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EFFICACY AND SAFETY OF GENERAL ANESTHESIA AND SEDATION FOR MAGNETIC RESONANCE IMAGING EXAMINATION IN CHILDREN

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Abstract:

Aim: *The purpose of this study was to evaluate the efficacy and safety of this sedation protocol and to emphasize that pediatric patients need an MRI kit with general anesthesia equipment.*

Place and Duration: *In the Pediatrics and radiology department of Jinnah Hospital Lahore for one-year duration from June 2019 to June 2020.*

Patients and Methods: *Nine hundred and twenty-five patients underwent Magnetic Resonance Imaging. Oral sedation was to be administered to children up to 5 years of age. Oral sedation consisted of oral administration of 90 mg / kg of lymphatic hydrate. All MRI orders for unsuccessful oral sedation and those referred for general anesthesia were reviewed by an anesthetist consultant, who then assigned patients to surgery under general anesthesia or intravenous sedation. Intravenous sedation consisted of either propofol 0.5 mg / kg bolus followed by infusion or midazolam 0.2-0.5 mg / kg. General anesthesia was performed with sevoflurane, and intravenous propofol was introduced.*

Results: *Five hundred and fifteen patients (57.15%) scans were done without sedation. On the other hand, 46 scans were performed during sessions supervised by a consultant anesthesiologist. Oral sedation was unsuccessful in 25 of 364 patients (6.9%). Eighty-seven percent of children 5 years of age and under required sedation compared with 4.5% of children aged 10 and over.*

Conclusion: *This study concluded the structured sedation protocol for MRI scanning as it is both effective and safe.*

Keywords: *measurement techniques, magnetic resonance imaging, anesthesia, pediatric sedation.*

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INTRODUCTION:

Magnetic resonance imaging (MRI) is an established radiograph for children. This examination requires children to remain still for a variable amount of time up to an hour in a magnetic, closed, claustrophobic and noisy environment, hence sedation is required in some patients. Patients 1 to 5 years of age and patients with mental retardation or developmental delay require sedation for most imaging procedures. Reassurance is also needed for older children who, despite being encouraged, are very anxious or scared. The line between sedation and anesthesia is blurred and is part of the continuum between full awake and anesthesia. In the UK, deep sedation is considered to be "light anesthesia" and good practice guidelines suggest that anesthesia should only be performed by or at least in the presence of an anesthetist. Due to the potential safety risks posed by the sedation protocol, planning, patient selection, proper monitoring, the use of appropriate equipment and adequate staff training should be of great importance. This high standard of practice is not always achieved, as research carried out in Scotland shows. Sedation protocols vary widely, have different organizational requirements, and affect costs. However, the optimal level of organization needed to offer a safe and efficient MRI sedation service that is cost effective is unclear, although recently there is an increasing need for a fully dedicated sedation team for MRI scanning. The Structured Sedation Protocol (SSP) was launched at our facility in January 2007 to raise the standards of patient selection, preparation, monitoring and treatment of children requiring MRI examinations. The purpose of this study was to evaluate the effectiveness and safety of this sedation program.

PATIENTS AND METHODS:

This study was held in the Pediatrics and radiology department of Jinnah Hospital Lahore for one-year duration from June 2019 to June 2020. All children who underwent MRI were included in the study. The MRI scanner suite has full anesthesia and monitoring equipment, and staff is manned by radiologists and one staff nurse. During this SSP, oral sedation was the mainstay of sedation and was expected to be used in most children 1-5 years of age. However, under 1-year old were to be properly wrapped and allowed to sleep, but if this failed a sedative was to be used. Patients ≥ 6 years of age were administered oral sedation only when the referring physician considered their level of cooperation insufficient. However, it was the attending physician in the ward and, to a lesser extent, the radiologist in the MRI room, in consultation with patients and parents, who made the final decision about who received oral sedation. All MRI applications for children who have not been adequately sedated after oral sedation and for those referred to an anesthesiologist who then assigned patients to undergo surgery under their supervision under general anesthesia or intravenous sedation. This decision was made on the basis of patient data such as age, type and length of examination, underlying medical condition, and the presence of any specific airway problems (eg, Mucopolysaccharidosis and Treacher-Collins syndrome, etc.). The consultant anesthesiologist underwent weekly, half-day sessions during which he was given intravenous sedation or general anesthesia. In all cases, informed consent was obtained from the parents. Patients requiring sedation or general anesthesia were admitted to the ward on a day-to-day basis for evaluation and general health assessment by the medical team. Patients not requiring sedation were transferred directly to the MRI scanner waiting room. An oral sedation protocol was made available to all departments and patients were fasted for at least 6 hours according to the hospital's policy for patients undergoing general anesthesia. Oral sedation (chloral hydrate) was given 30 minutes before the scan. Collaboration and flexibility between the ward and scanner staff ensure that patients are called as soon as sedation becomes effective. Patients received further sedation in the scanner waiting room next to a set of scanners if it was found that the sedative was insufficient. Those who failed to obtain sedation at this stage were referred for scans during sessions supervised by an anesthetist. The oral sedation protocol consisted of oral administration of chloral hydrate 90 mg / kg, 30 minutes prior to surgery. The intravenous sedation protocol included either a 0.2-0.5 mg / kg bolus midazolam alone or a 0.5 mg / kg bolus propofol followed by an infusion of up to 3 mg / kg / h. In the case of general anesthesia, post-induction laryngeal mask airway device by inhalation (sevoflurane) or intravenous (propofol). Anesthesia was continued with spontaneous ventilation with an air-oxygen mixture delivered through an Ayer tee. After oral sedation, monitoring was carried out by the staff nurse who accompanied the patients to the scanner room. Oxygen saturation and heart rate were monitored continuously from the time of sedation until the patient was fully awake. During the consultant anesthesiologist sessions, the staff nurse was always available to assist in monitoring patients who had received intravenous sedation or general anesthesia. An Operations Assistant was also available for all supervised sessions. Full patient monitoring was performed by the staff nurse, including electrocardiogram, oxygen saturation, pulse rate and non-invasive blood pressure measurement.

RESULTS:

A total of 925 patients (5 months to 16 years of age) were scanned during the study period. Twenty-four of these patients were from an intensive care unit with a secured airway (endotracheal intubation) and were not included in any further analysis. Of the remaining 901 children (502 boys and 399 girls), 57.4% did not require any sedation. Three hundred and eighty-five were successfully scanned using either oral / intravenous sedation or general anesthesia. Oral sedation was successful in 93% of the cases where it was used, while all patients who received intravenous sedation (27%) or general anesthesia (73%) during sessions under an anesthesiologist's supervision successfully completed MRI scans. Three hundred and thirty-five out of three hundred and eighty-five (87%) children 5 years of age or younger required some form of sedation, compared with only 4.5% of children ≥ 11 years of age. The only adverse effect occurred in the group of patients taking oral sedation. In this group, one patient had significant respiratory depression (respiratory rate <12 bpm and arterial oxygen saturation of ≤92%) requiring 12-18 hours of observation in hospital after scanning. One patient received only absorbent lubrication.

TABLE 1 shows the number of patients who underwent MRI scanning with or without the use of sedation according to age group. Values are numbers (%). Numbers in square brackets refer to patients who required intravenous sedation or general anesthesia because they failed oral sedation.

Sedation/Anesthesia	Age				
	< 1 year	1-5 years	6-10 years	≥11 years	Total
None	7 (7.4)	42(15.1)	172(80.2)	294(95.5)	515(57.4)
Oral sedation (Successful)	90(88.2)	202(76.5)	32(14.9)	4(1.4)	326(37.4)
Intravenous sedation	1(1)	5(1.6)	3(1.6)	3(1.1)	13(1.4)
[failed oral sedation]	[1]	[5]	[2]	[1]	[8]
General anesthesia	3(2.5)	18(6.7)	7(3.3)	6(1.9)	34(3.8)
[failed oral sedation]	[3]	[10]	[5]	[0]	[17]
Total	**102(100)**	**276(100)**	**215(100)**	**311(100)**	**904(100)**

DISCUSSION:

Computed tomography (CT) and magnetic resonance imaging are two of the most common procedures requiring sedation in children. It is widely accepted that effective sedation is essential for a successful MRI scan service, and an organized pediatric sedation program that is safe and effective has been recommended for all centers offering these services, but this is far from being achieved. With this in mind, we launched our SSP. There has been a growing need for a comprehensively organized and fully dedicated sedation team for MRI scanning. Hollman et al. Operated an organized pediatric sedation program with two sedation rooms and a pediatric sedation staff, including two registered nurses, a second-year resident of pediatrics, and a pediatric intensive care physician. Our program is not as extensive as their staff, though it has proven effective so far. The need for sedation not only depends on age, but is also influenced by the patient's neurodevelopmental maturity. Keeter et al. In a review of pediatric sedation practice for CT in the US reported that more than 80% of young children were sedated for CT. In our study, the need for sedation decreased with age, from 93% in those under 1 year of age to less than 5% in those aged 11 and over. Some infants have successfully undergone scans without sedation by being properly wrapped and allowed to sleep before and during surgery. Most of the MRI reports (57%) are for patients who do not need any sedation. It seems logical to improve the services we offer to this category of patients. Actions to increase the efficiency of MRI services include improving the information given to parents or children, as appropriate, creating a child-friendly environment, including play facilities, and increased coordination between the departments and the scanning department. We believe that the measures we have tried to improve can reduce patients' anxiety and possibly the need, as well as the amount of sedation, thus reducing the overall cost. Verification of MRI reports by an anesthesiologist for patients who failed oral sedation and who were referred for general anesthesia from the outset ensured competent and objective decisions about the type and appropriateness of sedation. In our hospital, MRI performed under general anesthesia costs Rs. 600-1000 more. Patients 1 to 5 years of age usually require sedation for most imaging procedures. The use of a structured sedation protocol could save between Rs. 24,000 to 40,000 during the study period as 40 children in the above age group were scanned without sedation. The choice of sedatives used varies greatly. Chloral hydrate is a predominantly used agent at our facility as there is general consensus that it has a wide margin of safety, although this practice may differ from that in the US. The dose used is variable, but is usually from 50 to 1001 mg / kg;

doses up to 125 mg.kg. The success rate of our oral sedation program was 93%. This compares favorably with reports in the literature where the primary sedative agent is chloral hydrate. No adverse critical incidents occurred in the group supervised by an anesthesiologist. However, one case of respiratory depression was reported in the oral sedation group, which gave a critical incident rate of 0.3% in this group. This incidence of adverse events is lower than other groups that use high doses of chloral hydrate as their primary sedative agent. Since one of the major concerns in any sedation program is safety, we can say that our program has achieved this goal. The use of a complex and dedicated sedation unit for MRI scanning is probably not advisable at present in our setup as it would not significantly reduce costs or improve patient safety. Morton and Oomen looked at the selection and monitoring of patients by developing a protocol to check the safety of staff before, during and after sedation. While they recommend staff adequately trained in pediatric resuscitation, monitoring techniques, and sedation techniques to monitor a sedated child, they have not looked specifically at the number of staff and who selects patients. It will be interesting to see the overall results (morbidity and success rate) in Morton and Oomen's ward once their protocol is established. We recommend using SSP for MRI scanning as it is effective, safe and efficient, as evidenced by our research. However, neither a pediatric sedation unit, as suggested by Lowrie et al. Nor a specialized pediatric sedation team, seems to be a prerequisite for the success of such a program.

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