Supplemental oxygen reduces the incidence of postoperative nausea and vomiting

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Postoperative nausea and vomiting (PONV) are unpleasant for patients and increase the risk of aspiration pneumonia. PONV is the leading cause of unexpected admission following planned day surgery. Despite new anaesthetic drugs and antiemetics, the incidence of PONV remains high. The incidence of PONV depends on numerous factors including age, gender, obesity, anxiety, gastroparesis, history of motion sickness, previous PONV, and the duration and type of surgery. Anaesthesia-related factors include premedication, ventilation techniques, and postoperative pain management.

Recently, the intraoperative inspired oxygen concentration was identified as a factor that influences PONV. Among the three studies that evaluated intraoperative supplemental O$_2$ for prevention of PONV, two found that it halves PONV while the third failed to identify any benefit.

Since supplemental O$_2$ is inexpensive and essentially risk-free, it appears preferable to pharmacologic anti-emetics for prevention of PONV in abdominal surgery.

Key words: PONV - Oxygen - Review.

Postoperative nausea and vomiting (PONV) are unpleasant for patients and increase the risk of aspiration pneumonia. PONV is the leading cause of unexpected admission following planned day surgery. Despite new anesthetic drugs and anti-emetics, the incidence of PONV remains high. The incidence of PONV depends on numerous factors including age, gender, obesity, anxiety, gastroparesis, history of motion sickness, previous PONV, and the duration and type of surgery. Anaesthesia-related factors include premedication, ventilation techniques, and postoperative pain management.

Recently, the intraoperative inspired oxygen (O$_2$) concentration was identified as a factor that influences PONV. Among the three studies that evaluated intraoperative supplemental O$_2$ for prevention of PONV, two found that it halves PONV while the third failed to identify any benefit. In this short review, we discuss these studies.
Materials and methods

In 1999, Greif et al., studied patients undergoing colon resection surgery (age 19-80 yr; ASA I-III; n=231). Patients were anesthetized with fentanyl and isoflurane. During and for two hours after surgery, they were randomly assigned to: 1) 30% O₂, balance nitrogen (n=119); or 2) 80% O₂, balance nitrogen (n=112). Nurses, blinded to group assignment and O₂ concentration, evaluated the incidence PONV during the first 24 postoperative hours. The data was analyzed with unpaired "t" or Mann-Whitney-U tests.

In 2001, Goll et al. studied patients undergoing gynecological laparoscopy (age 19-70 yr; ASA I-II; n=240). These patients have a high incidence of PONV. The ability of intraoperative supplemental O₂ to prevent PONV was compared to high-dose ondansetron, the gold standard medication. After induction with isoflurane, patients were randomly assigned to three groups: 1) Routine O₂ administration with 30% O₂, balance nitrogen (30% O₂); 2) Supplemental O₂ administration with 80% O₂, balance nitrogen (80% O₂); or 3) Ondansetron (8 mg immediately after induction) combined with 30% O₂, balance nitrogen (Ondansetron). PONV was followed for 24 hours. The incidence of PONV and potential confounding factors were evaluated by both univariate and multivariate statistics. One-way ANOVA and χ² analyses were used for the univariate analyses. Nausea severity was evaluated with Kruskal Wallis tests. The incidence of nausea and combined nausea and vomiting (PONV) were compared by χ² analyses. Additionally, multivariate regression analyses were used to evaluate the contributions of potential confounding factors on the combined incidence of PONV.

In 2001, Poth et al. studied patients scheduled for elective thyroidectomy (age 19-70 yr; ASA I-III; n=60). In this doubled-blinded study, patients were randomly assigned to one of three groups (n=20 each): 1) routine O₂ administration with 30% O₂, balance nitrogen; 2) supplemental O₂ administration with 80% O₂, balance nitrogen or 3) droperidol (0.625 mg IV) given just after induction of anesthesia (FIO₂=30%). Patients were allowed to drink 4 hours and eat 5 hours after the end of surgery. Exclusion criteria, which were similar to the other studies, included motion sickness, prior history of PONV, and obesity. Anesthesia was induced with propofol (1.5 mg/kg), sufentanil (15 g), and rocuronium (0.6 mg/kg), and then maintained with sevoflurane (2-3%). Episodes of PONV were recorded for the first postoperative 24 h. Data were analyzed with one-way ANOVA and χ² analyses.

Results

In Greif et al. study, first postoperative day O₂ saturation was within normal limits and comparable in both groups. The incidence of PONV in the first 24 postoperative hours was 30% in patients assigned to 30% O₂, but only 17% in those given 80% O₂ (p=0.027, Table I). Only two patients in the 80% O₂ group vomited whereas seven in the 30% group did (p=0.11). Oxygen concentration showed a probability of 0.03 in reducing PONV in the multivariate regression. Additionally, previous history of postoperative nausea and vomiting, gender, and fentanyl use also showed statistically significant contribution in causing PONV.

In Goll et al. study, the overall incidence of PONV during the initial 24 postoperative hours was 44% in the patients assigned to 30% O₂, but only 17% in those given 80% O₂ (p=0.027, Table I). Only two patients in the 80% O₂ group vomited whereas seven in the 30% group did (p=0.11). Oxygen concentration showed a probability of 0.03 in reducing PONV in the multivariate regression. Additionally, previous history of postoperative nausea and vomiting, gender, and fentanyl use also showed statistically significant contribution in causing PONV.

In Poth et al. study, the overall incidence of PONV during the initial 24 postoperative hours was 44% in the patients assigned to 30% O₂, 30% in the ondansetron group, but only 22% in those given 80% O₂. The difference between 30% and 80% O₂ was statistically significant. There were, however, no statistically significant differences between the 30% O₂ or 80% O₂ groups and the ondansetron group (Table I). The difference in the incidence of PONV in the 30% and 80% O₂ groups was confirmed by multivariate analysis. Patients in each of the three treatment groups began liquid and solid food at similar times, and were discharged from the PACU and hospital at similar times.

In Poth et al. study, incidence of PONV...
were similar in the 30% O₂ group (60% had nausea, 35% vomited) and 80% O₂ group (70% had nausea, 30% vomited); but was significantly less in the Droperidol group (15% had nausea, 5% vomited). Additional-
ly, in the Droperidol Group, time to first meal was significantly shorter than in the 30% O₂ Group (30% O₂ Group = 10±1.3 hour, 80% O₂ Group = 9±1 hour, Droperidol Group = 6.5±1 hour).

**Conclusions**

Greif et al. study demonstrated that 80% O₂ during and for two hours after colon resection reduces the incidence of PONV by a factor of two. This was surprising because there is no established mechanism by which O₂ given during and shortly after surgery influences nausea and vomiting many hours after patients leave the PACU. Goll et al. results nonetheless confirm this finding. This study also confirmed that supplemental O₂ is effective even when restricted to the intraoperative period.

Intestinal tissue is highly metabolically active and has a notoriously poor tolerance for even brief periods of hypoxia or ischemia. An important intestinal response to ischemia is release of serotonin — a highly emetogenic substance. Supplemental O₂ may reduce PONV by ameliorating subtle intestinal ischemia, thereby reducing release of emetogenic substances from compromised bowel. Colon resection is associated with at least some intestinal ischemia because perfusion is reduced by gut manipulation. Insufflation of the abdomen during laparoscopy significantly increases peritoneal pressure and thus also reduces intestinal blood flow. Patients undergoing either colon resection or laparoscopy are thus both subject to subtle intestinal ischemia that supplemental O₂ might ameliorate.

Recently, another study found that sup-
Supplemental O\textsubscript{2} during emergency transport of elderly patient reduces motion sickness.\textsuperscript{11} Hyperoxia decreases dopamine release by the carotid bodies.\textsuperscript{12} This is potentially important because the chemotactic trigger zone is sensitive to dopamine as well as serotonin.\textsuperscript{13} Hyperoxia per se may thus reduce nausea and vomiting mediated by dopamine in these patients. However, patients participating in the described studies presumably experienced little vestibulocochlear stimulation, and there is no reason to assume that O\textsubscript{2} administration reduced PONV by influencing this region. It is unlikely therefore that this dopamine related mechanism is affected by intraoperative supplemental O\textsubscript{2}.

The conventional method of preventing PONV is administration of 5-HT\textsubscript{3} antagonists. However, these drugs are expensive and cause occasional complications.\textsuperscript{14} In contrast, 80% perioperative O\textsubscript{2} is not associated with clinically important complications including atelectasis\textsuperscript{15} and is remarkably inexpensive.

Poth et al. failed to observe any benefit of supplemental O\textsubscript{2} on PONV in their thyroid surgery patients. Neither intestinal ischemia nor a cerebral dopamine-related mechanism appears to explain PONV in these patients. One possible explanation is that intraoperative dissection of the recurrent laryngeal nerve(s) contributes since this nerve is a branch of the vagal nerve, which is highly involved in emetic reflexes. PONV after thyroidectomy may also result from nociceptive reflexes originating from the pharynx and larynx.\textsuperscript{16} Pharyngeal pain, exacerbated by swallowing, is typical after thyroid surgery; to the extent that PONV results from throat pain, it is unlikely to be affected by hyperoxia.

PONV has numerous etiologies and many factors are known to influence its incidence. Since supplemental O\textsubscript{2} is inexpensive and essentially risk-free, it appears preferable to pharmacologic anti-emetics for prevention of PONV in abdominal surgery.

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Riassunto

L’ossigenazione supplementare riduce l’incidenza di nausea e vomito postoperatorio

La nausea e il vomito postoperatorio (PONV) sono esperienze spai evoli per il paziente ed aumentano il rischio di polmonite ab ingestis. Inoltre rappresentano la causa principale degli ingressi non programmati in terapia intensiva dopo chirurgia elettiva. Nonostante i nuovi farmaci anestetici e gli antiemetici l’incidenza di PONV rimane alta. Questa dipende da numerosi fattori che includono età, sesso, obesità, ansia, gastroparesi, storia di cinetosi, esperienza di PONV in passato, durata e tipo di chirurgia. I fattori collegati all’anestesia includono: premedicazione, la tecnica di ventilazione e trattamento del dolore postoperatorio.

Recentemente la concentrazione inspiratoria di ossigeno intraoperatoria è stata riconosciuta come un fattore in grado di influenzare la PONV. Tre studi hanno valutato gli effetti di un aumento dell’FiO\textsubscript{2} nella prevenzione della PONV, tra questi due hanno dimostrato che dimezza l’incidenza di PONV, mentre il terzo non ha identificato alcun beneficio.

Dato che un aumento dell’FiO\textsubscript{2} non è dispendioso ed è essenzialmente privo di rischi, sembra preferibile agli agenti antiemetici farmacologici nella prevenzione del PONV

Parole chiave: PONV - Ossigeno - Review.

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