Original Article

Sedation of Children undergoing Magnetic Resonance Imaging in a Resource Poor Setting using low doses of Ketamine and Diazepam

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ABSTRACT

We aimed to describe the successful use of low doses of ketamine hydrochloride with diazepam premedication to sedate children with ages between 3days to five years who presented at three diagnostic centres in Port Harcourt Nigeria for magnetic resonance imaging (MRI) within a five-year period. This was done in an environment with no MRI compatible anaesthetic machine and monitoring was done by the anaesthetist within the suites. The average age of the children was ten months with a mean dose of 18mg of ketamine used. The mean duration of the procedures was 44.92 minutes and constant presence of the anaesthetist was required throughout the procedures for monitoring. Two incidences of self-limiting laryngospasm occurred with a safe outcome for all of the patients. Children can be satisfactorily sedated with low doses of ketamine for MRI in some less than ideal situations.

INTRODUCTION

Diagnostic imaging procedures have become regular activities in the Nigerian environment as a result of ease of access to radiological scanners[1]. The increasing prevalence of congenital diseases, hollow organ abnormalities and diseases of the central nervous system require access into the respective body systems to ease diagnosis and for therapeutic purposes[23]. Lower Tesla Magnetic resonance imaging (MRI) scanners are the traditionally closed MRI machines which are largely tubular and produce lots of noise. They are cheaper and are commonly available in West Africa. They produce good quality images but pose problems for claustrophobic patients. The need to ensure comfort and stillness in such patients necessitates the use of sedation for the duration of the procedure. In stable adults, such a procedure may be tolerable especially against the backdrop of the noise associated with the procedure. Adults or children who are unstable, would require some stillness for a satisfactory MRI session. Children are occasionally restive and often would not tolerate the procedure especially with the available noisy machines that abound in our environment. More sophisticated machines that are less noisy may not require anaesthesia to calm the paediatric age group but anaesthesia in the form of sedation is required to ensure some motionlessness to prevent motion artefacts. Most diagnostic procedures are done on outpatient basis. This requires proper assessment and fast-tracking of recovery of the patients for home readiness. Monitoring is vital in sedated children especially in the absence of MRI compatible anaesthetic machines. Similarly, the availability of resuscitation equipment such as suction machine, oxygen source, airway paraphernalia, medications for resuscitation, are necessary. The aim of this study was to assess the ease of sedating these children aged 3days to five years using low doses of ketamine after premedication with diazepam.

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METHODS

The local diagnostic centres ethical committees represented by the management approved this prospective study. Written informed consent for each procedure was obtained from the parents or accompanying guardian on the day of the procedure. Children with American Society of Anesthesiologists (ASA) physical classes 1 and 2, aged three days to five years who presented for MRI between May 2012 to December 2017 at Transview medical diagnostics 17b Igboukwu street, Intercontinental diagnostic centre and Image diagnostics, all in Port Harcourt, Nigeria and required sedation were consecutively sampled and enrolled for the study. Sample size determination was done using the Fischer formula[19] $n = Z^2pq/e2$ with allowance for non-response to arrive at a sample size of 60.All the cases were day cases and the pre sedation assessments were done on the same day, few minutes prior to the administration of the sedation. Children were asked to be fasted of solid meals for six hours and two hours for clear liquids prior to their presentation to the centre by telephone. Excluded were children who were recently fed, those with recent history of upper respiratory tract infections and those at risk of full stomach. The authors were solely responsible for the clinical assessment of the patients and the administration of the medications. All children had their baseline heart ratesand peripheral oxygen saturations (SpO2) recorded. Intravenous lines were established, and intravenous fluids commenced if fasted beyond two hours for clear fluids. Intravenous atropine at a dose of 0.02mg/kg was administered prior to the induction of sedation. For older children above two years, intravenous diazepam at a dose of 0.2mg/kg was administered as a premedicant. A Low dose of ketamine is defined as sub-anaesthetic doses using 0.5mg to 2mg/kg as induction doses as well as maintaining them with 0.5mg/kg for the duration of the procedures[5]. The authors accompanied the children with the guardian/ parents into the MRI suites and monitored the patients till the end of the procedure. The Ramsay sedation score was used to assess the degree of sedation and a preset target was 3 or 4. Top ups were administered when the score decreased towards 2. Monitoring was done by the anaesthetists in the suites with the patient. The pulse oximeter was available only at one of the centres whilea portable battery operated pulse oximeter was used for monitoring at the other centres.Home readiness for the patients was defined by their ability to maintain airway, cry, be active, and mobile. Instructions were given to the accompanying parents to closely monitor the child at home and to feed only when the child was fully awake and could tolerate feeds. They were also instructed to inform the authors if any complications such as vomiting, nausea or airway obstruction occurred. The telephone numbers of the parents were also accessible to the authors. Data were entered into Microsoft Excel ® version 2010 where it was coded and cleaned. Data analysis was conducted using ANALYSIS in the Epi-Info v7.02 and the Statistical Package for Social Sciences (SPSS) version 22. Categorical data were presented in the form of frequencies and percentages (%) and summary statistics in means and standard deviations (SD).

RESULTS

Sixty children were administered low doses of ketamine and successfully had MRI done with two children who had undeclared upper respiratory tract infection experiencing laryngospasm. Each incident was promptly relieved with administration of 1mg/kgintravenous lidocaine.

Table 1 Demographic and intra-procedural data

Total number of patients	60
M: F ratio	1.7: 1
Age (months)	15.01 ± 11.10
ASA 1	45(75%)
ASA 2	15(25%)
Weight (kg)	10.49 ± 3.41
Ramsay sedation score Median	3
Average dose of ketamine (mg)	18.46 ± 9.48
Duration of procedure (minutes)	44.92 ± 6.86

Table 2. Diagnosis and outcome of sedation

	Number	Percentage
Satisfactory outcome	58	96.67
Laryngospasm	2	3.33
Total	60	100

Table 3: Diagnosis of children requiring MRI

Diagnosis	Number	Percentage (%)
Seizure disorder	36	60.00
Exophthalmus	3	5.00
Delayed milestone	5	8.33
Meningitis	3	5.00
Cerebral palsy	1	1.67
Hydrocephalus	5	8.33
Post meningitis	2	3.33
Proptosis	1	1.67
Frontal encephalocoele	2	3.33
Autism	1	1.67
Cerebral malaria	1	1.67
Total	**60**	**100**

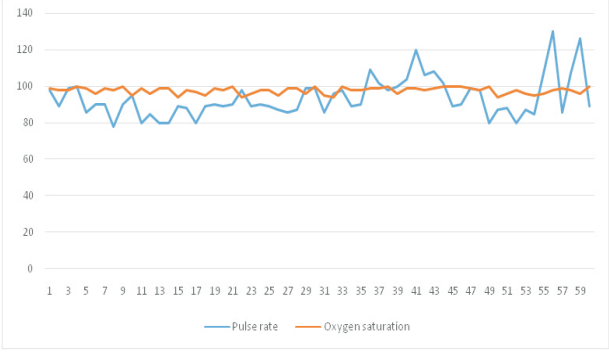

Figure 1; Pulse rate and oxygen saturation variability during the Procedure.

DISCUSSION

Sedation of sixty ASA 1 and 2 children aged between 3days and five years for MRI imaging was successfully done using low doses of ketamine with diazepam premedication over a period of five years. It is necessary to ensurethat the child is safe and calm during procures performed with the usually noisy and low Tesla MRI scanners that are predominant in most resource limited environments. Pharmacological agents that are easy to administer and with a wider safety margin for ambulatory services are necessary especially as MRI compatible anaesthetic machines to administer oxygen and inhalational agents with airway protection are often unavailable. Our study was done at private diagnostic centres which were the only places that provided MRI services for a population of over five million people in Rivers state and adjoining states at the time of the study. MRI services abound at both private and public health facilities in Nigeria. Ogbole et al [4] reported the associated limitations in accessing MRI services at private diagnostic facilities. Public health facilities offer greater advantages in terms of patronage because of the cost implications hence the differences in number between our study and the audits from government health facilities[5]. Arlachor and colleague had reported the difficulties that are associated with obtaining good quality images in children without sedation[3]. Cravero JP et al[6] in their review of paediatric sedation advocated that the skill for sedation is critical to ease the performance of diagnostic and therapeutic procedures in children. This emphasizes the necessity for trained manpower to undertake this arduous responsibility. While sedation and anaesthesia may be required in most instances, newer technologies and play-based calming techniques are evolving[7].In spite of the accruable benefits of these newer techniques, majority of children below six (6) years require sedation to minimize artefacts to obtain quality diagnostic images[7]. Studies from similar environments like our study centres have reported the successful use of medications like benzodiazepines[1], chloral hydrate[8,9], ketamine and propofol[10], dexmedetomidine and thiopental for paediatric sedation. The ease of access and ubiquitous use of ketamine hydrochloride in third world countries makes its use for such procedures imperative. The potency of ketamine for sedation in paediatric age group offers profound advantages especially in situations where airway compromises may be inevitable especially in confined MRI suites

without air way protection by way of a definitive air way. Ketamine stimulates the respiratory system and stabilizes the cardiovascular system to minimize complications. The authors have adequate experience with the use of ketamine for anaesthesia in children as old as one day and have found it very helpful when used for sedation. The World health organization recognises the importance of this medication by enlisting it as an essential drug[11]. And the controversies about the effects of anaesthetics on neurocognitive development of neonates excluded commonly used anaesthetics like ketamine [12,13] . At high doses of ketamine, adverse effects occur especially in children that are less than 2years [14]. The standard average dose of 2mg/kg was utilized in this study and for day old babies, the calculated doses were administered very slowly and at intermittent rates to effect calmness. The mandatory insertion of intravenous lines in all patients ensured the administration of multiple doses of ketamine until the end of the procedure. One of the drawbacks of ketamine administration was the often associated movement which is counterproductive in MRI, this is attenuated with the use of benzodiazepines in very active children. Low doses of diazepam were used by the authors only in older children, those whose ages were greater than 2years as premedicant. The usually observed post procedure hallucinations in adult was not experienced in our patients and it was observed by Green et al [14], that it is not common in children [15]. Sethi et al [17] premedicated his patients with midazolam, and then administered bolus doses of either ketamine 1mg/kg 0r propofol 1mg/kg in a comparative and randomised study comparing various doses of propofol for paediatric sedation. Satisfactory sedative results were obtained with the use of 50mcg/kg/min of propofol. In their study with propofol, it was evident that adequate monitoring with standard monitoring devices in addition to the presence of an anaesthetist was necessary. However, propofol alone does not ensure immobility and requires repeated dosing[10].Repeated dosing with propofol comes with the risk of respiratory compromise which is risky in very low birth weight babies and at environments without standard MRI compatible anaesthetic machines, ketamine suffices in such climes. The duration of the procedures in our study was about 39-49 minutes which correlates with a previous study.[1] During such periods, the authors accompanied the patients into the MRI suites to monitor them. Some MRI scanners have inbuilt pulse oximeters which display the heart rates on the monitor at the control room. This was available at one of the diagnostic centres but in all of the procedures, the authors accompanied the patients in company of one of the parents to augment sedation and for monitoring of the patients. Serafini et al[18] observed the need for mandatory standard monitors, in addition to the availability of resuscitation equipment. These are considered life saving devices which complement ambulatory procedures in addition to the presence of adults to accompany the patients home. Home readiness was accomplished following the full recovery of all the patients. It is worthy of note that the two incidences of laryngospasm that were recorded in this study were associated with children who presented with undeclared upper respiratory tract infection, but it was self-limiting in each case.

CONCLUSION

Children irrespective of their ages could be successfully sedated using low doses of ketamine for MRI and other diagnostic procedures in resource limited climes. Careful selection of the cases is required to avoid odd sequelae of events such as airway irritations.

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