An experimental model of oculorespiratory reflex

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Abstract

An experimental study of the oculorespiratory reflex (ORR) was conducted on 20 albino rabbits using a square wave (SW) type of stimulus. The ORR could be elicited in 100% of animals. The medial rectus was observed to be most reflexogenic for ORR. The frequency and pattern of ORR was not affected by bilateral vagotomy, intravenous atropine or glycopyrrolate, but could be completely abolished by retrobulbar block.

The oculorespiratory reflex (ORR), which manifests as slowing of respiratory rate and/or respiratory rhythm changes due to pressure or manipulation of the eye, was first described by Aschner¹ in rabbits. It was later elicited by evoking pressure on human eyes.² Since then little attention has been paid to it till a recent article in which Blanc *et al*³ reported that ORR is a frequent and potentially dangerous occurrence

Table 1 Patterns of oculorespiratory reflex

Pattern of oculorespiratory reflex	No. of rabbits	%
1 Slowing of respiration only	6	30
2 Apnoea followed by irregular respiration	7	35
3 Irregular respiration followed by rapid shallow breathing	7	35
Total	20	100

during extraocular muscle traction. Therefore the present experimental work was planned to study the different aspects of occurrence and prevention of the ORR.

Material and methods

Experiments were carried out on 20 albino rabbits of either sex weighing between 1 and 2 kg. Overnight fasting rabbits were anaesthetised with intravenous pentobarbitone (40 mg/kg body weight). Tracheostomy was performed for endotracheal intubation. The vagi were separated in the cervical region. The femoral vein of one side was cannulated for intermittent injection of anaesthetic and infusion of drugs. Respiration was recorded from a tracheal cannula by a transducer on Polyrite (Inco). The electrocardiogram was recorded by needle electrodes.

All four rectus muscles – medial (MR), lateral (LR), superior (SR), and inferior (IR) were exposed by a gently performed peritomy and a silk suture loop was passed under each muscle. A silk suture with wire hooks on both ends was passed over a pulley fixed on a stand. One hook was engaged in the silk suture loop under the muscle tendon and on the other weights were attached.

In each rabbit, after taking the basal recording of respiration and ECG, traction with a 150 g weight was applied by a square wave (SW) type of stimulus (acute traction sustained for a minimal period of 20 seconds followed by acute release) to medial rectus and changes in heart and respiratory rate as well as rhythm were recorded. The procedure was repeated for lateral, superior, and inferior recti after a pause of 3 minutes. For further study the 20 rabbits were divided into four groups of five rabbits each. In group I, after taking the basal recordings, bilateral vagotomy was performed in the cervical region and its effects on ORR were elicited by a SW stimulus to the medial rectus only. Similarly effects of intravenous atropine (15 µg/kg body weight), intravenous glycopyrrolate (7.5 µg/kg body weight), and retrobulbar block (after 10 minutes of injection of 2 ml of 2% xylocaine) were elicited in rabbits in groups II, III, and IV, respectively.

A fall in respiratory rate of 10% or more and/or respiratory rhythm changes and/or development of shallow respiratory movements during muscle

Figure 1 Basal record of respiration and electrocardiograph.

Figure 2 Positive ORR. Pattern I: slowing of respiration.

Figure 3 Positive ORR. Pattern II: apnoea followed by irregular respiration.

Figure 4 Positive ORR. Pattern III: irregular respiration followed by rapid shallow breathing.

traction was the criterion considered for positive ORR.³

Results

All 20 animals (100%) exhibited positive ORR on extraocular muscle traction. The frequency of ORR on stretching lateral, superior, and inferior rectus muscles was identical (90% each), while the medial rectus was observed to be more sensitive (100%). As shown in Table 1 three different patterns of ORR were observed in this experimental study. Slowing of respiratory rate was observed in six (30%), apnoea followed by irregular respiration in seven (35%) and irregular respiration followed by rapid shallow breathing in seven (35%) animals. The basal recordings and the three patterns of ORR observed are shown in Figs 1 to 4. Occurrence of ORR was observed in 100% of animals after vagotomy and intravenous atropine as well as glycopyrrolate; while none of the animals demonstrated positive ORR after retrobulbar block (Table 2).

Discussion

The SW stimulus was chosen in the present experimental model as it is considered highly reflexogenic.⁴ The oculorespiratory reflex could

be elicited in all the animals studied. Our results are similar to those of Blanc *et al*³ who noted ORR in 100% of the cases studied using an SW traction of 200–250 g lasting for 10–15 seconds. Joffe and Gay⁵ also observed ORR in all the cases by uniocular or binocular manual pressure on the eyeball.

In the present study the medial rectus was observed to be most sensitive, as 100% of the muscles on stretching demonstrated positive ORR in comparison to 90% each with LR, SR, and IR. In the available literature we could find no study relating the incidence of ORR with the muscle stretched. However higher sensitivity of the MR as regards occurrence of oculocardiac reflex (OCR) is well documented in the literature.^{6,7}

We have observed three different patterns of ORR (Table 2, Figs 2 to 4). Blanc *et al*³ reported slowing of respiration, and/or shallow respiratory movements in each patient and apnoea of 20 seconds duration in only one patient. Joffe and Gay⁵ noticed expiratory pause by uniocular or binocular manual pressure and apnoea, and respiratory arrhythmia occasionally leading to irregular respiratory arrest by intraorbital and intracranial stimulation.

In the present study no effect of vagotomy, atropine, or glycopyrrolate was seen on the ORR, which could be completely abolished by retrobulbar block (Table 2). Delva⁸ also could not prevent ORR after bilateral vagotomy and section of the spinal cord at the level of the seventh cervical vertebra (phrenic nerve intact) on dogs. Patizetakis² noted a similar response and reported that atropine does not change the incidence of ORR. However Delva⁸ like Joffe and Gay⁵ demonstrated that atropine enhances the ORR. In the available literature we could trace no study on the effects of glycopyrrolate and retrobulbar block on ORR. Our observations clearly reflect that the efferent pathway of ORR must be different from that of OCR, as the latter could be abolished by vagotomy,⁸ intravenous atropine,⁴ and glycopyrrolate.⁹ Therefore it seems that OCR and ORR are not interrelated but are independent of each other. However Blanc *et al*³ have reported a high incidence of OCR in patients with hypoxia. Hence it is tempting to speculate that ORR by producing hypoxia might be increasing the incidence of OCR.

The results of the present study fully corroborate the views of Blanc *et al*³ that ORR is a frequent and potentially dangerous occurrence during extraocular muscle traction. However this reflex is not widely recognised by ophthalmologists or anaesthesiologists. This phenomenon may not be recognised in the centres where

Table 2 Frequency of oculorespiratory reflex before and after treatment in different groups

Group	Total no. of rabbits	Rabbits with positive ORR (%)	
		Before treatment	After treatment
Group I (vagotomy)	5	5 (100)	5 (100)
Group II (atropine)	5	5 (100)	5 (100)
Group III (glycopyrrolate)	5	5 (100)	5 (100)
Group IV (retrobulbar block)	5	5 (100)	0

squint patients are anaesthetised with controlled ventilation. Many anaesthetists may still be using spontaneous respiration. ORR is often ignored by the anaesthetist who responds by introducing assisted or controlled ventilation so that the significance of the reflex is overlooked.

These significant results in the rabbit may suggest a similar phenomenon in the human patient and would strengthen the case for further research. There is little evidence of patients having suffered a fall in oxygen saturation or a rise in carbon dioxide for a sufficient period to have clinical significance. There may be a case for encouraging controlled ventilation during squint surgery.³ The results of the present study in preventing ORR with retrobulbar injection are in close agreement with those of Mandelblatt *et al*,⁷ who have recommended its routine use to block the OCR in all cases of local or general ophthalmic surgery, and also agrees with the results of Kirsch *et al*.¹⁰

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