## **Original Research Article**

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# Retroactive analytical study by one surgeon using air in operative laparoscopy - exitus acta probat

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#### **ABSTRACT**

**Background:** This is a retroactive analysis that presents and discusses practical issues relating to ambient air (AA) in operative laparoscopy (OL) and Author used AA perforce in OL with good result after using CO2.

**Methods:** Patient pool from North Eastern India and adjoining countries is presented with use of AA in OL. Technique was verses needle first in majority cases irrespective of their American Society of Anesthesiologists (ASA) status or previous abdominal surgery.

**Results:** A total 233 procedures carried out unselectively are presented with results from ASA Grades I to V, along with surgical difficulties and complications observed. There was no mortality, no clinical evidence of embolism or wound infection.

**Conclusions:** This first study of use of AA in OL analyses that it is safe, useful sans side effects of CO<sub>2</sub>. Gas embolism (GE), CO<sub>2</sub> embolism, air embolism(AE) are interchangeably used. The mechanism of death in GE or AE is gas lock or air lock and traffic jam in right heart and pulmonary tree (PT) along with ill understood PT immunopathological events.

**Keywords:** Ambient Air, CO<sub>2</sub>, Gas or air embolism, Operative laparoscopy, Pneumoperitoneum

#### INTRODUCTION

Author used CO<sub>2</sub> for pneumoperitoneum (PP) in the operative laparoscopy (OL) cases initially. Suddenly CO<sub>2</sub> supply was stopped sine die with discontinuation of OL for months. An account of use of ambient air (AA) in PP in diagnostic laparoscopies with biopsies helped us to explore AA in OL cases with good results, prompting us to continue its use.<sup>1</sup>

This first of its kind original work is presented, analyzed and discussed with brief mechanism of gas embolism (GE) or air embolism (AE) that lie in gas lock (GL) or air

lock (AL) to blood flow in and out of right heart (RH) and pulmonary tree (PT) with all its consequences and evolving PT immunopathological events in OL.

In 1960s, laparoscopy and AE were so sullied that German Federal medical institutions had banned laparoscopy proclaiming it prohibitively hazardous procedure.<sup>2</sup>

Where does laparoscopy stand today? Thanks to industry and public media; 1987-89 proved watershed in history of laparoscopy.<sup>3</sup>

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#### **METHODS**

Patient pool comprises from Northeastern states of India and adjoining countries viz. Nepal, Bangladesh and Bhutan from May 1999 to January 2002. Intravenous fluids were given 3 to 4 hours preoperatively for preload hydration in planned OL.

Table 1: Physical status graded by modified ASA system.

Grade I	Clinically healthy
Grade II	Either BP or DM controlled on medication and uncomplicated.
Grade III	Chronic bronchitis and asthmatics, COPD, compensated cardiac problems, both BP and DM together, mild chronic renal failure.
Grade IV	Severe clinical disability but operable with calculated risk, e.g., severe chronic anemia.
Grade V	Seriously ill with gross systemic instability but without life risk in twenty-four hours with or without surgery e.g., acute pancreatitis, septicemic shock with impending multiple systemic failure, acute complicated asthmatics; treated intensively and downgraded appropriately.
Grade VI	Inapplicable.

Blood Pressure - BP; Diabetes mellitus - DM; Chronic obstructive pulmonary disease - COPD

Antibiotics were given in weight adjusted doses of intravenous gentamycin and metronidazole in eight hourly regimes two hours preoperatively. Other antimicrobials and fluids in relevant cases were added on requirements by clinical status. Table 1 shows physical status graded by American Society of Anesthesiologists (ASA) modified system.<sup>4,5</sup>

Technique comprised briefly, general aneasthesia with  $O_2$ ,  $N_2O$ , muscle relaxants and supplements of halothane in supine position. Veress needle was used to create PP with air insufflator made by Om surgical, Mumbai, India. Lowest ergonomic intraabdominal pressure (IAP) of  $\sim 10$  mm Hg was used to operate with flow rate of 1 to 2 L per minute. Four ports were used with cannulae inserted obliquely at  $75^0$  angled towards target site. Skin was coapted with stitches or clips which were removed after 72 hours before discharging patient. Suction drains were used when needed with moderate suction till drainage became serous; usually 24 to 48 hours.

#### **RESULTS**

A total 246 surgical procedures were carried out on 161 patients detailed in Table 2. Under adhesiolysis head, major adhesions hampering operation are included. Carbuncle thigh is shown to project the risk factor for extended surgery and anesthesia but excluded in count.

Table 2: Laparoscopic surgical procedures done.

Laparoscopic surgery	No.
Lap cholecystectomy	133
Lap appendectomy	25
AALA#	01
BTV + DGDA#	01
Large renal cyst excisions	02
LAVH	01
Diagnostic laparoscopy	04
Other gynec procedures	04
Adhesiolysis	63
Carbuncle thigh*	01
LACBDE	06
Conversions to open	03
Hasson technique	03

# 45<sup>th</sup> Annual Conference, ICS-IS \* With LA - Local anaesthesia; Lap - Laparoscopic; AALA - Acute Appendicular Lump + Abscess; BTV + DGDA - Bilateral Truncal Vagotomy + Division of Gastro-duodenal Artery without bypass; LAVH - Laparoscopic Assisted Vaginal Hysterectomy; LACBDE - Laparoscopy Assisted Common Bile Duct Exploration

Table 3 shows details of concurrent illnesses relating to ASA Grades, Viz., ASA Grade I: 109 patients, Grade II: 33, Grade III: 15, Grade IV: 4, Grade V: 10 patients which were subsequently downgraded as: Grade I: 4, Grade II: 5, Grade III: 1, which were added to the respective Grades.

Table 3: Concurrent medical illnesses relating ASA grading.

Medical illnesses	No.	
Pulmonary problems		
(a) Chronic Bronchitis and/or Asthma		
(b) Chronic Obstructive Pulmonary Disease		
(c) Chronic thick-walled abscess cavity at apex		
of right lobe of lung		
Cardiac problems		
(a) Sinus arrhythmia	1	
(b) Bradycardia	2	
(c) Cardiomegaly	1	
Hypertension in various stages	24	
DM type I, II or mixed in various stages	8	
Psychiatric illness with or without medication		
Severe septic shock with multisystem involvement	2	
Hyperpyrexia of 103 <sup>o</sup> to 105 <sup>o</sup> F		
Jaundice with or without ascending cholangitis		
Severe anemia around 4- 5gm Hb		
Eosinophilia		
(a) severe 62%		
(b) moderate 24%	1	
Congenital blindness with bifid uterus		
Corticosteroids		
(a) Mostly asthmatics		
(b) Arthritic, also on salazopyrin		

Table 3: Concurrent medical illnesses relating ASA grading.

Medical illnesses	
Hypothyroidism	
Gout and periarthritis of shoulder joint	
Chronic renal failure with creatinine ~ 3mg	
Compensated cirrhosis of liver and acute inflammatory hepatitis	4
Myasthenia gravis-past history of treatment with neostigmine	1
Severe acute pancreatitis	8
Gross obesity and thick pancake like greater omentum	1
Koch's infection	
Pulmonary tuberculosis	
Enteritis	
Mesenteric enteritis	
Plastic peritonitis	
Chronic alcoholic	2

Table 4 enumerates previous operations undergone; pointing increased surgical risks in OL.

Table 4: History of previous surgeries.

Surgeries	No.
Open tubectomy	12
Laparoscopic tubectomy	
Diagnostic laparoscopy for primary sterility	
Copper T in situ	
Abdominal hysterectomy one had total hysterectomy done for endometriosis	
Urinary bladder neck suspension (open)	
Electrosurgery to cervix for dyspareunia	1
Caesarian section	
Once	4
Twice	3
Appendicectomy (open)	8
Laparotomy for ectopic pregnancy twice	
Bilateral truncal vagotomy plus	
pyloroplasty	
Bypass not known	
Hematoma over anterior abdominal wall in an athlete, I/D	
Multiple abdominal open surgeries with plastic adhesive peritonitis	1
Modified right hemicolectomy, partial thyroidectomy, and hormonal therapy for uterine bleeding with anemia	
Minilaparotomy cholecystectomy	
Transurethral resection of prostate	
Tumor over thigh excised (Benign)	1

I/D - Incision and drainage

A total 110 were females and 51 males; youngest was 11, oldest 89; mean age 39 years. Total mean age in years is:

39.1; female mean age: 39.05; male mean age: 39.16. Minimum time taken in OL was forty minutes and maximum were five and half hours with a mean of two hours.

On segregating them into hourly groups; one-hour (44) patients, two hours (81), three hours (24), four hours (8), five hours (2), five and half hours (1). No time recorded in one patient. Weight was recorded in Kilograms. 5 patients (two males and three females), had no weight records. In rest 156, mean weight was 57.90 (female mean: 57.2, male mean: 59.4). Minimum weight in 11 years old boy was 33 and 56 years old lady 34. Maximum weight in 57 years old male and 30 years old female was 80 each. In six patients with bleeding from GB beds: one had intense arteriovenous bleed, another with ascending cholangitis and undetected common bile duct (CBD) stone incurred intense bleed from deep laceration in inflamed friable liver during adhesiolysis.

Patient with advanced cancer GB had spurting bleed from fundus after biopsy and procedure was abandoned after bleeding control (Table 5).

**Table 5: Intraoperative complications.** 

Intraoperative complications	No.
Perforation of diaphragm	2.
Laceration of diaphragin	
Inflamed liver	4
Fatty liver	6
Cirrhotic liver	6
Bleeding from liver bed	6
Hand instrument fracture	-
Needle holder jaw	1
Grasper's jaw	2
Cystic artery bleeding	9
Operating port bleeding	2
Cystic duct injuries	
Avulsion	1
Laceration at CBD junction	1
Perforation of GB with spillage of bile	33
Perforation of GB with stones	
Intraperitoneal	7
Operating port	1
Lost ligaclips recovered	2
Acute empyema GB ruptured in port and part	1
got stuck in port	1
CBD tenting due to frozen Callot's triangle	1
Surgical emphysema	5
Extraperitoneal parietal insufflation	1
Appendicular artery injury near base	1
Hemorrhage from very vascular advanced cancer GB with gross 2 <sup>0</sup> s	

GB - Gall Bladder; RH - Right hypochondrium; ICS - Intercostal space; CBD - Common Bile Duct; 20s - Secondaries; LC - Laparoscopic cholecystectomy.

**Table 6: Postoperative complications.** 

Immediate Postoperative complications	No.
Shoulder pains	10
(a) Both sides	7
(b) Right side	2
(c) Side not recorded	1
Presternal pain	1
Postoperative pyrexia; 5 <sup>th</sup> day-104 <sup>0</sup> F, cause?	
Bile leak due to injury at CD -CBD junction	1
Friction burns to skin edges in operative port	
Very violent recovery from anesthesia (? fear psychosis)	
Late postoperative complications	
Huge subhepatic bile collection 12 days postoperative after LC	
Port wound infection	1
Anxiety neurosis	1

CD - Cystic duct; CBD - Common bile duct; LC - laparoscopic cholecystectomy

In vascular injuries: in five cases posterior branches of cystic artery, in two main branches and in one both anterior and posterior branches were injured. Main appendicular artery was injured near base in one patient. In one laparoscopic cholecystectomy (LC) with acute cholecystitis, an anomalous arterial twig bled running over anterior surface of CBD. On failing to control, soft monopolar coagulation was used. Bleed was controlled leading to delayed perforation of CBD with sub-hepatic biliary collection two weeks postoperative drained under local anesthesia with uneventful recovery (Table 6). An empyema GB needed port extension for tissue retrieval resulting in brisk wound bleeding; minor subcutaneous oozing was noted in thirty-one cases. Bleeding in all was controlled instantly.

case with Mirizzi syndrome (Cholecystobiliary fistula) had injury at cystic duct and CBD junction.6 Despite suturing, it leaked bile postoperatively for few days with satisfactory recovery. An asthmatic on bronchodilators, steroids, antihypertensives with gangrenous appendicitis and acute hepatitis, possibly from portal pyemia, had two caesarians also with plenty of adhesions; yet made uneventful recovery after LA. Out of ten patients with shoulder pains, eight were females and two males.

Of five cases of surgical emphysema one had it all over abdomen; one obese patient had extraperitoneal insufflation for first difficult trocar entry; one case of bilateral truncal vagotomy and division of gastroduodenal artery for bleeding duodenal ulcer had surgical emphysema in neck, face and chest (Table 5). In three cases of Hasson technique: port was converted in minilaparotomy in one case of tuberculous plastic peritonitis; an infraumbilical hernia fashioned as Hasson port in appendectomy case was repaired with two mass stitches with good result over a decade follow up; one

patient with Koch's enteritis had preemptive Hasson port but peritoneal cavity turned out virgin. Friction burn was due to insertion of cannula in tight fit skin port that needed extended postoperative wound care defeating the aim to reduce pain by smaller cut.

#### **DISCUSSION**

Oblique entry of cannulae results in Z-ports on deflation of abdomen due to differential stretching properties of different layers of abdominal wall and averts layer closure of wound to prevent hernia formation and wound infection by omitting foreign material. Diaphragm perforations, cases of bleeding from GB and liver bed, bile leaks, injured arteries, skin wounds, extrahepatic biliary injuries, conversions due to technical reasons, Hasson technique, lost ligaclips, surgical emphysema, spillage of bile and stones are known hazards irrespective of insufflation gas. Such events should be relegated to surgeon team<sup>7-9</sup> factor elaborated later.

Difficult liver conditions with lacerations and bleeding, several cases of cystic artery injuries, many cases with previous surgeries, dense adhesions irrespective of ASA Grades, e.g., two LC cases had previous bilateral truncal vagotomies and pyloroplasty ten years ago needing tedious adhesiolysis just to reach GB and took four hours in one case and five and half hours in another to achieve difficult LC: were significant for no infection or events of clinically discernible AE despite major surgical emphysema. Late bile leak from CBD due to unwary monopolar injury shows that bipolar energy or sutures may have been better (Table 6B). It stresses on knowledge of biophysics of electrosurgery in OL; when ignorance of direct coupling, insulation leak, capacitive coupling and density of monopolar current can be dangerous. 7,8,10 No electrosurgical burns, explosions or event of wound infection occurred alleviating fear with use of AA. One late postoperative wound infection case was due to faulty sterilization, recovered with conservative management. High rate of shoulder pains in females is puzzling and may indicate some psychosomatic lability (two females are known) or neurohormonal instability. One fifty-six years male was found to suffer shoulder periarthritis and one forty-four years had entire bodyache with shoulders, making it mostly feminine event.

Considering age in years, overall mean: 39.1, female mean:39.05, male mean:39.2; is almost same, while considering weight wise, again there is no significant difference but males appeared to be slightly heavier than females: F:M::57.2:59.4. This seems to go against the established view of fat, female, since majority patients had extrahepatic biliary lithiasis.

Two cases of conversions were for imponderable adhesions with no peritoneal cavity. Conversion without extra needle holder shows, "How OL is technology dependent despite technical efficiency"? These three

cases should not be confused with three cases of Hasson technique. Park et al observed more pain with CO<sub>2</sub> postoperatively.<sup>11</sup> Author needed less postoperative analgesia adjudged by visual analog and numeric pain rating scales with AA compared to CO<sub>2</sub>.<sup>12</sup> Events in 'Results' section and Tables 5, 6, are well known with CO<sub>2</sub> also.<sup>13-16</sup>

Full discussion of mechanism from myth of serious venous AE or GE and incidental historiographic faux pas relating to use of AA in OL is out of scope here and has been dealt with separately.

It is noted that words like air, CO<sub>2</sub>, O<sub>2</sub>, He, N<sub>2</sub>O, are exclusive and are subsets of gas in physics. In light of experiences presented herewith from a peripheral centre; this brief exegesis shows that AA in OL is useful, as safe as CO<sub>2</sub>, e.g., in remotest corners of world, weaker economies, camp surgeries, pregnancy, war fronts, cirrhotics, elderly, cardiopulmonary cripples, renal insufficiency, ASA Grade III and IV, prolonged procedures and cancer surgery.<sup>12,17</sup> Risk of acidosis, hypercarbia, hypothermia are more with CO<sub>2</sub> compared to AA.<sup>11,18</sup> CO forms due to chemical reaction between hydrogen ions generated during OL and CO<sub>2</sub> in anaerobic milieu with generation of carboxy-hemoglobin and methemoglobin in blood that is highly undesirable in critical cases.<sup>19,20</sup>

#### **CONCLUSION**

Judging scrupulously, this first of its kind study testifies safety with prima facie economy of cylinders and advantages of AA in OL even in a non-institutional center; and can be useful in difficult places and difficult clinical situations, without cumbersome expensive monitors. Hence outcome justifies the deed- exitus acta probat. This work might be viewed with skepticism under current surgical ethos against AA but begs a neutral view for its mass useful utility.

The precise mechanism of AE or GE and death in OL is still vague, especially since embolus alone per se is not the cause for moribund event Vis a Vis AL or GL in RH and PT. There are other factors also. It is wiser to deal with commoner surgeon factor than rarer issues of AE or GE due to AA. Events ascribed to AA are now occurring with CO<sub>2</sub> also but without noise.

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