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Cochrane Database of Systematic Reviews 2017, Issue 6. Art. No.: CD009569.
DOI: 10.1002/14651858.CD009569.pub3.

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[Intervention Review]

Gases for establishing pneumoperitoneum during laparoscopic abdominal surgery

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Editorial group: Cochrane Colorectal Cancer Group.
Publication status and date: Edited (no change to conclusions), published in Issue 6, 2017.

Citation: Yu T, Cheng Y, Wang X, Tu B, Cheng N, Gong J, Bai L. Gases for establishing pneumoperitoneum during laparoscopic abdominal surgery. *Cochrane Database of Systematic Reviews* 2017, Issue 6. Art. No.: CD009569. DOI: 10.1002/14651858.CD009569.pub3.

ABSTRACT

Background

This is an update of the review published in 2013.

Laparoscopic surgery is now widely performed to treat various abdominal diseases. Currently, carbon dioxide is the most frequently used gas for insufflation of the abdominal cavity (pneumoperitoneum). Although carbon dioxide meets most of the requirements for pneumoperitoneum, the absorption of carbon dioxide may be associated with adverse events. People with high anaesthetic risk are more likely to experience cardiopulmonary complications and adverse events, for example hypercapnia and acidosis, which has to be avoided by hyperventilation. Therefore, other gases have been introduced as alternatives to carbon dioxide for establishing pneumoperitoneum.

Objectives

To assess the safety, benefits, and harms of different gases (i.e. carbon dioxide, helium, argon, nitrogen, nitrous oxide, and room air) used for establishing pneumoperitoneum in participants undergoing laparoscopic general abdominal or gynaecological pelvic surgery.

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) (the Cochrane Library, 2016, Issue 9), Ovid MEDLINE (1950 to September 2016), Ovid Embase (1974 to September 2016), Science Citation Index Expanded (1970 to September 2016), Chinese Biomedical Literature Database (CBM) (1978 to September 2016), ClinicalTrials.gov (September 2016), and World Health Organization International Clinical Trials Registry Platform (September 2016).

Selection criteria

We included randomised controlled trials (RCTs) comparing different gases for establishing pneumoperitoneum in participants (irrespective of age, sex, or race) undergoing laparoscopic abdominal or gynaecological pelvic surgery under general anaesthesia.

Data collection and analysis

Two review authors identified the trials for inclusion, collected the data, and assessed the risk of bias independently. We performed the meta-analyses using Review Manager 5. We calculated risk ratio (RR) for dichotomous outcomes (or Peto odds ratio for very rare outcomes), and mean difference (MD) or standardised mean difference (SMD) for continuous outcomes with 95% confidence intervals (CI). We used GRADE to rate the quality of evidence,

Main results

We included nine RCTs, randomising 519 participants, comparing different gases for establishing pneumoperitoneum: nitrous oxide (three trials), helium (five trials), or room air (one trial) was compared to carbon dioxide.

Three trials randomised participants to nitrous oxide pneumoperitoneum (100 participants) or carbon dioxide pneumoperitoneum (96 participants). None of the trials was at low risk of bias. There was insufficient evidence to determine the effects of nitrous oxide and carbon dioxide on cardiopulmonary complications (RR 2.00, 95% CI 0.38 to 10.43; two studies; 140 participants; very low quality of evidence), or surgical morbidity (RR 1.01, 95% CI 0.18 to 5.71; two studies; 143 participants; very low quality of evidence). There were no serious adverse events related to either nitrous oxide or carbon dioxide pneumoperitoneum (three studies; 196 participants; very low quality of evidence). We could not combine data from two trials (140 participants) which individually showed lower pain scores (a difference of about one visual analogue score on a scale of 1 to 10 with lower numbers indicating less pain) with nitrous oxide pneumoperitoneum at various time points on the first postoperative day, and this was rated asvery low quality .

Four trials randomised participants to helium pneumoperitoneum (69 participants) or carbon dioxide pneumoperitoneum (75 participants) and one trial involving 33 participants did not state the number of participants in each group. None of the trials was at low risk of bias. There was insufficient evidence to determine the effects of helium or carbon dioxide on cardiopulmonary complications (RR 1.46, 95% CI 0.35 to 6.12; three studies; 128 participants; very low quality of evidence) or pain scores (visual analogue score on a scale of 1 to 10 with lower numbers indicating less pain; MD 0.49 cm, 95% CI -0.28 to 1.26; two studies; 108 participants; very low quality of evidence). There were three serious adverse events (subcutaneous emphysema) related to helium pneumoperitoneum (three studies; 128 participants; very low quality of evidence).

One trial randomised participants to room air pneumoperitoneum (70 participants) or carbon dioxide pneumoperitoneum (76 participants). The trial was at unclear risk of bias. There were no cardiopulmonary complications or serious adverse events observed related to either room air or carbon dioxide pneumoperitoneum (both outcomes very low quality of evidence). The evidence of lower hospital costs and reduced pain during the first postoperative day with room air pneumoperitoneum compared with carbon dioxide pneumoperitoneum (a difference of about one visual analogue score on a scale of 1 to 10 with lower numbers indicating less pain, was rated as very low quality of evidence.

Authors' conclusions

The quality of the current evidence is very low. The effects of nitrous oxide and helium pneumoperitoneum compared with carbon dioxide pneumoperitoneum are uncertain. Evidence from one trial of small sample size suggests that room air pneumoperitoneum may decrease hospital costs in people undergoing laparoscopic abdominal surgery. The safety of nitrous oxide, helium, and room air pneumoperitoneum has yet to be established.

Further trials on this topic are needed, and should compare various gases (i.e. nitrous oxide, helium, argon, nitrogen, and room air) with carbon dioxide under standard pressure pneumoperitoneum with cold gas insufflation for people with high anaesthetic risk. Future trials should include outcomes such as complications, serious adverse events, quality of life, and pain.

PLAIN LANGUAGE SUMMARY

Different gases for insufflation of the abdominal cavity during key-hole abdominal surgery

Review question

What are the benefits and harms of various gases for insufflation (inflation with gas) of the abdominal (tummy) cavity to allow easier access to organs during laparoscopic (key-hole) abdominal surgery?

Background

Laparoscopic (key hole) surgery is now widely performed to treat various abdominal diseases. An ideal gas for insufflation of the abdominal cavity, increasing working and viewing space, should be cheap, colourless, not flammable, inexplosive, easily removed by the body, and completely non-toxic to participants. Currently, carbon dioxide is the most frequently used gas for this purpose. However, use of carbon dioxide may cause heart or lung complications. So, other gases have been suggested as alternatives to carbon dioxide.

Study characteristics

We searched for all relevant studies up to September 2016. We identified nine clinical trials with 519 participants, of which three trials (196 participants) compared nitrous oxide (laughing gas) with carbon dioxide, five trials (177 participants) compared helium with carbon dioxide, and one trial (146 participants) compared room air with carbon dioxide. Studies were conducted in the USA, Australia, China, Finland, and Netherlands. The age of the participants in the trials ranged from 19 to 62 years.

Key results

We are uncertain as to whether there are differences in the number of people with heart or lung complications or surgical complications between nitrous oxide and carbon dioxide. We are uncertain as to whether there are any differences in heart or lung complications, surgical complications, or pain scores between helium and carbon dioxide.

There were no serious side effects related to the use of carbon dioxide, nitrous oxide, or room air, but generally serious side effects are rare events and it would take larger studies with many more participants to be sure that these gases are equally safe. There were three serious side effects when helium was used. Room air seemed to be associated with lower total hospital costs compared with carbon dioxide for insufflation of the abdominal cavity.

Because of the few participants included in the review, the safety of using nitrous oxide, helium, or room air is unknown. There is no evidence for any clinical improvement by using nitrous oxide, helium, or room air instead of carbon dioxide.

Quality of the evidence

Overall, the quality of the evidence for the results is very low. Thus, future well-designed trials examining complications, harms, quality of life, and pain are urgently needed.