Effect of dexmedetomidine premedication on the intraocular pressure changes after succinylcholine and intubation

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Background. Succinylcholine is still recommended for some situations in open globe injuries. However, the use of succinylcholine is associated with an increase in intraocular pressure (IOP). This may be deleterious in open globe injuries. No method has previously been shown to abolish completely this rise in the IOP. We investigated whether dexmedetomidine, an alpha-2 agonist, could attenuate this increase in the IOP after succinylcholine and intubation.

Methods. Forty patients with no pre-existing eye disease undergoing general anaesthesia were randomly premedicated by i.v. dexmedetomidine 0.6 μg kg⁻¹, or saline. Heart rate (HR), mean arterial pressure (MAP), and IOP (using Schioetz tonometer) were measured before, after the premedication, after thiopental, after succinylcholine, immediately after intubation, and then every 2 min for 6 min.

Results. Succinylcholine and intubation increased IOP in both groups. However, in the dexmedetomidine group, the IOP rise was not different from the baseline value (P = 0.65) and was significantly lower than in the saline group (P = 0.003). After intubation, the MAP in the control group was higher than that in the dexmedetomidine group (P = 0.041) and exceeded the baseline value (P < 0.001). The HR also showed less fluctuation in the dexmedetomidine group than in the saline group.

Conclusions. We conclude that dexmedetomidine could be a beneficial premedication in open globe injuries.

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Anaesthesia for patients with open globe injury who need emergency surgical intervention may be hazardous. When the eye globe is open, any factor that increases the intraocular pressure (IOP) may possibly cause drainage of the aqueous humour or extrusion of the vitreous humour through the wound, which can permanently damage vision.1

Succinylcholine is used to facilitate rapid tracheal intubation in high-risk patients for aspiration because of its fast onset time and excellent intubating conditions.12 It is, however, associated with an increase in the IOP.3 4 Laryngoscopy and tracheal intubation further aggravate the rise in IOP.15 Various methods have been used to attenuate the effects of succinylcholine on IOP. They included self-taming, where a small dose of succinylcholine is given initially followed by the remaining amount of succinylcholine, and pretreatment with non-depolarizing neuromuscular blocking agents, lidocaine, narcotics, nifedipine, and nitroglycerin.3 However, no modality was devoid of drawbacks and limitations.

Dexmedetomidine is a highly selective alpha-2 adrenergic agonist that has sedative and analgesic effects.6 7 Alpha-2 agonists provide potentially beneficial effects in ophthalmic surgery because of their IOP lowering properties.8 9 The aim of this study is to investigate the effects of dexmedetomidine premedication on the IOP changes after succinylcholine and endotracheal intubation.

Methods

After the local research committee approval and written informed patient consent, 40 adult patients of ASA I or II,
undergoing elective non-ophthalmic surgeries under
general anaesthesia, were included in the study. Patients
were excluded if they were older than 60 yr, had a body
weight more than 150% of their ideal body weight using
Broca’s index, had acute or chronic eye disease, had any
contraindication to the study drugs, or were receiving any
medication known to alter IOP. Patients were randomly
allocated using an online research randomizer (http://www.
randomizer.org) into two equal groups (20 patients each)
to receive either single bolus i.v. dose of dexmedetomidine
as premedication (dexmedetomidine group) or saline
(control group). Surgery was performed early in the
morning to avoid diurnal variations in IOP. No other seda-
tive premedication was given to patients.

Standard intraoperative monitoring including three-lead
ECG, plethysmographic pulse oximeter, capnometry, and
non-invasive arterial pressure was performed (Datex-
Ohmeda S/5, ADU, Sweden). IOP was measured with a
Schioetz tonometer by an ophthalmologist who was
unaware of the anaesthetic technique. For this procedure,
topical oxybuprocaine hydrochloride 0.4% (BNX) was
applied to the cornea before measurement.

Dexmedetomidine (Precedex®, Abbott Laboratories)
was prepared by diluting 1 ml of dexmedetomidine 100
μg ml⁻¹ with 49 ml of normal saline to a concentration of
2 μg ml⁻¹. Syringes containing aqueous solutions of either
dexmedetomidine or saline were prepared in a double-
blind fashion by a team member who was not involved in
data recording. Before induction of anaesthesia, a single
dose of dexmedetomidine 0.6 μg kg⁻¹ was administered
i.v. using a syringe pump (Life Care 5000 Infusion
System, Abbot, Ireland) over 10 min. The same amount of
saline was given to the patients in the control group using
the same pump.

Anaesthesia was standardized in all patients. After pre-
oxxygenation for 3 min, anaesthesia was induced with thio-
pental 5 mg kg⁻¹ and fentanyl 1 μg kg⁻¹. Succinylcholine
was then administered at a dose of 1.5 mg kg⁻¹. When the
fasciculations had ceased, the trachea was intubated under
direct vision laryngoscopy and the correct position of

Table 1 Patient characteristics (n=20 each). Data are mean (range) or mean
(sd); HR, heart rate; MAP, mean arterial pressure; IOP, intraocular pressure

<table>
<thead>
<tr>
<th></th>
<th>Control group</th>
<th>Dexmedetomidine group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>29.3 (19–44)</td>
<td>28.3 (21–49)</td>
<td>0.76</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>168.9 (5.5)</td>
<td>166.3 (5.9)</td>
<td>0.17</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>71.7 (14.0)</td>
<td>72.6 (9.5)</td>
<td>0.82</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>15/5</td>
<td>12/8</td>
<td>0.50</td>
</tr>
<tr>
<td>Preoperative HR (beat min⁻¹)</td>
<td>74.4 (13.2)</td>
<td>73.0 (8.8)</td>
<td>0.70</td>
</tr>
<tr>
<td>Preoperative MAP (mm Hg)</td>
<td>92.4 (11.5)</td>
<td>89.9 (13.0)</td>
<td>0.52</td>
</tr>
<tr>
<td>Preoperative IOP (mm Hg)</td>
<td>13.2 (3.0)</td>
<td>12.7 (1.7)</td>
<td>0.48</td>
</tr>
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Fig 1 Changes in HR, MAP, and IOP in the control and dexmedetomidine
groups. Measurements were recorded before premedication (T1), 10 min
after premedication (T2), 30 s after thiopental (T3), 30 s after
succinylcholine (T4), after intubation (T5), and 2, 4, and 6 min after
intubation (T6–8). Vertical bars denote 0.95 confidence intervals.
*Significance difference in comparison with T1. #Significant difference
between the dexmedetomidine and the control groups.

the tracheal tube was verified by auscultation of the chest
and by capnometry. If the trachea could not be intubated
at the first attempt with direct laryngoscopy, the patient
was excluded from the study. Rocuronium 0.6 mg kg\(^{-1}\) provided the intraoperative neuromuscular block. The lung was ventilated to maintain the end-tidal carbon dioxide partial pressure between 4.3 and 4.6 kPa. Anaesthesia was maintained in both groups with sevoflurane in a mixture of oxygen and air. Fluid administration of lactated Ringer solution was standardized at 4 ml kg\(^{-1}\) h\(^{-1}\). If hypotension (MAP\(\leq\)30% from the baseline) or bradycardia (HR\(<40\) beat min\(^{-1}\)) occurred, it was recorded and managed according to the preference of the attending anaesthetist.

Mean arterial pressure (MAP), heart rate (HR), and IOP were recorded at the following time points:
- T1: 5 min after arrival to the operating room, before premedication (baseline).
- T2: 10 min after premedication.
- T3: 30 s after thiopental.
- T4: 30 s after succinylcholine.
- T5: immediately after intubation.
- T6–8: every 2 min for 6 min after intubation.

**Statistical analysis**

Sample size was selected to detect a mean IOP difference of 30% between the two groups with type I error of 0.05 and type II error of 0.20. Power analysis was based on a pilot study of 10 patients which showed an average increase in IOP after succinylcholine and intubation of 6 mm Hg (with an sd of the highest IOP of 5.7 mm Hg). Data were tested for normal distribution using the Kolmogorov–Smirnov test. Differences between the groups in the demographic data and baseline values were analysed using unpaired \(t\)-test except for gender which was analysed using Fisher’s exact test. For comparison of different observations within and between the groups, data were first analysed by repeated measures analysis of variance, and differences were then calculated by post hoc testing (Newman–Keuls test). Analysis was performed using Statistica software version 6.0 for windows (Statsoft, Inc.). Data were presented as mean (sd) in the text and in Table 1, and as mean (95% confidence intervals) in Figure 1.

**Results**

There were no significant differences between the two groups with regard to age, weight, height, and gender. There were also no significant differences at baseline HR, MAP, and IOP (Table 1).

The values of HR, MAP, and IOP are shown in Figure 1. No significant differences in HR between the two groups were recorded at any time. However, in the control group, the HR increased significantly after injection of thiopental, succinylcholine, and intubation. These increases in HR were not observed in the dexmedetomidine group. The MAP increased significantly compared with the preoperative value after intubation in the control group and was significantly higher than the MAP in the dexmedetomidine group (\(P=0.041\)). In the dexmedetomidine group, the MAP was not significantly higher than the preoperative value at all times. No incidence of hypotension or bradycardia requiring intervention was reported in both groups.

There was no significant difference in the baseline IOP between both groups. After dexmedetomidine injection, there was a significant decrease in IOP, compared with baseline (\(P=0.017\)). Thiopental decreased IOP significantly in both groups (\(P<0.001\)). Succinylcholine and intubation increased IOP in both groups. However, IOP in the dexmedetomidine group after intubation was not significantly different from that at baseline (\(P=0.65\), unlike that in the control group (\(P<0.001\)).

**Discussion**

The main finding in this study was that dexmedetomidine premedication in a dose of 0.6 \(\mu\)g kg\(^{-1}\) over 10 min blunted the rise in the IOP caused by succinylcholine and intubation. In addition, dexmedetomidine attenuated the haemodynamic response to laryngoscopy and intubation.

The intraocular hypotensive effect of dexmedetomidine in the present study is consistent with previous several researches on alpha-2 agonists. Clonidine was effective in preventing the rise of the IOP in response to succinylcholine and tracheal intubation.10–12 Dexmedetomidine infusion as an adjunct to local analgesia in ophthalmic surgery was effective in reduction of the IOP significantly.13 The drug was also found to reduce the IOP by 34% after a single i.v. dose of dexmedetomidine 0.6 \(\mu\)g kg\(^{-1}\).9 Similar effects were shown in elderly patients during cataract surgery.14 15 On the contrary, when Lee and colleagues16 infused dexmedetomidine as a supplement to isoflurane anaesthesia, they found no IOP lowering effect. However, the loading dose of dexmedetomidine used in their study was lower than that in the present study. No previous study examined the effect of dexmedetomidine on the succinylcholine-induced ocular hypertension.

The effect of dexmedetomidine on the IOP may be caused by a direct vasoconstrictor effect on the afferent blood vessels of the ciliary body, which results in reduction of aqueous humour production.17 Moreover, it could increase outflow of the aqueous humour caused by a reduction of the sympathetically mediated vasomotor tone of the ocular drainage system.18 Additionally, its associated haemodynamic response could contribute to the IOP lowering effect.19

In the present study, HR and MAP increased significantly after intubation in the control group. On the
contrary, in patients who received dexmedetomidine pre-
medication, this response was attenuated. Several previous
studies have reported the blunting effect of dexmedeto-
didine on this sympathetic response to laryngoscopy and
intubation.8 9 20 21 This could be due to the centrally
mediated sympatholytic effects of alpha-2 agonists and by
its decreased norepinephrine release via peripheral pre-
synaptic alpha-2 receptors.22 23
The dose of dexmedetomidine premedication adminis-
tered in the present study (0.6 µg kg⁻¹) was based on a
previous clinical study,9 where the selected dose resulted in
a significant reduction in IOP and prevented the rise in
the IOP in response to intubation. In addition, the pressor
response to laryngoscopy and endotracheal intubation was
also significantly attenuated. Higher doses of dexmedeto-
didine were associated with an additional reduction in the
arterial pressure and HR without any further decrease in
the IOP.14 15
Some authors find that the use of succinylcholine in
open ocular trauma is controversial and an alternative
anaesthetic management based on the use of non-
depolarizing neuromuscular blocking agents, despite its
slower onset, was suggested.1 Various methods have been
tried to speed up this onset, including priming,24 adminis-
tering the non-depolarizing relaxant before the induction
agent,1 and high-dose regimen.25 Despite these strategies,
non-depolarizing neuromuscular blocking agents can still
result in non-ideal intubation conditions: increases in the
IOP from mask application and longer time with insecure
airway and prolonged paralysis.1 Although sugammadex
may overcome the prolonged effects of large doses of
rocuronium or vecuronium, the drug is not launched yet
for routine clinical use.26 Despite this debate about the use
of succinylcholine in open globe injury, most authors still
agree on its use in difficult airway cases with salvageable
eye situations.1
A limitation of this study is that the effect of dexmedeto-
didine on the IOP changes after succinylcholine and
intubation cannot be isolated from its action on the haemo-
dynamics since both effects are parallel and a causal
relationship cannot be denied. However, this limitation
should not decline the potential advantage of using dex-
medetomidine as an alternative agent to obtund the IOP
changes of succinylcholine and intubation.
We conclude that the rise of IOP with succinylcholine and
endotracheal intubation can be blunted with i.v. dex-
medetomidine premedication. The haemodynamic stability
is an additional advantage.

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