Original Article

Is Oxygen Supplementation Necessary for Patients under Spinal Anaesthesia? - A Prospective Hospital-Based Study

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ABSTRACT

Background: Oxygen supplementation is given routinely to patients undergoing surgery under spinal anaesthesia, the basic aim being to prevent oxygen desaturation and hypoxemia.

Objective: This study aimed to find out the incidence of hypoxemia under spinal anaesthesia and determine if oxygen supplementation is necessary for patients under spinal anaesthesia.

Materials and methods: This was a prospective non-randomised study, conducted at a central hospital in Zimbabwe: Parirenyatwa Group of Hospitals, Harare. Fifty- nine (59) consenting patients, both sexes, ASA I-IV undergoing surgery under spinal anaesthesia with standard doses of heavy bupivacaine and fentanyl were recruited. Oxygen saturation was measured before the spinal anaesthetic and continuously after the spinal anaesthetic up to the recovery room, until discharge to the ward using a Datex Ohmeda pulse oximeter. Rescue oxygen supplementation was given to patients that became hypoxemic (SPO2< 90% for >30 seconds with a normal wave form on plethysmogragh).

Results: The incidence of intra operative hypoxemia under spinal anaesthesia in this study was 1.69%, and there was a relationship between height of block and saturation change.

Conclusion: From the study, it is concluded that it is not necessary to routinely supplement oxygen to patients under spinal anaesthesia.

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INTRODUCTION

Spinal anaesthesia is one of the safest anaesthetic techniques when indicated. This is accounted for in part by its minimum respiratory effects.[1] However, oxygen desaturation is known to occur in some patients. Although a number of factors are attributed, the extent of their influence on desaturation is still unknown.[1] Some of the factors include weight, age, height of block and type of surgery. These factors are thought to be involved in the pathogenesis of hypoxemia. Intraoperative hypoxemia is defined as a state of reduced arterial hemoglobin oxygenation, when the arterial oxygen tension is less than 60mmHg and the saturation measured by pulse oximetry is less than 90% .[2]

Although routine oxygen supplementation is given under spinal anesthesia, some patients do not need supplementary oxygen. This is because the ventilatory changes that occur after a spinal are well tolerated in normal healthy patients without consequent hypoxia occurring.[3] Monitoring of patients under spinal anesthesia by measurement of arterial hemoglobin saturation then becomes important. This is so that we can promptly identify and treat those patients that desaturate and are at risk of becoming hypoxemic. The use of clinical signs such as cyanosis as a measure of arterial hemoglobin saturation is not reliable .This is because it may be difficult to identify especially in circumstances where light levels are low or in patients who are pigmented.[4]

Pulse oximetry is a noninvasive method for measurement of arterial hemoglobin saturation. This utilizes the principle that the amount of light absorbed by a pigment or solution is proportional to its concentration.[4] It therefore assesses the absorbance of oxy- and deoxy-hemoglobin spectrophotometrically and reliably gives an indication of the arterial haemoglobin oxygen saturation as a percentage.[5] It has the advantage that it is noninvasive and rapid with an accuracy of ± 2% above an oxygen saturation of 70 % .[4] It is therefore instrumental in the identification of hypoxemic patients.

A further concern regarding routine oxygen supplementation is related to the increased oxygen free radicals in patients. Several studies done in parturients having lower segment caesarean section under spinal anesthesia with oxygen supplementation have demonstrated an increase in oxygen free radical activity both in maternal and fetal blood. [6] There is therefore a possibility of damage from free radicals and routine supplementation of oxygen in uncomplicated caesarean deliveries is therefore not recommended .[7]

Additionally, due to the high cost stemming from the use of oxygen and oxygen delivery devices,[8] that are more expensive than oxygen itself in most Zimbabwean institutions, unnecessary oxygen supplements to patients also translate to unnecessarily high cost of anesthesia. Thus, the clinical practise of routinely administering high fractional inspired concentrations of oxygen to all patients under spinal anaesthesia is questionable if continuous monitoring with pulse oximetry is available. [9]

Based on observations in clinical practice, it is still a common practice for some anaesthetists in Zimbabwe to routinely supplement oxygen to patients during surgery under spinal anaesthesia. At the same time, the incidence of intraoperative hypoxemia in patients under spinal anaesthesia in our local setting is unknown. Pulse oximetry is now a standard monitor in anaesthesia and is able to identify patients that desaturate and appropriate oxygen therapy thereafter instituted.

It is therefore against this background that information obtained from this study will assist in the review of the current intraoperative anaesthetic practise, during spinal anaesthesia, to benefit both the medical institutions and patients. The objective of the study was to determine the incidence of intraoperative hypoxemia during spinal anaesthesia, as well as to determine if it is necessary to routinely supplement oxygen to patients undergoing surgery under spinal anaesthesia.

METHODOLOGY

Study population

Adult patients scheduled for surgery under spinal anaesthesia were included in the study.

The study included those patients who consented to the study, and ASA I to IV having surgery under spinal anaesthesia. Patients who refused to participate in the study, as well as those with significant cardiopulmonary disease requiring oxygen preoperatively, obstetric patients, those aged < 18 years, and morbidly obese patients, were excluded from the study

Setting

The participants were collected from main theatres at Parirenyatwa Group of Hospitals, Harare, Zimbabwe. The study was approved by the Joint Parirenyatwa Hospital and College of Health Sciences Research Ethics Committee and Medical Research Council of Zimbabwe

Design

The study was a prospective non randomised study on a sample of 59 eligible patients. This was one group of patients all treated the same: patients were not assigned to experimental and control groups. Oxygen saturation was measured before administration of spinal anaesthesia, using a Datex Ohmeda pulse oximeter. Oxygen saturation was then continuously measured after the spinal anaesthetic had been administered, intraoperatively and in the recovery room up to discharge from recovery. Other monitors used included non-invasive blood pressure (NIBP) and electrocardiograph (ECG). The spinal anaesthetic was done at L3/4 or L4/5 in the sitting or lateral position using standard doses of heavy bupivacaine and fentanyl. Patients were then positioned appropriately whilst breathing room air. Temperature using an ice pack was used to assess height of block. Rescue oxygen supplementation was to be given to those patients who desaturated to 90% or less for more than 30 seconds while breathing normally with a normal plethysmograph saturation wave form on the monitor. A venturi face mask delivering 40% oxygen was used.

Ephedrine or phenylephrine and anticholinergics such as atropine were used by the anaesthetist per rising need intraoperatively. Patients' age, sex, height, weight and ASA grade were recorded.

Data Analysis

The data was analysed using R-statistical software package. Descriptive statistics were used to compare the mean base line oxygen saturation and the mean oxygen saturation during spinal anaesthesia. Skata protocol was used to tentatively investigate the relationship between the mean base line oxygen saturation and the mean oxygen saturation during spinal anaesthesia. Graphical methods were used to come up with the box and whiskers, and hypothesis testing on the difference on the means was used to ascertain whether they are significantly different statistically.

RESULTS

A total of 59 eligible patients participated in the study. The patients were enrolled from different specialties and underwent different types of surgery ranging from lower abdominal (16), pelvic (16), perineal (14) and lower limb surgery (13). Both elective cases and emergency cases were enrolled. All patients had a preoperative baseline saturation of greater than 90%, that is, none were hypoxemic. There was a predominance of lower limb surgery and none of the patients developed cardiopulmonary complications. Fig 1 below shows the age distribution.

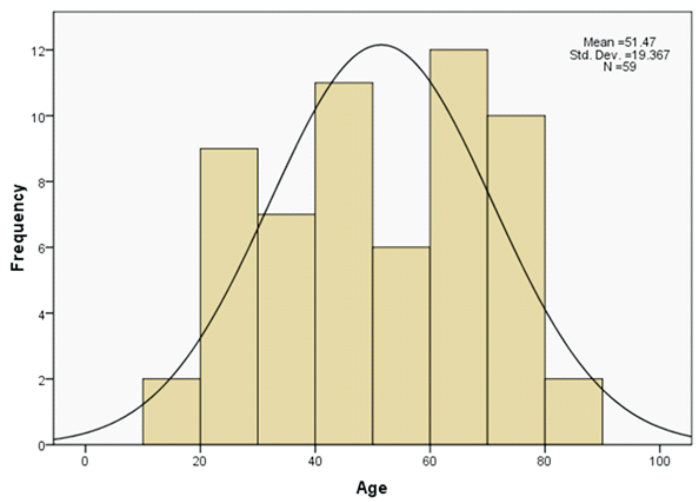


Fig 1: Age distribution

The study group consisted of young, middle age and elderly patients. The average age was about 51 years; the age distribution of participants follows a normal distribution.

Table 1 below shows the age, sex and body mass indices of the patients in the study.

Table 1: Patient characteristics

Age (years,mean±sd)	**Sex** (n; male:female)	**Body mass index** (mean±sd ;kg/m^{-2})
51.47±19.37	38:21	25.0 ±5.00

Males constituted a larger proportion; 64.4% compared with 35.5 % for females. The average BMI was 25. Obese patients constituted 5 % and overweight patients about 25 %. The population sample was skewed towards normal people. The morbidly obese and even obese were not represented and these were the very people who may have required supplementary oxygen.

ASA grading

Represented in Table 2 below is the ASA (American Society of Anaesthesiologists) grading and patient position after the spinal anaesthetic. The majority were ASA II constituting 42% and none were ASA IV patients. The patients were placed in supine, lateral and lithotomy position with the majority of patients, 45.8 %, in supine position.

Table 2: ASA classification and patient positions

ASA class	**Percentage**
I	30.5
II	42.4
III	27.1
Patient position during surgery	**Percentage**
Supine	45.8
Lateral	39.0
Lithotomy	15.2

Height of block

About 8.5 % of the participants had a block of T4 level which is high as compared to 33.9 % who had T10 height of block. Only 1 patient required oxygen supplementation.

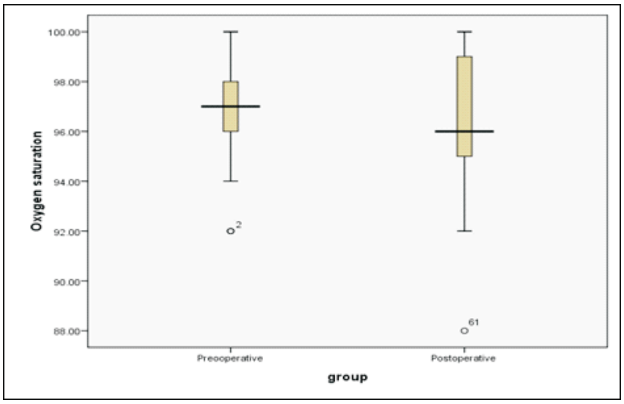
Table 3: Height of block and number of patients who required supplementary oxygen

Height of block (assessed using ice)	Percentage
T4	8.5
T6	23.7
T7	10.2
T8	23.7
T10	33.9
Patients needing supplementary oxygen(%;n)	1.7; 1

Mean baseline oxygen saturation and mean oxygen saturation during spinal anaesthetic

Fig 2 represents the mean base line oxygen saturation and the mean oxygen saturation during the spinal anaesthetic. Also presented are the 2 outliers .These are a mean base line preoperative oxygen saturation of 92% and a mean oxygen saturation during spinal anaesthesia of 87%.The differences between the two means is not statistically significant (p=0.89) at 95% significance level.

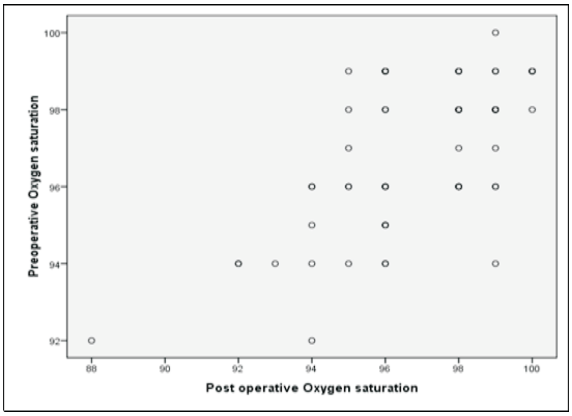
Fig 2: *Box and whisker plot showing the mean baseline oxygen saturation and the mean oxygen saturation during the spinal anaesthetic.*



Mean baseline oxygen saturation and mean oxygen saturation during spinal anaesthetic

Repesented in Fig 3 is a scatter plot to assess the relationship between the mean baseline oxygen saturation and the mean oxygen saturation during the spinal anaesthetic. There is a positive correlation between the mean pre and post-operative saturation with r = 0.635.This suggests that a patient's base line oxygen saturation had a bearing on the patient's mean oxygen saturation during the spinal anaesthetic. Therefore, the lower the patient's base line oxygen saturation was, the more likely that the patient was going to have a much lower oxygen saturation during the spinal anaesthetic. The relationship is statistically significant at both 95% and 99% level of testing (P<0.01).

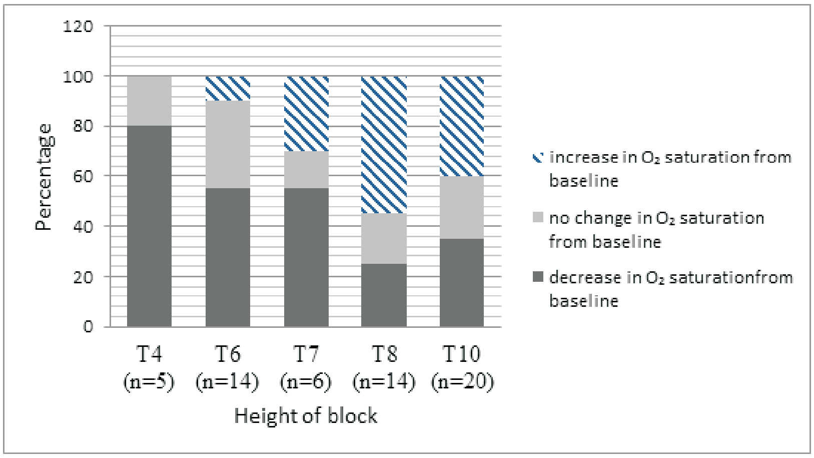
Fig 3: The relationship between the mean baseline oxygen saturation and the mean oxygen saturation during the spinal anaesthetic.



Height of block and saturation change

Figure 4 below demonstrates the relationship between the height of block and saturation change. The study findings show that there is a relationship between oxygen desaturation and increasing height of block. The higher the level of block, the greater the decrease in the patient's saturation from the baseline oxygen saturation to the mean oxygen saturation during spinal anaesthesia and vice versa. For example, in this study about 80% of patients with height of block T4 had post subarachnoid block decrease in oxygen saturation from the baseline as opposed to about 40 % of patients with height of block T10. One patient out of the total had a postoperative saturation of 87%, translating to incidence of hypoxaemia of 1.69 % and this was a male patient.

Figure 4: Relationship between height of spinal block and change in saturation



DISCUSSION

This study showed an incidence of intraoperative hypoxemia under spinal anaesthesia of 1.69% amongst the studied group. This incidence is low when compared to other studies in literature. A study conducted by Murthy *et al* to investigate factors influencing oxygen desaturation during spinal anaesthesia in 50 patients found a 16% incidence of hypoxemia of 16 %.[1] In their study patients were premedicated with diazepam 0.1mgkg^{-1} before the spinal anaesthetic was performed. Munoz *et al* in their study done to determine the effects of benzodiazepine premedication on hypoxemia during spinal anaesthesia in elderly patients, showed an incidence of hypoxemia of 42 % and 15 % for those premedicated with midazolam and for controls respectively.[34]

A study done by Siriussawakul *et al* in Thailand to investigate the effects of supplemental oxygen on maternal and neonatal oxygenation in obstetrics had an incidence of desaturation of 7.4 % in the group that was assigned to breathe room air.[37] They however attributed most of this desaturation to intraoperative hypotension and the rest to sedative use. The Thai Anaesthesia Incident Monitoring Study of desaturation which analysed 1,996 incidents, had an incidence of desaturation of 4% amongst patients who received regional anaesthesia.[38]

The rather low incidence of hypoxemia found in this study could be related to the fact that the patients in the other studies were premedicated with benzodiazepines. It was demonstrated in earlier studies that oxygen desaturation is associated with sedation during spinal anaesthesia. A combination of sedation and a high block predispose to a higher degree of desaturation.[1] The mechanism is thought to be through the de-afferentation phenomenon that occurs with loss of facilitatory input to the reticular activating system. This sensitizes the patients to the action of sedatives.[1, 35, 36] The control group in the study by Munoz et al to determine the effect of benzodiazepines on hypoxaemia in elderly patients had a higher incidence of hypoxemia of 15% in the unpremedicated group.[34] The differences could be due to the predominantly elderly population in their study group. A greater intrathecal spread of local anaesthetic has been observed in extremes of age which is thought to be related to age related changes in spinal anatomy and cardiopulmonary function.[10]

The study by Siriussawakul *et al* had a higher incidence of 7.4% and was done in obstetric patients. Additionally, they used a higher saturation of 94 % below which was defined as desaturation. The physiological changes that accompany pregnancy affect the volume of the local anaesthetic used and the physical spread of the intrathecal drug.[4, 10] The changes in lumbar lordosis[39], the decrease in the density and volume of CSF in pregnancy increase the spread of local anaesthetic in pregnancy.[10] The use of a higher saturation value to define hypoxaemia and the use of obstetric patients who are prone to have higher blocks in their study also might explain why my study had a lower incidence of hypoxaemia as compared to the obstetric study.

Even though only one patient desaturated to less than 90%, the study results also demonstrate a relationship between a high level of block and desaturation during spinal anaesthesia. It has been shown in previous studies that there is a significant negative correlation between lowest saturation and height of block and the reasons are attributed to intercostal muscle paralysis with changes in ventilator function[1] The positive correlation between preoperative and postoperative oxygen saturation shown from my study (r=0,6) suggests that the patients' initial saturation might have a bearing on the drop in saturation that occurs after spinal anaesthesia.

Despite overwhelming evidence and protocols for oxygen use, there continue to be use of oxygen in patients who are not hypoxemic.[8, 30] There are various conditions which contraindicate oxygen use or which necessitate permissive hypoxemia. Uncontrolled oxygen use in patients who rely on the hypoxemic drive for their ventilation may precipitate or worsen hypercapnic respiratory failure.[28, 30] This includes conditions such as COPD, motor neurone disease and obesity-hypoventilation amongst others. There has also been changes in oxygen use in neonatal resuscitation protocols.[32] Studies on oxygen use in certain patient populations such as obstetrics or ASA IV patients may be difficult in our setting as the ethical bodies are also fixated on routine oxygen use and any deviation from this is deemed unethical. It is therefore imperative that an intervention needs to be carried out on oxygen use so that evidence based and laboratory based practice that has been demonstrated are put into clinical practice.

The cost of oxygen is an important factor to be considered. The cost of one unit of oxygen (equivalent to 1 minute) is USD0.50 at Parirenyatwa group of hospitals. For an average procedure taking an hour, this amounts to USD 30.00.Considering that at Parirenyatwa, the obstetric and non-obstetric spinal blocks constituted 75 % and 10 % respectively of the total anaesthetics done in 2012, the potential cost saved is very significant and such funds can be put to good use to better the health delivery service to our patients.[40] Avoiding unnecessary oxygen therapy saves oxygen and reduces the cost to both the patient and hospital. The necessity to save oxygen is further increased against a background where the hospital has in the past had critically low oxygen levels. The effect is quite significant in remote settings where oxygen cylinders are in use .In such centres, unnecessary oxygen use saves oxygen and helps to preserve stores for more deserving patients and emergencies ,but with pulse oximetry being a major monitor in such practice.

STUDY LIMITATIONS

There were no ASA IV patients in the study to evaluate the objective in less clinically stable patients. The ethical bodies have concern on the study including ASA IV patients and obstetrics patients despite current evidence suggesting that they do not need routine oxygen supplements.

The sample size was too small to make inference to the rest of the population.

CONCLUSION

The low incidence of hypoxemia from this study suggests that healthy ASA I-III patients do not routinely desaturate when they have surgery under spinal anaesthesia. The result however applies to ASA I to III patients in the study group and may not be representative of all groups of patients. The decision to give oxygen therapy should not therefore be empirical but should be based on the anaesthetist's assessment of each individual patient. A high level of block is associated with a greater decrease in saturation from base line, therefore it is important to monitor such patients closely and give supplementary oxygen promptly if required. It is therefore important to incorporate this recommendation into anaesthetic practice in our current setting.

RECOMMENDATIONS

Some patients can be safely managed without routine oxygen supplementation during surgery under spinal anaesthesia. Use of pulse oximetry is integral in choosing which patient receives supplementary oxygen or not. A study with a larger sample size and better patient stratification would be recommended. An intervention to increase awareness to practioners and regulatory bodies on the benefits of not routinely supplementing oxygen to patients is recommended. Protocols for the use of oxygen in our setting need to be put in place

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