Ketamine monoanaesthesia for diagnostic muscle biopsy in neuromuscular disorders in infancy and childhood: Floppy Infant Syndrome

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The anaesthetic management of children with neuromuscular diseases giving rise to hypotonia is associated with a variety of problems. Ketamine alone was given by the intravenous or intramuscular route to 32 children with Floppy Infant Syndrome for diagnostic muscle biopsy. The patients aged between three months and 12 yr and weighing 3.2 to 28 kg were studied over three years (1986–1988). The special anaesthetic problems are discussed. The use of ketamine dissociative anaesthesia is reviewed with emphasis on congenital neuromuscular disorders.

Les enfants victimes de maladies neuromusculaires avec hypotonie posent une panoplie de problèmes à l'anesthésiste. Entre 1986 et 1988, nous avons utilisé seulement de la kétamine par voie intraveineuse ou intramusculaire lors de biopsies musculaires diagnostiques chez 32 enfants de trois mois à 12 ans, pesant de 3,2 à 28 kg et atteint du syndrome de flaccidité infantile. Nous discutons des problèmes rencontrés et revoyons la place de l'anesthésie à la kétamine surtout dans le cadre des maladies neuromusculaires congénitales.

Key words
ANAESTHESIA: paediatric;
ANAESTHETICS, INTRAVENOUS: ketamine;
SYNDROME: floppy infant.

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Floppy Infant Syndrome is a term used to describe infants who have weak and hypotonic muscles. The term is used because the limbs and head of the floppy infant hang limply "like a rag doll." The syndrome comprises a variety of disorders with varying prognosis.[1] They are classified under neuromuscular disorders and non-neuromuscular causes. Muscle biopsy is essential to determine that diagnosis and it is examined by electromyography, histopathology, histochemistry and electron microscopy.[2]

Floppy infants due to neuromuscular diseases are often born weak and hypotonic or have delayed motor milestones. Decreased resistance to passive movement leads to adoption of an abnormal posture such as the frog position. Diminished cough reflex, aspiration and recurrent chest infection are common. In severe cases, motor weakness involving the bulbar musculature may produce difficulty in swallowing and breathing.[3] In benign variants progressive weakness and wasting of the muscles leads to contractures and kyphoscoliosis.[4] Neuromuscular diseases giving rise to hypotonia in infancy are described according to the part of the motor unit affected.[3] They can be categorized as diseases of the anterior horn cell (spinal muscular atrophy), nerve (hereditary neuropathy), neuromuscular junction (congenital myasthenia gravis) and of muscle (cogenital myopathy, congenital muscular dystrophy). The anaesthetic management of these disorders is beset with complications.[5] In this paper we report the use of ketamine hydrochloride for muscle biopsy in the floppy infant syndrome due to a variety of neuromuscular disorders.

Methods

After institutional approval and informed parental consent, 32 children between the ages of three months and 12 yr undergoing muscle biopsy for histopathological diagnosis were studied. There were 20 male and 12 female floppy children with weights 3.2 to 28 kg. Children with clinical evidence of hypotonia due to

neuromuscular disease and benign congenital hypotonia in which muscle biopsy findings were expected to be normal were also included. Respiratory, cardiovascular and central nervous system status was assessed before anaesthesia. All patients received premedication with 0.2 $mg \cdot kg^{-1}$ diazepam IM 30 min before the procedure. Resuscitative equipment was available and anaesthesia was administered with ketamine hydrochloride IV or IM.

Group I

Eighteen children of both sexes and weight 10–25 kg received ketamine 2 $mg \cdot kg^{-1}$ by slow IV injection. When required, subsequent doses of 1 $mg \cdot kg^{-1}$ were given every ten minutes.

Group II

Fourteen infants of both sexes and weight less than 10 kg received 10 $mg \cdot kg^{-1}$ ketamine IM The onset of anaesthesia was within 30 sec after IV and three to five minutes after IM injection. After the onset of anaesthesia, surgical incision was made for muscle biopsy. The average time for the procedure was 20 min. The ECG was monitored throughout the procedure for heart rate. Blood pressure, respiration and temperature were monitored at regular ten-minute intervals for 40 min from the onset of anaesthesia. Patients were observed in the recovery ward for one hour after surgery.

Results

There were increases in heart rate and blood pressure after ketamine (Table I). The overall quality of anaesthesia in most cases was good. Two patients who had received IM ketamine showed restlessness with gross movements within 20 min after the start of the surgery which was due to inadequate anaesthesia (Table II). Almost half the patients showed increased oral secretions. Delayed recovery was observed in three patients who had received IM ketamine (Table III). None of the children developed convulsions during or after ketamine anaesthesia. Table IV shows the final diagnosis based on electromyography, histopathology, histochemistry and electronmicroscopy of muscle.

TABLE I Changes in heart rate and blood pressure after ketamine

Variable	*Control*	*Peak*	*Significance*
Heart rate ($beats \cdot min^{-1}$)	112.3 ± 1.7 (80–130)	129 ± 2.2 (94–142)	$P < 0.001$*
Systolic blood pressure (mmHg)	110.6 ± 1.7 (100–130)	133.1 ± 2.6 (110–170)	$P < 0.001$*

Mean ± SE and (range).
*Significantly higher than the mean control values.

TABLE II Quality of anaesthesia

Grades of anaesthesia	*n*
Good	
No movements	29 (90)
Fair	
Occasional but slight movements	1 (3)
Poor	
Gross movements with restlessness	2 (6)

TABLE III Unwanted effects seen with ketamine

Unwanted effects	*n*
Intraoperative	
Oral Secretions	15
Apnoeic episodes	2
Postoperative	
Increased oropharyngeal secretions	2
Involuntary movements	2
Involuntary movements with verbalizing	2
Vomiting	1
Delayed recovery	3

TABLE IV Diagnostic classification of floppy infant syndrome

Diagnosis	*n*
Congential muscular dystrophy	12
Spinal muscular atrophy	8
Benign congenital hypotonia	9
Congenital myasthenia gravis	1
Mitochondrial myopathy	1
Glycogen storage disease (Pompe's disease)	1
Total	32

Discussion

The anaesthetic management of children with hypotonia due to neuromuscular disorders is beset with a variety of problems. Serious complications and occasionally death may occur in patients with neuromuscular disorders following the use of muscle relaxants. The common complications are prolonged paralysis with non-depolarising muscle relaxants, hyperkalaemia, rigidity and malignant hyperthermia.[5] Cardiac arrest has been reported with succinylcholine.[6] The susceptibility for malignant hyperthermia in several myopathies restricts the use of halothane.[7,8] Regional analgesia has limitations in infants. Local infiltration at the biopsy site should be avoided because it can distort the biopsy specimen.[9]

The main objectives in the management of floppy infants with neuromuscular disorders was to provide

satisfactory surgical anaesthesia without respiratory depression, to avoid muscle relaxants and triggering agents to malignant hyperthermia and to minimize distortion of the biopsy specimen.

Rosen and Broadman have reported the anaesthetic management for diagnostic muscle biopsy in an infant with glycogen storage disease (Pompe's disease) who had hypertrophic cardiomyopathy.[9] They used three titrated low doses of IV ketamine (0.5 $mg \cdot kg^{-1}$ each) in conjunction with a modified femoral nerve block (inguinal paravascular block). It is of interest that in one of the patients in our series who had Pompe's disease with hypertrophic cardiomyopathy, the usual dose of IV ketamine (2 $mg \cdot kg^{-1}$) for anaesthesia did not result in any untoward effects. In the present study it was found that ketamine as a single anaesthetic agent produced satisfactory anaesthesia for performing muscle biopsy in the upper or the lower extremity. Ketamine may be the agent of choice as it is not associated with respiratory or cardiovascular depression, maintains muscle tone and helps in sustaining high PaO_2 by reducing the shunt fraction.[10] However, half of our patients showed increased oral secretions with ketamine administration. Premedication with an antisialagogue is desirable when patients are to be anaesthetised with ketamine. Atropine was not used in our cases as most showed an increased heart rate before anaesthesia. Oral premedication was avoided since most of the infants with neuromuscular weakness had difficulty in swallowing and aspiration. Premedication with diazepam 0.2 $mg \cdot kg^{-1}$ IM was preferred to IV injection to avoid respiratory depression, since most of the patients had compromised respiratory reserve.

In our series two patients had transient apnoeic episodes which were due to rapid IV administration of ketamine. These patients required respiratory assistance with an Ambu bag and face mask for two to three minutes. Intramuscular ketamine showed unpredictable action; two of our patients showed restlessness with gross movement and three patients had delayed recovery. Seizures have been reported with ketamine anaesthesia in clinical practice and in experimental animals.[11,12] In our series of 32 floppy infants and children we did not encounter seizures although three patients had had generalized seizures in the past. Premedication with diazepam might have been partly responsible for the non-occurence of seizures.

It can be concluded that ketamine monoanaesthesia is a useful anaesthetic agent to overcome the risk factors involved in anaesthetising patients with neuromuscular disorders of infancy. Early recovery and preservation of the cough reflex are necessary to reduce the pulmonary complications.

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