Medico Research Chronicles

ISSN No. 2394-3971

Review Article

CONTROVERSIES IN LOW VERSUS STANDARD PRESSURE PNEUMOPERITONEUM USAGE IN LAPAROSCOPIC SURGERIES.

Dr Priyanka Suhag, Dr Abhishek Chandavarkar

Dr. D. Y. Patil Medical College, Navi Mumbai

Submitted on: September 2017
Accepted on: September 2017
For Correspondence
Email ID:
priyankasuhagbhardwaj@gmail.com

Abstract

Background:

Laparoscopic surgery has evolved over a past few decades and continues to advance. When compared with open surgeries, laparoscopic surgeries have several advantages of faster recovery and decreased postoperative pain. The workplace so created by pneumoperitoneum has its negative implications on cardiovascular, pulmonary and intrabdominal organ functioning. Several trials have been done to see these impacts using low pressure and standard pressure pneumoperitoneum. Recently attention is focused on improving clinical outcomes based on altering the laparoscopic surgical environment.

Methods: Systematic review of all randomized controlled clinical trials and observational studies comparing low versus standard pressure pneumoperitoneum.

Results and conclusions:

In healthy individuals undergoing laparoscopic procedures, limited data are available to suggest supremacy of low-pressure pneumoperitoneum over standard pneumoperitoneum. However certain parameters seem to have an impact with low-pressure pneumoperitoneum but to generalize at present with lack of significant randomized controlled clinical trials would be inappropriate. One can safely conclude that low-pressure settings does seem to reduce postoperative pain and would be safer in patients with the high-risk group but in low-risk patients using low-pressure settings would risk the safety with regard to workspace and dissection.

Keywords: Laparoscopic surgery, pneumoperitoneum, Pressure difference.

Introduction

The advantages of laparoscopic procedure over open techniques are undeniable. However, in recent events of evidence regarding the use of low pressures to create pneumoperitoneum being better than the standard pressure pneumoperitoneum, concerns regarding their safety and usefulness have arisen. Usually, an intraperitoneal pressure of 12 mm Hg is used during standard laparoscopic surgical procedures1. And in the era to be more minimally invasive, use of low-pressure pneumoperitoneum has come as a boon. Despite very little data that exists on the

safety of performing laparoscopy using peritoneal pressures below standard pressure 10-11, using less CO_2 insufflation can actually avert postoperative morbidity on an already compromised patient. However, in an uncompromised patient, risking space constraints with poor visualization would not be beneficial. Influence of pressure on adhesion formation, intraocular and intracerebral pressure and thromboembolic complications remain uncertain as no human trials have been performed.

A Cochrane review in 2009 concluded that the safety of low-pressure pneumoperitoneum is yet to be established.2

Methods:

This narrative review will discuss the impact of pneumoperitoneum at standard pressure (12 mm Hg) versus low-pressure settings (8mm Hg) on the patient postoperative period. Articles included in this review were identified via PubMed database using following search string: 'low-pressure pneumoperitoneum and standard pressure pneumoperitoneum. The search was limited to English language articles and review of more than 100 publications was conducted and additional publication was identified from citations within individual articles.

Results and discussion:

Table 1: Characteristics of Randomized controlled trials.

AUTHOR	YEAR OF PUBLICATION	COUNTRY	PRESSURE	PROCEDURE	NUMBER OF PATIENTS
BHATTACHARJEE(5)	2016	INDIA	9-10 VS 14	LC	40 VS 40
BOGANI (31)	2014	ITALY	8 VS 12	LH	20 VS 22
EKICI (16)	2009	TURKEY	7 VS 15	LC	20 VS 32
ERYILMAZ(14)	2011	TURKEY	10 VS 14	LC	20 VS 23
HASUKIC (20)	2005	BOSNI HERZEGOVINA	7 VS14	LC	25 VS 25
JOSHIPURA(4)	2009	INDIA	8 VS 12	LC	9 VS 17
VIJAYARAGHAVAN(6)	2014	INDIA	8 VS 12	LC	22 VS 21
WARLE (7)	2013	NETHERLANDS	7 VS 12	LDN	10 VS 10

LC: Laparoscopic Cholecystectomy; LH: Laparoscopic Hysterectomy;
LDN: Laparoscopic Donor Nephrectomy

Table 2: Quality Assessment

AUTHOR	RANDOM SEQUENCE	ALLOCATION CONCEALMENT	BLINDING	INCOMPLETE OUTCOME	SELECTIVE REPORTING
BHATTACHARJEE(5	LOW	UNCLEAR	UNCLEAR	LOW	LOW
BOGANI (31)	LOW	UNCLEAR	UNCLEAR	LOW	LOW
EKICI (16)	UNCLEAR	UNCLEAR	UNCLEAR	UNCLEAR	HIGH
ERYILMAZ(14)	UNCLEAR	UNCLEAR	UNCLEAR	LOW	UNCLEAR
HASUKIC (20)	LOW	LOW	UNCLEAR	UNCLEAR	UNCLEAR
JOSHIPURA(4)	UNCLEAR	LOW	LOW	UNCLEAR	UNCLEAR
VIJAYARAGHAVAN(6)	LOW	LOW	LOW	LOW	UNCLEAR
WARLE (7)	UNCLEAR	LOW	LOW	LOW	UNCLEAR

Table 3: Summary of Findings, Outcomes and Level of Evidence

ENDPOINTS	TYPES OF SURGERIES AND NUMBER	OUTCOMES	QUALITY OF EVIDENCE
PAIN	LDN 1 LC 4	LESS PAIN AND LESS CONSUMPTION OF ANALGESIA IN LOW PRESSURE GROUP	B/C
PULMONARY FUNCTION	LC 3	NO CLINICAL CONSEQUENCE IN ASA I AND II	B
CARDIAC FUNCTION	LC 4 OTHER 1	NO DIFFERENCE NOTED	B
LIVER FUNCTION	LC 2 OTHER 2	INCREASED TRANSAMINASES BUT NO CLINICAL CONSEQUENCE IN UNCOMPROMISED PATIENTS	B

Of 100 papers searched, 31 were included after the abstract and full-text screening. Characteristics of the included randomized studies are shown in table 1 and 2.The quality assessment of the available evidence and their grading with outcomes are shown in table 3. Influence of pressure on various patient outcomes was studied.

Pain

Pain after a laparoscopic procedure has three components: referred shoulder pain, wound pain, deep intraabdominal pain.3 Referred pain is mostly due to CO_2 induced diaphragm / phrenic nerve irritation Deep intraabdominal pain is mostly due to traction on bowel, abdominal wall stretch and compression of intraabdominal organs. Few blinded studies suggested decreased pain postoperatively in low-pressure pneumoperitoneum but were not statistically significant.4, 5, 6, 7

Certain studies suggested that a low intraperitoneal pressure (8mm Hg) is better for regeneration of injured peritoneal tissues than the standard intraperitoneal pressure (12 mm Hg) during the perioperative period.11but all these studies were not randomized and the duration of surgery was also short.

Pulmonary functions: Another important fact that was gathered during analysis of articles was that pneumoperitoneum increases the respiratory system elastance. Pneumoperitoneum could stiffen the abdominal wall and diaphragm while raising pleural pressures and compressing the lungs.

When exposed to high sustained pleural pressure, Lungs become stiffer secondary to airway closure, as in obesity.12but studies concluded that although the pneumoperitoneum increases respiratory system elastance, chest wall dimensions; the inspiratory action of diaphragmatic tension on rib cage counteracts the expiratory effect of increased abdominal pressures.

Postoperative pulmonary function tests were evaluated by three randomized controlled trials which showed no difference in pulmonary function tests.4, 6, and 13

Cardiac function

Studies comparing effect of low pressure vs. standard pressures on cardiac function did not observe any significant difference in cardiac index and mean arterial pressure.14-18

However, in one study done on porcine model, improved cardiopulmonary response was observed with low-pressure pneumoperitoneum as compared to standard pressure pneumoperitoneum.19

Liver function tests

None of the trials demonstrated persistently raised liver enzymes or liver failure. Studies done, showed pressure dependent decrease in hepatic blood flow and enzyme elevations of AST and ALT.20, 21, 22

However, a trial using indocyanine green elimination tests showed decreased value at standard pressure(14 mm Hg) when compared with low pressure group.14 Low-pressure pneumoperitoneum is associated with less liver and kidney injury when compared to standard pressure pneumoperitoneum, this does not seem to have clinical implications for healthy individuals.

A study done on dogs showed that irrespective of the pressures, significant increases were noticed in gamma glutaryl transferase, ALT, AST, creatinine levels in laparoscopic surgeries which suggested that in compromised functions and prolonged surgeries, low-pressure pneumoperitoneum may be considered.22

Renal function tests

Very few human trials have been conducted comparing renal functions at different pressure settings. In two RCT, despite the urine output being lower at standard pressure settings, there was no Difference in the creatinine levels.7, 23

Thromboembolic complications

The incidence of thromboembolic complications at different pressure settings has not been studied so far. However certain studies indirectly hinted at risk by evaluating blood flow velocity which was decreased at standard pressures and diameter of blood vessels which was not significantly affected.4, 24, 25

Anastomosis healing

No literature citing leakage at anastomosis site at various pneumoperitoneal pressure settings found.

Intracranial pressure

No adult trials comparing effects of low pressure versus standard pressure have been done. However, a study done in children comparing low and standard pressure setting showed no changes in cerebral blood flow and cerebral oxygenation.26 Although it has been observed that pressure-dependent increase up to 25 cm H2O at insufflation pressure of 15 mm Hg has been found.27

Intraocular pressure

Although increase in intraocular pressure has been found in laparoscopic surgeries when compared to open surgeries clinical trials comparing intraocular pressure in low versus normal pressure pneumoperitoneum are lacking.28-29

Quality of surgical conditions

The operative workspace decreases at low-pressure pneumoperitoneum settings and hence the risk of intraabdominal injuries increases. One study did evaluate this constraint of decreased visibility and decreased space for dissection along with surgeons discomfort in a low-pressure pneumoperitoneum group compared to standard pressure.6

Deep neuromuscular blockade helps in relieving space constraint in low-pressure pneumoperitoneum when compared to moderate neuromuscular blockade.30

Regarding incidence of adverse events and conversions to open procedures, low-pressure settings may be a cause as compared to standard pressure settings.7, 31

Conclusion:

In healthy individuals undergoing laparoscopic procedures, limited data are available to suggest supremacy of low-pressure pneumoperitoneum over standard pneumoperitoneum. However certain parameters seem to have an impact with low-pressure pneumoperitoneum but to generalize at present with lack of significant randomized controlled clinical trials would be inappropriate. One can safely conclude that low-pressure settings does seem to reduce postoperative pain and would be safer in patients with the high-risk group but in low-risk patients using low-pressure settings would risk the safety with regard to workspace and dissection.

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. Gurusamy KS et al (2009) Low pressure versus standard pressure pneumoperitoneum in laparoscopic cholecystectomy. Cochrane Database Syst Rev 2: CD006930
3. Bisgaard T et al (2001) Characteristics and prediction of early pain after laparoscopic cholecystectomy. Pain 90 (3): 261-269
4. Joshipura VP et al (2009) A prospective randomized, controlled study comparing low pressure versus high-pressure pneumoperitoneum during laparoscopic cholecystectomy. Surg Laparosc Endosc Percutan Tech 19(3):234-240
5. Bhattacharjee HK et al.Impact of standard pressure and low –pressure pneumoperitoneum on shoulder pain following laparoscopic cholecystectomy: a randomized controlled trial. Surg Endosc 2016 July 21; PMID 27444831
6. Vijayaraghavan N et al. Comparison of standard- pressure and low – pressure pneumoperitoneum in laparoscopic cholecystectomy: a double-blinded randomized controlled study. Surg Laparosc, Endosc Percutan Tech 2014 Apr; 24(2):127-33. PMID 24686347
7. Warle MC et al (2013) Low –pressure pneumoperitoneum during laparoscopic donor nephrectomy to optimize live donors' comfort. Clin Transplant 27(4) :E478-E483
8. Bourdel N et al. Peritoneal tissue oxygen tension during a carbon dioxide pneumoperitoneum in a mouse laparoscopic model with controlled respiratory support. Hum Reprod 2007; 22:1149-1155
9. Wittich P et al. Intraperitoneal tumor growth is influenced by the pressure of carbon
dioxide pneumoperitoneum. Surg Endosc 2000; 14:817-819
10. Matsuzaki S et al. Molecular mechanisms underlying postoperative peritoneal dissemination might differ between a laparotomy and a CO2 pneumoperitoneum: a syngeneic mouse model with controlled respiratory support. Surg Endosc 2009; 23:705-714
11. Matsuzaki S et al. Impact of the intraperitoneal pressure of a CO2 pneumoperitoneum on the surgical peritoneal environment. Hum Reprod 2012; 27(6):1613-1623
12. Loring SH et al. Respiratory mechanical effects of surgical pneumoperitoneum in humans. J Appl Physiol 2014; 117:1074-1079
13. Karagulle E et al (2008) The effects of different abdominal pressures on pulmonary function test results in laparoscopic cholecystectomy. Surg Laparosc Endosc Percutan Tech 18(4):329-333
14. Eryilmaz HB et al (2012) The effects of different insufflation pressures on liver functions assessed with LEMON in patients undergoing laparoscopic cholecystectomy. Sci World J 2012: 172575
15. Dexter SP et al (1999) Hemodynamic consequences of High- and low-pressure capnoperitoneum during laparoscopic cholecystectomy. Surg Endosc 13(4):376-381
16. Ekici Y et al (2009) Effect of different intra-abdominal pressure levels on QT dispersion in patients undergoing laparoscopic cholecystectomy. Surg Endosc 23(11):2543-2549
17. Sood J et al (2006) laparoscopic approach to pheochromocytoma: is a lower abdominal pressure helpful? Anesth Analg 102(2):637-641

18. Koivusalo AM et al (2008) Laparoscopic cholecystectomy with carbon dioxide pneumoperitoneum is safe even for high-risk patients. Surg Endosc 22(1):61-67
19. Delius SV et al. Natural –orifice transluminal endoscopic surgery: low –pressure pneumoperitoneum is sufficient and is associated with an improved cardiopulmonary response (Pressure Pig study) Endosc 2011 sep; 43(9):808-15.PMID 21732271
20. Hasukic S (2005) Postoperative changes in liver function tests: a randomized comparison of low- and high-pressure laparoscopic cholecystectomy. Surg Endosc 19(11):1451-1455
21. Morino M et al (1998) Alterations in hepatic function during laparoscopic surgery. An experimental clinical study. Surg Endosc 12(7):968-972
22. Jae Yeon Lee, Seok Hwa Choi. Results of hepatic and renal function test to different CO_2 pneumoperitoneum conditions: An experimental capnoperitoneum study in dogs. Research in Veterinary Science 2015 Aug; 101:1-5.PMID:26267080
23. Hawasli A et al (2003) The effect of pneumoperitoneum on kidney function in laparoscopic donor nephrectomy. Am Surg 69(4): 300-303 (discussion 303)
24. Rist M et al 2001 Influence of pneumoperitoneum and patient positioning on preload and splanchnic blood volume in laparoscopic surgery of the lower abdomen. J Clin Anesth 13(4):244-249
25. Ido K et al(1995) Femoral vein stasis during laparoscopic cholecystectomy: effects of graded elastic compression leg bandages in preventing thrombus formation. Gastrointestinal Endosc 42(2):151-155
26. Eric EC et althea effects of low –pressure carbon dioxide pneumoperitoneum on cerebral oxygenation and cerebral blood volume in children. Anesth Analg 2002 Mar; 94(3): 500-5; table of contents. PID 11867365
27. Kamine TH et al (2014) Effect of abdominal insufflation for a laparoscopy on intracranial pressure. JAMA Surg 149(4):380-382
28. Hwang JW et al (2013) Does intraocular pressure increase during laparoscopic surgeries? It depends on anesthetic drugs and the surgical position. Surg Laparosc Endosc Percutan Tech 23(2): 229-232
29. Yoo YC et al (2014) Increase in intraocular pressure is less with propofol than with sevoflurane during laparoscopic surgery in the steep tredenlenbergs position. Can J Anaesth 61(4): 322-329
30. Anne K Stachr- Rye et al. Deep Neuromuscular blockade rather than moderate muscular relaxation. Anesth Analg 2014 Nov; 119 (5): 1084-92.PMID:24977638
31. Bogani G et al (2014) Low vs. standard pneumoperitoneum pressure during laparoscopic hysterectomy: prospective randomized trial. J Minim Invasive Gynecol 21(3):466-471.