Intraocular pressure changes in patients undergoing cataract extraction and lens implantation: laryngeal mask airway versus endotracheal tube

Motiang M J, MBChB, MMed
Dr George Mukhari Hospital and University of Limpopo (Medunsa campus), Department of Anaesthesiology and Intensive Care
Rantloane J L A, MBChB, MMed
Steve Biko Academic Hospital and University of Pretoria, Department of Anaesthesiology

Correspondence to: mammie@telkomsa.net

SAJAA 2009; 15(2): 23-27

ABSTRACT

Objectives: To investigate the influence on intraocular pressure (IOP) of airway management with a laryngeal mask airway (LMA) or tracheal tube (ETT), and secondly to compare the devices with regard to their impact on IOP.

Design: Prospective, randomized observational study over a four-month period (August – November 2002)

Setting: University-affiliated tertiary level hospital in Pretoria, South Africa

Subjects: Forty ASA I and II adult patients undergoing unilateral cataract extraction and lens implantation under general anaesthesia

Outcome measures: Changes in intraocular pressure after placement of airway device

Methods: Following a standard anaesthetic induction with propofol and atracurium, airway management was randomized to LMA or ETT.
IOP was measured pre-induction, 3 min post induction but before airway manipulation, 20 sec post LMA or ETT insertion and finally 2 min post airway instrumentation.

Results: There was a small increase in mean IOP in the LMA group, which was statistically insignificant. However there was a significant rise in mean IOP in the ETT group ($p = 0.0001$) which returned to almost pre-insertion levels at 2 minutes.

Conclusions: The LMA causes minimal changes in intraocular pressure when used to secure the airway during cataract surgery. The rise in IOP following tracheal intubation is significant, yet transient and probably clinically insignificant.

Introduction

Cataract surgery with lens implantation is one of the most commonly performed elective operations in the elderly. The surgery, under general anaesthesia, has conventionally required endotracheal intubation. The stress response to intubation, which entails laryngoscopy, is associated with a rise in intra-ocular pressure mainly due to increased ocular blood flow.[1] Increased sympathetic activity has also been postulated in the mechanism of IOP increase.Adrenergic stimulation causes vasoconstriction and leads to acute increase in IOP,by increasing the resistance to the outflow of aqueous humour in the trabecular meshwork between the anterior chamber and Schlem's canal.[2]

Tracheal intubation is also associated with hypertension and tachycardia as well as straining, coughing and breath holding.[3,4]

The laryngeal mask airway (LMA) has seen increasing application in patients undergoing cataract extraction and lens implantation. This is the result of a desire to minimize the rise in IOP because there is minimal laryngo-tracheal stimulation associated with LMA placement.The LMA offers many advantages, e.g. the insertion technique is easily learnt; it can be inserted without the use of a neuromuscular blocking agent and it is rarely associated with trauma to the larynx or pharynx. Other potential benefits are shortened overall operating theatre time and less coughing during emergence from anaesthesia.[5,6]

A rise in IOP is preferably avoided during eye surgery as the control of intraocular contents is of paramount concern. Surgical access to the lens is most commonly via the anterior chamber and it is inevitable for some aqueous humour to be lost through the incision. If at this time the IOP is increased, the intraocular contents are forced towards the incision. The iris,lens or vitreous may prolapse either immediately or when the surgeon attempts to move the lens.Another complication may arise in patients with impaired perfusion of the optic nerve as a result of a pre-existing raised intraocular pressure.In this setting, a further rise in IOP during anaesthesia may result in loss of visual field and acuity, with eventual blindness.[7]

This study aimed to assess the influence on intraocular pressure of placement of the airway devices under investigation, and to compare the devices regarding their impact on IOP following a standard anaesthetic induction.

METHODS

Following ethics approval and informed written consent, forty ASA I and II adult patients were recruited into the study. They ranged in age from 40-90 years, had normal intraocular pressure

and were scheduled for unilateral cataract extraction under general anaesthesia.
Patients presenting with the following conditions were excluded from selection.

- Glaucoma
- Diabetes mellitus
- severe respiratory disease
- uncontrolled hypertension
- known allergy to any of the drugs to be used
- Mallampati Class III and IV airway assessment score.

The patients were randomized to two groups of twenty patients each. In the LMA group, the airway was secured with a Laryngeal Mask Airway, while the ETT group represented patients in whom the airway was secured with a tracheal tube.
Premedication was standardized to Hydroxyzine 1mg/kg orally 2hours preoperatively.

Anaesthesia was induced with Propofol titrated to loss of eyelash reflex and this was followed by an intubating dose of Atracurium (0.6mg/kg). Tracheal intubation or LMA placement proceeded three minutes thereafter. A peripheral nerve stimulator was used to monitor the degree of muscle relaxation. Anaesthesia was maintained with isoflurane and a 67% nitrous oxide in oxygen mixture. Ventilation of the lungs was controlled on volume control mode and adjusted to maintain $EtCO_2$ at 32 - 35mmH$_g$. Monitoring consisted of continuous three lead electrocardiography, non-invasive blood pressure, pulse oximetry, capnography and peripheral nerve stimulator. A Schiotz tonometer was used to measure IOP after instillation of one drop of 0,4% benoxinate, in the non-operated eye pre-induction.

Repeat measurements were undertaken 3 min post induction but before airway manipulation, 20sec after LMA or ETT insertion and 2 min after placement of the airway device. Haemodynamic parameters including heart rate and systolic blood pressure were recorded simultaneously with the IOP measurements. No patients were excluded subsequent to recruitment.

Statistics

Changes in IOP, systolic blood pressure (SBP) and heart rate were compared within each group as well as between groups before airway instrumentation and alternately at 20sec and 2 min post airway device insertion. The two groups were compared using a two sample students t-test. A p-value < 0.05 was considered statistically significant.

Results

There was no significant difference in demographic characteristics, ASA class or duration of anaesthesia between the two groups. Our results show a small increase in IOP in the LMA group at 20sec, which was statistically insignificant (p = 0.4296). However, there was a significant rise in IOP at 20sec following ETT placement (p = 0.0001). Also, the difference between the groups was statistically significant (p < 0.001).

The study also demonstrates a significant increase in SBP at 20s (p < 0.05) in the ETT group, but mean heart rate changes were not significantly different from baseline.

From the table below it can be seen that in the LMA group the IOP *increased* by 0.44 for the period spanning pre-insertion to 20s post-insertion.This is a statistically insignificant change (p = 0.430).

In the ETT group, there was an *increase* of 5.35 from pre-insertion to 20 s, which was statistically significant (p < 0.001).

When comparing the groups for change in IOP,the difference was significant (p<0.001).

Figure 1: Mean values for Intraocular Pressure over time for both groups.

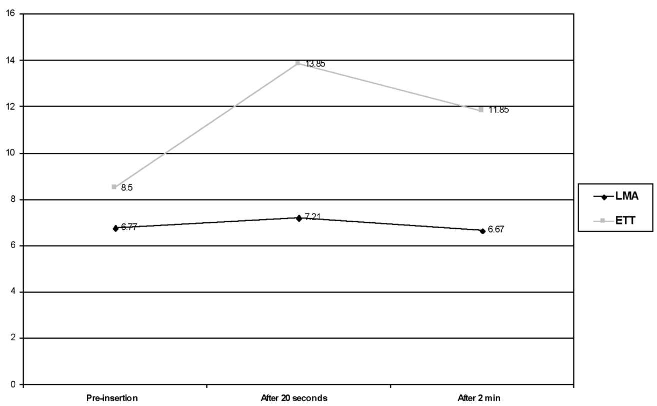


Table 1: Intraocular pressure: (mmhg)

	Pre-insertion P1	***20 s P2***	***2 Min P3***	***Change P1→P2***	***P Value***	***Change P1→P3***	***p-Value***
LMA							
N	20	20	20	20		20	
Mean	6.77	7.21	6.67	0.44	0.430	-0.10	0.792
SD2.03	3.30	2.40	2.41		1.67		
ETT							
N	20	20	20	20		20	
Mean	8.50	3.85	11.85	5.35	< 0.001	3.35	< 0.001
SD	3.88	4.47	4.34	2.70		3.53	
LMA vs ETT P - Value					< 0.001		< 0.001

Table 2: Systolic blood pressure mmHg (SBP)

	Pre-insertion P1	*20 s P2*	*2 Min P3*	*Change P1→P2*	*P Value*	*Change P1→P3*	*p-Value*
LMA							
N	20	20	20	20		20	
Mean	121.30	117.65	113.30	-3.65	0.617	-8.00	0.246
SD	29.00	22.61	19.95	32.07		29.91	
ETT							
N	20	20	20	20		20	
Mean	121.55	144.65	131.90	23.10	0.032	10.35	0.099
SD	20.45	30.50	24.23	30.64		26.58	
LMA vs ETT P - Value					0.010		< 0.05

There was a *decrease* of –3.65 in the mean SBP in the LMA group, which was statistically insignificant (p = 0.617). However, in the ETT group there was an *increase* of 23.10 which was statistically significant ($p < 0.05$).

When compared for changes in systolic blood pressure,the difference between the groups was significant ($p < 0.05$).

Discussion:

The goal of anaesthesia for intraocular surgery is two-fold.It entails firstly ensuring an immobile field to facilitate the fine surgical manipulations and secondly to prevent excessive increases in intraocular pressure which may result in bleeding complications or the unplanned extrusion of intraocular contents.[8] In patients with long-standing increases in intraocular pressure additional operative increases in ocular pressure may further compromise perfusion of the optic nerve, with resultant impairment or loss of vision in that eye.

Figure 2: Mean values for Systolic Blood Pressure over time for both groups.

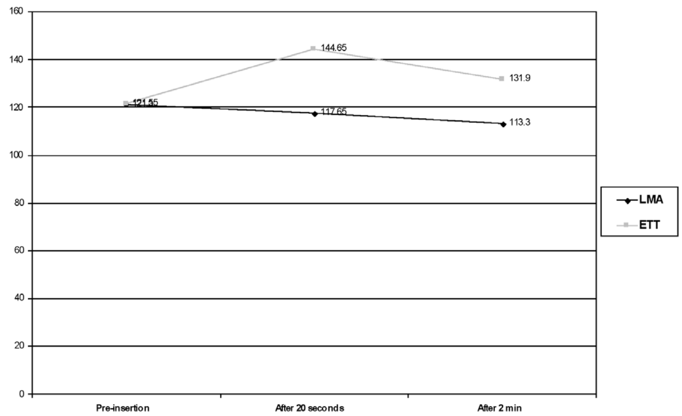
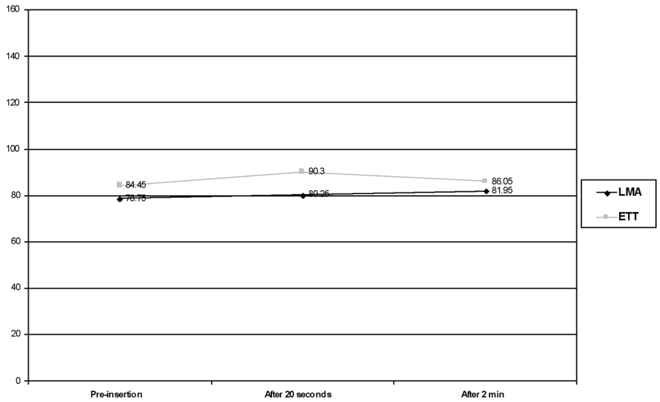


Table 3: Heart Rate (HR) b/min

	Pre-insertion HR1	*20 s HR2*	*2 Min P3*	*Change HR1→HR2*	*P Value*	*Change HR1→HR3*	*p-Value*
LMA							
N	20	20	20	20		20	
Mean	78.75	80.25	81.95	1.50	0.555	3.20	0.276
SD	16.36	18.40	18.82	11.16		12.76	
ETT							
N	20	20	20	20		20	
Mean	84.48	90.30	86.05	5.85	0.225	1.60	0.726
SD	18.38	30.50	13.96	20.86		20.08	
LMA vs ETT P - Value					0.418		>0.05

The heart rate *increase* for both the LMA and ETT groups was statistically insignificant. The difference between the two groups was also insignificant.

Figure 3: Mean values for Heart Rate over time for both groups



The surgical approach to cataract extraction has commonly been via an incision in the anterior chamber, a procedure that is not associated with significant pain. Newer techniques of phaco-emulsion require even smaller incisions, as the lens no longer has to be delivered whole. The requirement for anaesthesia is therefore minimal and most patients can now have their surgery under local anaesthesia with or without sedation.

However, there remains a cohort of patients who for personal or surgical reasons will require a general anaesthetic. This is particularly true of paediatric patients, needle-phobic patients, patients not competent to provide informed consent for the local technique or as a result of patient or surgeon's preferences.[9] Airway management during general anaesthesia for cataract extraction and lens implantation has traditionally been accomplished with a tracheal tube.The drawback of this approach is that tracheal intubation is associated with a significant stress response and undesirable increases in systemic blood pressure and heart rate as well as potentially catastrophic local ocular effects. The laryngeal mask airway has emerged as a suitable alternative to the tracheal tube especially in peripheral surgical procedures such as ocular surgery. The impact of LMA insertion on ocular pressure has been investigated before, and in comparative studies with the tracheal tube been shown to cause an insignificant rise in intraocular pressure.

Important also in the control of intraocular pressure rise is the anaesthetic regimen employed. Propofol and atracurium are individually associated with a reduction in IOP. We postulated that use of a LMA in combination with this regimen should result in little or no change in IOP. Our study confirms this, as do the results of Barclay et al, who in addition reported an attenuation of IOP increase following tracheal intubation.[10] Similar conclusions were drawn by Whitford et al. who reported a statistically insignificant decrease in IOP at 20s following insertion of an LMA, compared to a marked increase in IOP following tracheal intubation.[1] Our findings are also in agreement with those of Gulati et al. They compared the LMA with tracheal intubation in children undergoing ophthalmic procedures, and found an insignificant rise in mean IOP after LMA placement, but a significant increase in IOP following tracheal tube placement.[9]

Murphy et al studied the effect of atracurium on intraocular pressure by comparing it with pancuronium in a randomized controlled trial. In their study atracurium decreased intraocular pressure to a statistically greater degree than pancuronium, but they concluded that the stress of laryngoscopy and intubation led to a significant rise in IOP despite the use of atracurium.[8]

In another study comparing the LMA and tracheal intubation under propofol anaesthesia, Akthar *et. al.* concluded that the LMA does not appear to offer any advantage over tracheal intubation in the control of IOP but is associated with a significant decrease in the incidence of postoperative coughing, straining, breath-holding and sore throat.[11]

They reasoned that the attenuated increase in IOP following tracheal intubation could be explained by previous evidence that propofol caused a 30% decline in IOP from baseline and further that whereas the stimulus of tracheal intubation increased IOP, the resultant increase was still below the baseline.[12 13]

Their findings are at odds with ours regarding the impact of tracheal intubation on intraocular pressure,and the differences are most likely the result of the conduct of anaesthesia. Whereas we gave only an induction dose of propofol,they started an infusion at induction and maintained this throughout the anaesthetic.

Recently, Watts and colleagues reported the findings of their study into the impact on IOP of LMA placement in children. General anaesthesia was induced with either intravenous propofol or inhaled sevoflurane in oxygen and then maintained with 2% to 4% sevoflurane in oxygen and air. Remifentanil was used in some patients. No muscle relaxant was administered. They found a statistically significant rise in IOP in both groups (i.e. regardless of the induction regime) and postulated that the use of atracurium may have altered any change induced by LMA insertion in previous studies.[14]

Our study conditions were carefully controlled to ensure that factors other than insertion of the airway device were not responsible for changes in IOP. Thus, neuromuscular blocking agents were used in both groups, even though not required for LMA placement. Care was also taken not to exert pressure on the eye with the face mask in the period preceding placement of the selected airway device.

No difficulty was encountered in the placement of either device and respiratory parameters were satisfactory in all subjects.

LMA insertion is associated with minimal haemodynamic perturbations. Its placement does not require a laryngoscope, although introduction of the device and inflation of the cuff stimulates and exerts pressure on the anterior pharyngeal wall. This is almost certainly the mechanism by which the increases in blood pressure and pulse rate occur. The transient nature of the response suggests that it is not due to the continuous pressure exerted by the sealing cuff.[15]

Three of our study patients in the LMA group had a significant increase in IOP and SBP at 20 sec whereas there was a significant increase in all patients in the ETT group. Both these groups had an associated insignificant change in heart rate and this is in agreement with studies by Wilson.[16 17] Previous research has found no significant difference in the pressor response to insertion of either the LMA or tracheal tube, although Braude and colleagues reported an attenuated increase in systolic blood pressure in the tracheal tube group. [15 18]

Our study shows a gradual and sustained decrease of about 7% from the mean in the LMA group during the study period. The ETT group on the other hand, showed an initial sharp increase in mean SBP, peaking at 16% of baseline at 20 sec post-insertion and then declining to within 8% of baseline at 2 min. This is in keeping with the known haemodynamic impact associated with placement of these devices and further confirms that placement of the tracheal tube has a transient and unsustained ocular and haemodynamic effect.

Although the mean heart rate changes were not significantly different between groups in this study we can assume that it would have remained elevated beyond 2 minutes in the intubation group due to a continued effect caused by the tracheal tube.[19 20]

Although the LMA has been used successfully for head and neck surgery, there remains the possibility that it may be displaced during surgery with subsequent difficulty in maintaining a clear airway. None of the study patients suffered this complication.

A modification of the LMA with an armoured tube to maintain patency has been described for use in otolaryngological and dental anaesthesia, and it may also be useful in ophthalmic anaesthesia. Other advantages of the LMA over the tracheal tube include less chance of injury to surrounding structures, smooth recovery and reduced post operative oropharyngeal discomfort.[21]

Our study confirms the findings of previous studies in showing a transient but significant rise in IOP following tracheal intubation, which did not have immediate clinical implications for surgical outcome. However, increases in IOP may be clinically significant in patients with glaucoma because of the possible risk of loss of visual field and acuity.

In conclusion, our study confirms the superiority of the LMA over the tracheal tube as an airway management device during cataract surgery under general anaesthesia. SAJAA

Acknowledgements

The authors would like to thank Dr S Sebiloane, Prof H S Schoeman and Dr D R Bhagwandass for their contribution to the study.

References:

1. Whitford AM, Hone SW. Intraocular pressure changes following laryngeal mask airway insertion: Comparative study. *Anaesthesia 1997 Aug;52(8):794 - 6*
2. Ghai B, Sharma A. Comparative evaluation of intraocular pressure changes subsequent to insertion of laryngeal mask airway and endotracheal tube. *Journal of Postgraduate Medicine 2001;47(3):181 - 4*
3. Lamb K, James MFM. The laryngeal mask airway for intraocular surgery:effects on intraocular pressure and stress responses. *Br J Anaesth 1992;69:143 - 7*
4. Stone DJ,Gal TJ. Airway management In: Miller R.D (ed). Anesthesia 5th Ed. Philadelphia:Churchill Livingstone:1414 - 51
5. Hickey S, Cameron A.E. Cardiovascular response to insertion of Brain's laryngeal mask. *Anaesthesia 1990;45:629 - 33*
6. Brimacombe J, Berry A.The laryngeal mask and intraocular surgery. *Anaesthesia 1993;48:827*
7. Holloway K.B. Control of the eye during general anaesthesia for intraocular surgery. *Br J Anaesth 1980;52:671 - 9*
8. Murphy DF, Eustace P. Atracurium and intraocular pressure. *British Journal of Ophthalmology 1985;69:673 - 5*
9. Gulati M, Mohta M. Comparison of laryngeal mask airway with tracheal tube for ophthalmic surgery in paediatric patients. *Anaesthesia and Intensive Care 2004;32(3):383 - 9*
10. Barclay K, Wall T. Intraocular pressure changes in patients with glaucoma. Comparison between laryngeal mask airway and tracheal tube. *Anaesthesia 1994;49:159 - 62*
11. Akhtar TM, McMurray P. A comparison of laryngeal mask airway and tracheal tube for intraocular ophthalmic surgery. *Anaesthesia 1992;47:668 - 71*
12. Mirakhur R.K, Shepherd W.F. Intraocular pressure changes during rapid sequence induction of anaesthesia. Comparison of propofol and thiopentone in combination with vecuronium. *Br J Anaesth 1988;60:379 - 83*
13. Guedes Y, Rakoteseheno JC. Changes in intraocular pressure in the elderly during anaesthesia with propofol. *Anaesthesia 1988;43:58 - 60*
14. Watts P, Lim KM. The effect of laryngeal mask airway insertion on intraocular pressure measurement in children receiving general anaesthesia. *Am J Ophthalmol 2007;Oct 1444(4):507 - 10*
15. Braude N, Clements EAF. The pressor response and laryngeal mask insertion- A comparison with tracheal intubation. *Anaesthesia 1989;44:551 - 4*
16. Wilson IG, Fell D. Cardiovascular response to insertion of laryngeal mask. *Anaesthesia 1992;47:300 - 2*
17. Derbyshire A, Chmielewski. Plasma catecholamine responses to tracheal intubation. *Br J Anaesth 1983;55:855 - 9*
18. Griffin RM, Dodd P. Cardiovascular responses to insertion of the Brain laryngeal mask. *Br J Anaesth 1989;63:624 - 5*
19. Watcha MF, White P. Comparative effects of laryngeal mask airway and endotracheal tube insertion on intraocular pressure in children. *Anesth Analg 1992;75:355 - 60*
20. Holden R, Morsman D. Intraocular pressure changes using the laryngeal mask airway and tracheal tube. *Anaesthesia 1991;46:922 - 4*
21. Brain AIJ. The laryngeal mask – a new concept in airway management. *Br J Anaesth 1983;55:801 - 4*