, McCarthy J, Burke PE, Boucher-Hayes D. Exposure of the peritoneal cavity to air regulates early inflammatory responses to surgery in a murine model. \textit{Br J Surg} 1995;82:1060–5.

16. Henny CP, Hofland J. Laparoscopic surgery: Pitfalls due to anesthesia, positioning, and pneumoperitoneum. \textit{Surg Endosc}. 2005;19:1163-71.

17. Alijani A, Hanna GB, Cuschieri A. Abdominal wall lift versus positive pressure capnoperitoneum for laparoscopic cholecystectomy: Randomized controlled trial. \textit{Ann Surg}. 2004;239:388–94.

18. Galizia G, Prizio G, Lieto E, Castellano P, Pelosi L, Imperatore V, et al. Hemodynamic and pulmonary changes during open, carbon dioxide pneumoperitoneum and abdominal wall-lifting cholecystectomy. A prospective, randomized study. \textit{Surg Endosc}. 2001;15:477–83.

19. Mertens zur Borg IR, Lim A, Verbrugge SJ, IJzermans JN, Klein J. Effect of intraabdominal pressure elevation and positioning on hemodynamic responses during carbon dioxide pneumoperitoneum for laparoscopic donor nephrectomy: A prospective controlled
clinical study. Surg Endosc. 2004;18:919-23.

20. Egawa H, Morita M, Yamaguchi S, Nagao M, Iwasaki T, Hamaguchi S, et al. Comparison between intraperitoneal CO2 insufflation and abdominal wall lift on QT dispersion and rate-corrected QT dispersion during laparoscopic cholecystectomy. Surg Laparosc Endosc Percutan Tech. 2006;16:78-81.

21. Neudecker J, Sauerland S, Neugebauer E, Bergamaschi R, Bonjer HJ, Cuschieri A, et al. The European Association for Endoscopic Surgery clinical practice guideline on the pneumoperitoneum for laparoscopic surgery. Surg Endos. 2002;16:1121-43.

22. Gurusamy KS, Samraj K, Davidson BR. Abdominal lift for laparoscopic cholecystectomy. Cochrane Database Syst Rev. 2008;CD006574.

23. Dexter SP, Vucevic M, Gibson J, McMahon MJ. Hemodynamic consequences of high- and low-pressure capnoperitoneum during laparoscopic cholecystectomy. Surg Endosc. 1999;13:376-81.

24. Sarli L, Costi R, Sansebastiano G, Trivelli M, Roncoroni L. Prospective randomized trial of low-pressure pneumoperitoneum for reduction of shoulder-tip pain following laparoscopy. Br J Surg. 2000;87:1161-5.

25. Wallace DH, Serpell MG, Baxter JN, O’Dwyer PJ. Randomized trial of different insufflation pressure for laparoscopic cholecystectomy. Br J Surg. 1997;84:455-8.

26. Sandhu T, Yamada S, Arixakachon V, Chakrabandhu T, Chongruksut W, Ko-iam W. Low-pressure pneumoperitoneum versus standard pneumoperitoneum in laparoscopic cholecystectomy, a prospective randomized trial. Surg Endosc. 2009;23:1044-7.

27. Beebe DS, Zhu S, Kumar MV, Komanduri V, Reichert JA, Belani KG. The effect of insufflation pressure on CO2 pneumoperitoneum and embolism in piglets. Anesth Analg. 2002;94:1182-7.

28. Schwarte LA, Scheeren TW, Lorenz C, De Bruyne F, Fournell A. Moderate increase in intraabdominal pressure attenuates gastric mucosal oxygen saturation in patients undergoing laparoscopy. Anesthesiology. 2004;100:1081-7.