

วิธีการระงับความรู้สึกและภาวะแทรกซ้อนทางวิสัญญีในผู้ป่วยเด็กที่มาเข้ารับ การตรวจคลื่นแม่เหล็กไฟฟ้า: การศึกษาแบบย้อนหลัง

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Anesthetic Technique and Complications Associated with Anesthesia in Pediatric Patients Undergoing Magnetic Resonance Imaging (MRI): A Retrospective Study

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บทนำและวัตถุประสงค์: ในการตรวจคลื่นแม่เหล็กไฟฟ้า ต้องอาศัยความร่วมมือของผู้ป่วยให้ขณะตรวจโดยเฉพาะ ในผู้ป่วยเด็ก วิธีการระงับความรู้สึกหลายวิธีช่วยให้เด็กนิ่งใน ขณะได้รับการตรวจ วัตถุประสงค์ของการศึกษาแบบย้อนหลัง ในครั้งนี้คือการบรรยายวิธีการระงับความรู้สึกที่ใช้และอุบัติ การณ์ภาวะแทรกซ้อนที่เกี่ยวข้องกับวิสัญญี

วิธีการศึกษา: เก็บข้อมูลแบบย้อนหลังในผู้ป่วยจำนวน 383 ราย อายุระหว่าง 0-6 ปี ที่ได้รับการตรวจคลื่นแม่เหล็กไฟฟ้า ระหว่างพฤษภาคม 2555-ธันวาคม 2556 ในโรงพยาบาล ศิริราชโดยเก็บข้อมูลลักษณะทั่วไปของผู้ป่วย การวินิจฉัย ตำแหน่งที่ทำการตรวจคลื่นแม่เหล็กไฟฟ้า เทคนิคทางวิสัญญี ที่ใช้ระยะเวลาในการตรวจ และภาวะแทรกซ้อน

ผลการศึกษา: ผู้ป่วยจำนวน 383 รายที่ได้รับการดูแลโดย วิสัญญี ไม่รวมผู้ป่วยที่ตรวจคลื่นแม่เหล็กไฟฟ้าบริเวณหัวใจ ร้อยละ 41.8 เป็นผู้ป่วยอายุ 0-12 เดือน ร้อยละ 93 เป็นผู้ป่วย ASA class 1-2 วิธีการระงับความรู้สึกที่ใช้มากที่สุดคือการ ให้ยาทางหลอดเลือดทำให้เกิดภาวะสงบร่วมกับยาดมสลบ แบบระเหยผ่านทางหน้ากากออกซิเจนให้ผู้ป่วยสูดหายใจเอง (ร้อยละ 53.3) ภาวะแทรกซ้อนที่พบบ่อยที่สุดคือ หัวใจเต้นช้า โดยพบร้อยละ 1.2 และรองลงมาคือความดันเลือดต่ำพบได้ ร้อยละ 0.8

สรุป: วิธีการระงับความรู้สึกที่ใช้บ่อยที่สุดในโรงพยาบาล ศิริราชคือการให้ยาทางหลอดเลือดทำให้เกิดภาวะสงบร่วม

Background: Patients' co-operation or immobilization is required in Magnetic Resonance Imaging (MRI) procedure. Different techniques of anesthesia assist pediatric patients in controlling their movement. Our objective was to retrospective review and report anesthetic techniques used as well as incidence of complications associated with anesthesia.

Methods: Data of 383 pediatric patients aged between 0-6 years in from May 2012 to December 2013 in Siriraj Hospital were retrospectively chart review. The demographic characteristics, diagnosis, anesthetic techniques, duration of the procedure and complications were collected and analyzed in descriptive statistic.

Results: During the study period, there were 383 patients receiving MRI procedure under caring by anesthesiologists, excluded cardiac MRI. The majority of patients was in age group of 0-12 months (41.8%) and classified as ASA classification of 1-2 (93.2%). The main anesthetic of choice was intravenous sedation with inhalation insufflation (53.3%). The first and second most common complications were bradycardia and hypotension accounting for 1.2% and 0.8% respectively.

Conclusion: The most popular anesthetic technique used in MRI procedure in Siriraj Hospital was intravenous sedation with inhalation insufflation. Although the low

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กับยาดมสลบแบบระเหยผ่านทางหน้ากากออกซิเจนให้ผู้ป่วย
สุดท้ายใจเอง แม้ว่าอุบัติเหตุการฉีดยาจะแทรกซ้อนทางวิสัญญี
ขณะตรวจคลื่นแม่เหล็กไฟฟ้าจะพบได้ต่ำ บุคลากรที่ดูแล
ผู้ป่วยขณะตรวจต้องระมัดระวังเป็นอย่างยิ่งว่าภาวะ
แทรกซ้อนสามารถเกิดขึ้นได้ระหว่างผู้ป่วยเข้ารับการตรวจ
คำสำคัญ: การตรวจคลื่นแม่เหล็กไฟฟ้า, การระงับความรู้สึก
ในผู้ป่วยเด็ก, วิธีการระงับความรู้สึก, ภาวะแทรกซ้อน

incidence of adverse effects was shown, anesthetic
personnel should be aware of any complication that may
occur in anesthesia of pediatric patients undergoing MRI
procedure.

Keywords: anesthetic technique, magnetic resonance
imaging (MRI), pediatric anesthesia, complication

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Introduction

Magnetic resonance imaging (MRI) study is the
procedure using magnetic field for diagnosis a variety
of abnormality in different body parts. This procedure
takes approximately at least 10-30 minutes to obtain the
complete image¹. Thus, patients' co-operation or
immobilization is mandatory in this procedure. There
has been an increasing in the rate of diagnostic imaging
procedure over the years. Hence, the number of
children receiving care from anesthesia providers for
MRI and CT scans has been grown as the number of
scans performed^{2,3}. Different techniques of anesthesia
assist pediatric patients in controlling their movement.
Also, MRI compatible and non-metallic equipment is
required for anesthetized patients. More than a decade,
Siriraj Hospital has been developed the anesthesia
service system for the outside operating theatre and
has had the MRI compatible anesthetic machine.
However, the choice of anesthesia depends on
preference or acquaintance of individual attending
anesthesiologist.

Several anesthetic techniques can be successfully
implemented in pediatric imaging procedure. Amornyotin
et al.⁴ revealed total intravenous anesthesia was the
most common technique used in nuclear medicine
procedure in Siriraj hospital accounting for 87.7%.
Similarly, Jirativanont et al.⁵ showed sedation technique
was the most commonly used in children undergone
any diagnostic imaging in Siriraj hospital (68.1%).
Nevertheless, study concerning anesthetic technique
for MRI has not been carried out.

Numerous complications related to anesthesia in
MRI have been reported in the literatures. Respiratory
complications such as hypoxemia occurred in 2.9% of
sedated pediatric children⁶. In addition, there were
reports of respiratory adverse events (desaturation,
laryngospasm, apnea) and cardiovascular complications
(hypotension, arrhythmia) in pediatric patients
undergoing diagnostic imaging study (3% and 0.7%
respectively)⁵.

Our objectives were retrospective review of the
choice of anesthesia in pediatric patients undergoing
MRI study, as well as the incidence of complications
related to anesthesia.

Material and Method

This retrospective, descriptive study was approved
by Siriraj Institutional Review Board, Faculty of Medicine
Siriraj Hospital, Bangkok, Thailand (protocol approval
number Si281/2014). Patient's hospital and admission
number of pediatric patients undergoing MRI in Siriraj
Hospital between May 2012 and December 2013 were
searched by using the procedure "Magnetic resonance
imaging" as a keyword, which were retrieved from an
anesthesiology department database. Electronic
medical records of the abovementioned patients were
obtained from Siriraj Hospital database. An inclusion
criterion was pediatric patients aged less than 6 years
old scheduled for an elective MRI study under caring
by the anesthesiologists. Patients underwent cardiac
MRI study and patients who have endotracheal
intubated before undergoing MRI procedure were
excluded from the study.

Patients' demographic characteristics including gender, age, weight, diagnosis, type of MRI procedure and duration of the anesthesia were recorded. Anesthetic techniques and complications associated anesthesia during the procedure and in post-anesthetic care unit were collected. Primary outcome was the choice of anesthesia for the pediatric undergoing MRI. Adverse events related to anesthesia were recorded including respiratory complication such as pulmonary aspiration, desaturation and bronchospasm as well as cardiovascular complications such as hypotension and bradycardia. Pulmonary aspiration was defined as a witness of gastric content in oral cavity and desaturation occur. Desaturation was defined as oxygen saturation less than or equal to 90%. Patient with abnormal lung signs e.g. wheezing or rales and receiving bronchodilator treatment was described as bronchospasm. Hypotension was defined as a systolic blood pressure of $\leq 20\%$ of the preprocedural baseline value or receiving treatment with any vasoconstrictor such as ephedrine or norepinephrine. Bradycardia was defined as a heart rate of less than 100 bpm in children under age of 1 year or less than 80 bpm in children age 1 to 8 years or receiving treatment with atropine.

Statistical analysis

A pilot study of anesthetic techniques for MRI in Siriraj Hospital had been conducted for 2 months; revealing the most commonly anesthetic technique used was intravenous agents together with inhalation insufflation technique, accounting for 52%. Other techniques used were total intravenous anesthesia and general anesthesia with airway devices (32% and 16% respectively). Sample size calculation was done by using of 52% (intravenous together with inhalation insufflation anesthetic technique) from the pilot study, with the confidence level ($1-\alpha$) of 95% and allowable error 0.05, two-sided test using formula: $n = Z_{\alpha/2}^2 p(1-p) / d^2$; accordingly, 383 patients were required in this study.

All analyses were performed using PASW statistic (SPSS) Version 18.1 (SPSS Inc., Chicago, IL, USA).

Categorical data were presented as number and proportion, expressed as a percentage. Mean $\pm$ standard deviation (SD) was used for presentation of continuous data.

Result

Total of 383 pediatric patients under age of 6 years were included in our study. Patients' demographics including gender, age, weight, part of body for MRI study and duration of the study were recorded (Table 1). The predominant diagnoses were retinoblastoma and seizure accounting for 49 (12.7%) and 48 (12.5%) patients respectively. The diagnoses involving neurological system were common including brain tumor (8.3%), delayed development (4.6%), myelomeningocele (3.6%) and hydrocephalus (2.8%). The others diagnosis were vascular malformation, scoliosis, mass at extremities clubfoot, microcephaly, precocious puberty etc. The anesthetic techniques using in MRI procedure were shown in Table 2. The most prevalent technique used in pediatric patients having MRI procedure was intravenous sedation together with inhalation insufflation via face mask which account for 53.3%. All of patients undergoing MRI in this technique received sevoflurane for insufflation. Forty point two percent of patients received total intravenous anesthesia (TIVA), which was the second most common technique. The other techniques used were general anesthesia (GA) with endotracheal tube (5.7%) and GA with laryngeal mask airway (0.8%). Complications associated with anesthesia were described in Table 3. It is interesting to note that the most common complication was bradycardia (1.2%); most of which received intravenous sedation with or without inhalation insufflation. One patient in GA with endotracheal tube group experienced both hypotension and desaturation. Therefore, total of 8 patients (2.1%) had complications associated with anesthesia in the procedure room. None of patients has complication in the recovery room. There was no report of failed intubation, cardiac arrest or death in our study period.

Table 1 Clinical and demographic characteristics (N=383)

Characteristics	Value
Gender Female	186 (48.6%)
Male	197 (51.4%)
Age (year)*	2.4 ± 1.8
min-max	0.01-6.0
Age group (month)	
0-12	160 (41.8%)
13-24	67 (17.5%)
25-72	156 (40.7%)
Weight (kg)*	12.6 ± 5.8
min-max	1.9-41
ASA classification	
1-2	357 (93.2%)
3-4	26 (6.8%)
Duration of the study (min)*	73.19 ± 25.34
min-max	30 - 195
MRI procedure site	
Brain	269 (70.0%)
Spine	64 (16.7%)
Head&neck	33 (8.6%)
Abdomen	7 (1.8%)
Extremity	5 (1.3%)
Shoulder	3 (0.8%)
Chest	2 (0.5%)

* Mean ± standard deviation

Table 2 Anesthetic techniques

Anesthetic techniques	Number (Percentage)
Intravenous sedation with inhalation insufflation [#]	204 (53.3%)
Total intravenous anesthesia	154 (40.2%)
GA with endotracheal tube	22 (5.7%)
GA with Laryngeal mask airway	3 (0.8%)

[#]Intravenous sedation with inhalation insufflation via face mask

GA = general anesthesia

Discussion

A variety of anesthetic techniques have been used in pediatric patients undergoing MRI procedure in our institute. The most common technique was intravenous sedation with inhalation insufflation technique. The important complication from sedation technique with or without inhalation insufflation was bradycardia. We excluded patients underwent cardiac MRI procedure due to the fact that performing of breath-holding maneuver was required in this procedure. The most of patients undergoing cardiac MRI in our institute received general anesthesia with endotracheal intubation. Data from Amornyotin et al.⁴ and Jirativanont et al.⁵ also showed total intravenous anesthesia and sedation technique were the most common techniques used in children undergone diagnostic imaging in our institute. By comparison, Waikakul et al.³ showed general anesthesia with endotracheal tube was the most anesthetic technique used in one University hospital in Thailand. The attending anesthesiologists' preference for the technique was vary in different institutes. Malviya et al.⁶ reported reasons for preselection of general anesthesia in pediatric patients undergoing MRI and computerized tomography (CT) including previous failed sedation, potential failed sedation and perceived medical risk. Furthermore, for safety reason, general anesthesia usually performed in newborns and infants who were at risk from a short period time of respiratory insufficiency¹.

Table 3 Complications associated with different type of anesthetic techniques

Techniques/ Complications	Intravenous sedation with inhalation insufflation (n=204)	Total intravenous anesthesia (n=154)	GA with ETT (n=22)	GA with LMA (n=3)	Total (n=383)
None	201	152	19	3	374
Hypotension	1	0	2*	0	3 (0.8%)
Desaturation	0	0	1*	0	1 (0.3%)
Bradycardia	2	2	0	0	4 (1.2%)
Bronchospasm	0	0	1	0	1 (0.3%)

GA = general anesthesia, ETT = endotracheal tube, LMA = laryngeal mask airway

* One patient in GA with endotracheal tube group had both hypotension and desaturation

Although MRI is a non-painful procedure, noise from the MRI machine causes patient discomfort and anxiety, remarkably in pediatric patients. Thus, deep sedation or general anesthesia is required¹. Sury et al.⁷ reported successfully usage of sevoflurane insufflation via nasal cannula in 13 infants (median weight 4.4 kg) undergoing MRI. One of which desaturated that accounted for 7.69 percent, however, most infant were easily roused by touch. Intravenous sedation and inhalation insufflation technique provide several advantages. First, using of sevoflurane in combination with intravenous sedative medications can decrease the amount of intravenous drugs. Low level of sevoflurane has a slight effect on patients' respiration as well as sevoflurane can be administered in order to rapidly achieve the desire level of consciousness⁷. Nevertheless, close observation of patients' respiration is suggested as desaturation or apnea can occur.

The major concern and the main disadvantage from inhalation insufflation technique is the contamination from inhalation in the surrounding atmosphere. In our institute, we have a scavenging system drawing the exhaust gas around the patients. Although head box can be used to limit air pollution⁷, the contamination is still inevitable and uneasy to manage in the mask suite.

Monitoring and intra-procedural evaluation of the pediatric patients under MRI procedure appears to become more problematic than other procedures and may affect the choice of anesthesia. Several choice of anesthesia has been reported in the literature, such as chloral hydrate ingestion, total intravenous anesthesia using pentobarbital, midazolam, propofol or dexmedetomidine. Cortellazzi et al.⁸ reported high failure rate (20%) of using chloral hydrate in MRI scanning. Pentobarbital prolonged time to discharge in infant patients received MRI procedure comparing with propofol.⁹ Midazolam alone is not suitable for MRI procedure due to its duration is short and causes a risk of respiratory complication¹. Propofol can be effectively used in MRI procedure because its properties: short recovery time can be titrated to achieve the desirable sedation level with low adverse events¹. Mason et al.⁹

showed pediatric MRI successfully done after administration of dexmedetomidine with bradycardia occurring of 16%¹⁰. Our study revealed bradycardia and hypotension were the two most common complications. This was taken into consideration when using of sedative medication such as propofol. As can be seen from our result, none of patient in general anesthesia group experienced bradycardia.

A large retrospective study revealed respiratory complication eg. oxygen desaturation, pulmonary aspiration and airway resuscitation was the most common complication found in patients receiving sedation in imaging examination¹¹. Malviya et al.⁶ also showed hypoxemia was the most common complication accounting for 2.4% as well as was commonly found in children classified in ASA III or IV. As the patient's distance from the anesthesiologist, airway problems with difficulty management can occur. If an emergency situation occurs, it is necessary to discontinue the scan and bring the patient out of the scanner room for resuscitation in order to avoid ferromagnetic metal objects from anesthetic equipment moving to the MRI scanner.

The main limitation of this study is a retrospective design making incomplete data collection. The adverse events, such as respiratory adverse events included airway obstruction, apnea, laryngospasm, and pulmonary aspiration or cardiovascular adverse events included hypotension, and cardiac arrhythmia, might be under-reporting. Moreover, there was no record of inadequate sedation or prolonged sedation in the medical records.

Conclusion

The most common anesthetic technique used in MRI procedure was intravenous sedation together with inhalation insufflation in Siriraj hospital. Bradycardia and hypotension were the most frequent complications found in our study. Providing sedation or general anesthesia with high caution should be carried out to minimize any adverse events in pediatric patients particularly at the outside operating theatre such as in

the MRI procedure. Adequate preparation for MRI compatible equipment and readily available of resuscitation medications is recommended.

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