

## WORLD VIEW

## Ketamine anaesthesia for paediatric ophthalmology surgery

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**Aims:** Children with treatable, vision impairing conditions may not have access to surgical care when they live in regions where anaesthesia is unavailable. The use of ketamine anaesthesia in a developing region was studied to determine its safety and effectiveness.

**Methods:** This is a consecutive series of 679 children who had a variety of paediatric eye disorders necessitating a short general anaesthesia. Ketamine was administered intravenously by a paediatrician with training in paediatric resuscitation procedures. Both intraocular and extraocular procedures were performed. The location of treatment was the Tilganga Eye Hospital in Kathmandu, Nepal, a developing region of the world. The study took place over a 5 year period.

**Results:** All procedures were performed without any anaesthetic complications. No child required unanticipated resuscitation or laryngeal intubation. Postoperative dysphoria occurred occasionally and was difficult to measure quantitatively. This side effect of ketamine resolved by the first postoperative day.

**Conclusion:** Ketamine is an effective agent for both intraocular and extraocular surgery in the paediatric age group. None of the children in this series needed resuscitation or intubations, and the ophthalmic surgery was carried out safely. Ketamine can be used safely in any ophthalmic procedure of short duration by a person having some training in anaesthetic resuscitation procedures. Because of its simplicity and safety, ketamine may be useful in a simple ophthalmic setup in the developing world.

No one can argue about the devastating effects of a child's blindness on family and society. Although paediatric blindness is less common than acquired adult blindness, children who are blind experience a lifetime of severe disability and a shortened life expectancy. Recognising this, the World Health Organization (WHO) targeted blinding paediatric eye diseases in its 2020 eradication of blindness programme.<sup>1</sup>

Many cases of paediatric blindness are preventable, given an effective public health programme. Conditions such as trachoma, vitamin A deficiency, and measles could be eliminated with better vaccination, sanitation, and nutrition. Other conditions such as paediatric cataract, glaucoma, and retinopathy of prematurity can be treated, but treatment can only occur in a setting where analgesia and immobility during surgery are possible. Volatile anaesthetics and short acting agents such as barbiturates, widely used in the developed world, may not be safe or practical in the developing world. Volatile agents need sophisticated hospital and safety procedures, while short acting agents frequently suppress respiratory and cardiac effort. The ideal agent for developing regions of the world should not suppress respiratory effort, must be easy to administer, and should be inexpensive.

Ketamine is a phencyclidine derivative used for general anaesthesia in short surgical procedures. It is partially water soluble with high liquid solubility, 5–10 times that of thiopental. It is metabolised by hepatic microsomal enzymes to nor-ketamine and hydroxylated to form hydroxy-nor-ketamine and excreted in the urine.<sup>2</sup> Ketamine causes a dissociative anaesthesia with profound analgesia and crosses the blood-brain barrier rapidly, increasing cerebral blood flow and intracranial pressure.<sup>3</sup> Ketamine increases heart rate, cardiac output, and blood pressure, but relaxes bronchial smooth muscles.<sup>4</sup>

And ketamine has a wide range of uses. It may be used as the sole anaesthetic agent for short term procedures, and for induction and maintenance of anaesthesia in high risk

patients with respiratory and cardiac disorders and shock. Adverse effects include an increase in lacrimation and salivation, dilation of pupil, increase in intraocular pressure, nausea and vomiting.<sup>3</sup> None of these side effects is life threatening. The dissociative experiences associated with ketamine (hallucinations) are often not unpleasant, and last only a short time.<sup>5</sup>

Many of ketamine's pharmacological properties make it potentially useful in regions where it is difficult to deliver adequate general anaesthesia to children. We used it during a 5 year period in a developing region of the world, to determine its safety and effectiveness.

## METHODS

Ketamine has been the anaesthetic agent for paediatric ophthalmic surgery at the Tilganga Eye Center in Kathmandu, Nepal, for the past 5 years. The total number of children operated during this time was 679, ranging in age from 3 months to 18 years old. Table 1 lists the procedure and numbers. Surgery included extraocular procedures (chalazion, removal of foreign body, squint correction, correction of entropion, ptosis) and intraocular procedures (cataract extraction with intraocular lens implantation, capsulotomy, goniotomy, and cornea transplant). Time to perform these procedures ranged from 2 minutes to 1 hour. All procedures were performed by skilled surgeons, thereby minimising the length of time of surgery. Anaesthesia was always administered by a person trained in paediatric airway management and resuscitation.

## Screening for anaesthetic purpose

All children undergoing an operation using general anaesthesia were screened for any systemic or local infection, and for signs or symptoms of cardiopulmonary disease that could interfere with safe anaesthesia. Children were asked to fast for at least 6 hours. In older children, psychological preparation was included, to attempt to minimise fear of undergoing surgery.

**Table 1** Paediatric ophthalmology surgical procedures at the Tilganga Eye Hospital

Procedure	Number
Cataract extraction w/without IOL	240
Secondary IOL	15
Corneal transplantation	74
Strabismus	25
Post-capsulotomy	33
Glaucoma	32
Trauma, corneal laceration	27
Lacrimal probing	10
Others	223
Total	679

### Premedication

After assuring compliance with preoperative protocols, children were given oral atropine at a dose of 0.04 mg/kg, 20–30 minutes before anaesthesia. The aim of this intervention was to reduce salivation, thereby reducing chances of aspiration.

### Preparation in the preoperative area

All the necessary drugs for anaesthesia and resuscitation were made ready beforehand, including oxygen cylinder, laryngoscope, endotracheal tube of appropriate size, masks, and ambu bag.

### Dose

Intravenous ketamine, 0.5–2 mg/kg bolus; infusion, 10–50 µg/kg/min; maintenance, half to the induction dose as needed; intramuscularly, 3–10 mg/kg

### Anaesthetic procedure

Once the necessary arrangements were made, children were taken to the operating theatre where an intravenous line was positioned. Anaesthesia was induced with ketamine at the dose of 1–2 mg/kg, given slowly over 20–30 seconds. Half of the induction dose was given as needed throughout the course of surgery for maintenance. In children over 2 years of age, diazepam at a dose of 0.2 mg/kg was administered intravenously to reduce post-anaesthetic side effects.

In addition to ketamine, local anaesthesia (retrobulbar or parabolbar lignocaine 2%) was also administered especially for cataract surgery, followed by ocular massage for a few minutes. This supplemental local anaesthesia could be given safely after the patient received ketamine. The patient's vital signs were monitored in the usual way, including a pulse oximeter.

### Postoperative period

After surgery, the child was taken to the recovery room with the intravenous line in place. The child was kept in the left lateral position until regaining consciousness fully, and then he was handed over to his or her parents.

### RESULTS

A total of 679 children were operated and there were no serious side effects from ketamine. No child required intubation, and no resuscitations were necessary.

### DISCUSSION

The ideal paediatric anaesthetic agent in the developing world has a rapid onset, rapid offset, and ease of administration. Its duration of action must be long enough to allow completion of contemplated surgical procedures. The agent should not cause significant respiratory or cardiac suppression, but should offer

immobilisation of the patient and good analgesia. The anaesthetic should also be inexpensive. Ketamine offers these various qualities.

Administration of ketamine for paediatric ophthalmology has been studied in a number of settings, for a variety of conditions.<sup>6–9</sup> At least one survey on the use of ketamine in developing regions has been published.<sup>10</sup> The authors of this report found only one ketamine related death in over 12 000 administrations in developing regions of the world. The series of patients was not limited to children, and included a variety of short, non-ophthalmic procedures. In a large number of cases in this report, no trained anaesthetist was present. We are aware of one randomised, controlled study of ketamine, where ketamine was found to be as effective and safe as other anaesthetics in the developing world. In this report, ketamine was used for gynaecological procedures.<sup>11</sup>

Of the non-volatile agents ketamine may be the closest to being a “complete” anaesthetic, since it induces analgesia, amnesia, and unconsciousness.<sup>3</sup> Ketamine is a potent bronchodilator, making it a good induction agent for asthmatic patients. And in contrast with the depression of reticular activating system induced by barbiturates, ketamine functionally “dissociates” the thalamus (which relays sensory impulses from the reticular activating system to the cerebral cortex) from the limbic cortex (which is involved with the awareness of sensation). While some brain neurons are inhibited, others are tonically excited. Clinically, this state of dissociative anaesthesia causes the patient to appear conscious but unable to process or respond to sensory input.<sup>3</sup>

Besides being a powerful analgesic, ketamine is the only intravenous anaesthetic that routinely produces cardiovascular stimulation. The peak increase in these variables (heart rate, arterial blood pressure cardiac output) occurs 2–4 minutes after intravenous injection and then slowly declines to normal over the next 10–20 minutes.

In most patients ketamine decreases the respiratory rate slightly for 2–3 minutes. Upper airway reflexes are usually but not always active. Ketamine produces little change in other organ systems.<sup>2</sup>

Although it is a desirable anaesthetic in many respects, ketamine has been associated with disorientation, sensory and perceptual illusion, and vivid dreams following anaesthesia, effects that are termed “emergence phenomena.”<sup>12 13</sup> For children over 2 years of age, we routinely administer diazepam, 0.2–0.3 mg/kg intravenously 5 minutes before administration of ketamine, to reduce the incidence of these phenomena. This low dose of diazepam did not cause any additional problems for the children. In cases where cataract surgery was performed, we gave the children retrobulbar anaesthesia shortly after ketamine induction. The use of local anaesthesia in conjunction with ketamine seems to improve analgesia, and allows improved postoperative recovery.

In 5 years of experience with ketamine at the Tilganga Eye Hospital, none of the operated children needed resuscitation or intubation. All ophthalmic surgery was conducted safely. We used a simple pulse oximeter to monitor the patient's heart rate and arterial blood oxygen saturation intraoperatively.

Ketamine offers an additional advantage that is particularly useful in a developing world environment. It has a short recovery time, hence allowing quick turnover of patients. This means a great deal in a simple ophthalmic setup in the developing world, where space management and recovery room expenses must be minimised. Ketamine is also inexpensive.

First, and foremost, operating on children in the developing world must be safe. In this large collection of surgical experience using ketamine as the anaesthetic, we encountered no serious ill effects, but this does not mean that ketamine anaesthesia should be administered by untrained medical personnel. Just as it is important for the ophthalmic surgeon to have experience and training, so, too, must the anaesthetist. With appropriate personnel in place, surgical care of children with blinding eye diseases need not be avoided.

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