Oxygen Use in the Perioperative Period. Should We Change Our Practice?

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Traditionally, fraction of inspired oxygen (FiO₂) administered during an anesthetic, is between 30-100%, and remains an individualized practice that varies among Anesthesia Departments in the country.

Recently, there have been emerging studies showing that a higher than usual FiO₂ may be beneficial in reducing the surgical site infection rate after colorectal surgery.

Whether this is something that we should actively cultivate, remains to be seen while awaiting larger patient trials. Nevertheless, pursuing 2-6 hours 80% oxygen administration after surgery is no small task, especially since it appears that this is an inexpensive practice. While the FiO₂ administered intraoperatively may indeed be an uncostly maneuver, this extrapolation does not automatically apply to the Post Anesthesia Care Unit (PACU). If a patient requires continuation of a relatively high FiO₂ in the PACU, he/she must remain in that unit for a longer than expected time before being transferred to the floor or intensive care unit. It is a common practice among PACU personnel that a transition to a lower oxygen concentration administration should be conducted as soon as the patient tolerates it and together with addressing other discharge parameters will significantly reduce the PACU time. Even, when the PACU time is weighed at a bundled price, if patients spend longer than the usual time in the recovery room, it may impact the PACU’s ability to accept new patients from the operating room, which will then significantly impair the operating room and overall hospital costs.

Supplemental oxygen in the perioperative period has multiple benefits including prevention of hypoxemia, reduction of tachycardia and, postoperative nausea and vomiting, optimization of alveolar immune defense, and decrease of surgical wound infections in certain specific patient population. Nevertheless, there are counterarguments to high oxygen administration such as development of atelectasis, decrease in respiratory drive in patients with chronic obstructive pulmonary disease, free radical damage may be worsened, and even pulmonary toxicity if 100% FiO₂ is used for a long duration [1].

The use of 100% FiO₂ before tracheal extubation promotes atelectasis, which may be followed by significant complications such as pneumonia and in patients undergoing cardiopulmonary bypass may exacerbate lung injury manifested by a significant decrease in oxygenation and increased levels of bronchial tree cytokines [2,3]. Similarly, Zoremba et al. showed that perioperative saturation is significantly better in the first 24 hours in moderately obese adults undergoing minor peripheral surgeries if lower than 100% FiO₂ is used, and in their study 80% oxygen was employed. The mechanisms of atelectasis in the perioperative period are complex, and it seems that use of lower than 100% FiO₂ and perhaps a recruitment maneuver prior to extubation may be considered in order to resolve or at least partly improve the atelectasis that can develop in the postoperative period [4,5].

While there is significant evidence that 100% FiO₂ in the perioperative period is not beneficial, but rather potentially harmful there is no real number between 30 and 80% FiO₂ that perhaps should become the new guideline for oxygen therapy.

Lentschener et al. studied healthy patients and showed that there is no difference between pulmonary oxygenation if one uses 25 vs. 50% FiO₂ intraoperatively [6].

Even in regards to postoperative nausea and vomiting (PONV) results are contradictory in many studies, one of the most recent ones failed to show a difference between intraoperative 30, 50 and 80% respectively FiO₂ in gynecologic laparoscopic procedures [7]. When 80% FiO₂ is used, studies in colorectal surgery may show either a decrease in PONV, or no reduction in these symptoms after strabismus surgery respectively [8,9].

There are quite a few studies trying to clarify the benefit of higher FiO₂, namely 80%, rather than commonly used mixture of 1:1 oxygen and air during anesthesia, which yields an approximate 60% FiO₂, while using surgical site infection (SSI) as an endpoint.

This debate started with Grief et al who found a reduction in half of SSI in patients undergoing colorectal surgery after using 80% FiO₂ intraoperatively and two hours after surgery. Similarly, Belda et al. also showed a reduction in SSI by a factor of 2 in the same patient population, but using 6 hours instead of 2 postoperatively of 80% FiO₂ [10,11].

With other types of surgical procedures the results seem to be reproducible, although these studies have smaller study population. Puckridge et al. showed benefit in SSI with 80% vs 30% FiO₂ in patients undergoing infragenital arterial surgical, while Margakis et al. recommends that at least 50% FiO₂ should be used intraoperatively in spinal surgery in order to decrease SSI [12,13].

Other studies come to a different conclusion, such as Gardella et al. shows that when regional anesthesia is performed for cesarian section the risk for SSI is not decreased even when high concentration FiO₂ is used via a nonrebreathing mask. Pryor et al. showed no reduction in SSI in abdominal surgery including laparoscopic procedures, but instead a higher rate of SSI, which may have been related to the inequality of his study groups. Similarly, the Proxi trial failed to show positive results in elective and emergent abdominal surgical procedures, although critics believe that the procedures were somewhat heterogeneous [14-16].

Future areas of interest may be related to mild intraoperative hypercapnia, while using 80% FiO₂ which seems to increase tissue oxygen tension both in the arm and colonic tissue, and overall improves tissue oxygenation. This may represent a new pathway...
for a potential reduction of the risk for SSI in patients undergoing abdominal surgeries [17,18].

A recent meta-analysis showed no benefit in higher oxygen administration for reduction of SSI, therefore contradicting other previous meta-analyses. In the subgroup of patients undergoing colorectal surgery, these results seem to remain valid [19].

While the enthusiasm was great initially, now it seems more and more that SSI is a multifactorial process, where oxygen administered is only one factor of this complex equation, and maybe this data should be applied for now only to specific surgical procedures where good outcomes have been demonstrated [20].

Although there is increasing body of evidence that 80% FiO\textsubscript{2} appears to be beneficial for prevention of surgical wound infections, the results remain contradictory, especially since large randomized trials are lacking. Even if overly enthusiastic with regards to these results, one may easily implement the intraoperative use of higher oxygen concentration, since most studies that failed to prove any benefit, did not show a worse outcome, with the the exception of study by Pryor et al. [15]. Consequently, the developing trend in many institutions is to use higher than usual intraoperative FiO\textsubscript{2} for specific surgical procedures such as colorectal surgeries. There is one caveat though, that the timing of postoperative higher oxygen administration may be the limiting factor, and until more definitive data is available, hospital policies and specific guidelines for certain surgical procedures may be difficult to implement.

References

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