Rapid sequence intubation experiences in the pediatric emergency department

Çocuk acil servisinde hızlı seri entübasyon deneyimlerimiz

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Abstract

Aim: Patient selection and management of rapid sequence intubation (RSI) application in the emergency department can be challenging for clinicians. In this study, we aimed to describe the demographic information, clinical characteristics, and medical conditions of the patients who underwent RSI in our hospital's pediatric emergency department and to present patient management strategies.

Methods: Cases between 1 month to 18 years old who underwent RSI in the emergency department between January 2021 and January 2022 were analyzed retrospectively.

Results: Eleven patients; 7 girls (63,6%) and 4 boys (36,4%) were included in the study. The median age of the patients was 6(2-15) [minimum (min)-maximum (max)]. The median time from symptom onset to presentation was 120 minutes (min-max 15 minutes-2 weeks). RSI indications were trauma (n=5), intracranial mass (n=4), ventriculoperitoneal shunt dysfunction (n=1), and refractory status epilepticus (n=1). All patients had focal neurological deficits on examination. Glasgow Coma Scale median score was 8 (min-max 4-15). The first neuroimaging method was cranial tomography in ten (90.9%) patients. Intracranial hemorrhage was present in 45.4% (5 patients) of the patients. No complications were observed in any of the patients during the RSI application. One patient died due to intracranial hemorrhage and shunt dysfunction. Neurological deficits (dysarthria, gait disturbance, hemiparesis, and visual impairment) were detected in five patients during their first-month follow-up.

Conclusion: This retrospective study identified critically ill children who were admitted to the emergency department with acute neurological symptoms and underwent RSI to prevent increased intracranial pressure and further brain damage.

Keywords: Children; rapid sequence intubation; sedation

Öz

Amaç: Acil serviste hasta seçimi ve hızlı seri entübasyon (HSE) uygulamasının yönetimi klinisyenler için zor olabilir. Bu çalışmada hastanemiz çocuk acil servisinde HSE yapılan hastaların demografik ve klinik özelliklerini ile hasta yönetim stratejilerinin değerlendirilmesi amaçlandı.

Yöntemler: 1 Ocak 2021 ile 1 Ocak 2022 tarihleri arasında çocuk acil servisinde HSE uygulanan 18 yaşından küçük hastalar çalışmaya dâhil edildi.

Bulgular: Çalışmaya 11 hasta dâhil edildi. Hastaların medyan yaşı 6 (2-15) idi [minimum (min)-maksimum (maks)], 7'si kızdı (%63,6). Semptom başlangıcından başvuruya kadar geçen süre medyan değeri 120 dakikaydı (min-maks 15 dakika-2 hafta). HSE endikasyonları travma (n=5), kafa içi kitle (n=4), ventrikülöperitoneal şant disfonksiyonu (n=1), dirençli status epileptikus (n=1) idi. Hastaların Glasgow Koma skala skorları ortanca değeri 8 (min-maks 4-15) idi. Hastaların tamamında fokal nörolojik defisit mevcuttu. İlk nörogörüntüleme yöntemi 10 (%90.9) hastada kraniyal tomografiydi ve beş hastada (%45,4) intrakraniyal kanama mevcuttu. HSE'ye bağlı hiçbir hastada komplikasyon izlenmedi. Hastalardan ikisi exitus oldu (intrakraniyal kanama ve şant disfonksiyonu nedeniyle). Birinci ay kontrollerinde beş hastada dizartri, yürüme bozukluğu, hemiparezi, görme bozukluğu gibi nörolojik defisitler tespit edildi.

Sonuç: Bu retrospektif çalışma, akut nörolojik semptomlarla acil servise başvuran ve kafa içi basıncının artmasını ve daha fazla beyin hasarını önlemek için HSE uygulanan kritik hasta çocukları tanımladı.

Anahtar Sözcükler: Çocuklar; hızlı seri entübasyon; sedasyon

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INTRODUCTION

It is vital to ensure the management of the airway and ventilation in critically ill children. The selection of appropriate premedication, induction drugs, and paralytic agents is important for the success of endotracheal intubation and the minimization of complications. Rapid sequence intubation (RSI) describes a coordinated, sequential process of preparation, sedation, and paralysis to facilitate tracheal intubation (1). A quick and systematic approach is essential for the preparation and execution of the RSI process. It is recommended to use RSI by clinicians trained in tracheal intubation for most children who need emergent intubation and are not in cardiac arrest (1,2). Primary indications for RSI include trauma, change of consciousness, intracranial mass or suspected herniation, acute burns, and conditions with a high risk of aspiration (3). Patient selection and management of RSI applications in the emergency department can be challenging for clinicians.

In this study, we aimed to describe the demographic and clinical characteristics of the patients who underwent RSI in our hospital's pediatric emergency department (PED).

MATERIAL AND METHODS

Study Design and patient selection

The study was a single-center, retrospective, and descriptive case study. Our hospital is a tertiary pediatric hospital located in Ankara (the capital of Turkey), and during the pandemic period, approximately 120,000 patients applied annually to our emergency department. Clinical Research Ethics Committee of Dr. Sami Ulus Maternity and Child Health and Diseases Training and Research Hospital approved this study (Date: 06.04.2022, Decision no: E-22/04-318). We retrospectively analyzed the patients that were admitted to the PED and intubated between 1 Jan 2021 and 1 Jan 2022 from the hospital database. In this study, we included patients 1 month to 18 years who received treatment with RSI through induction and paralytic agents. Patients who were in deep coma or had cardiac arrest, given only induction agents for intubation, or intubated without sedation were excluded from the study.

Data collection

Patients' demographic (age, gender) and clinical features (symptoms, examination findings), duration between the onset of the symptoms to the emergency room, the Glasgow Coma Scale (GCS) scores, the final diagnosis, emergency management, and treatment were recorded. Neuroimaging methods [cranial computed tomography (CT), magnetic resonance imaging (MRI), angiography, and venography] and all physical examination findings were recorded. The drugs used in the RSI application process, their side effects, and complications, if any, were also recorded. The protocol of our hospital RSI includes preoxygenation, premedication (atropine for patients under one year old, lidocaine for over one year and fentanyl), the use of induction agents (midazolam, ketamine), and paralyzing agents (rocuronium). Possible complications were determined as esophageal intubation, right bronchial intubation, trauma (tongue, lips, teeth, pharynx, and trachea), pharyngeal-esophageal perforation, and hypoxia, hypocapnia, and dysrhythmia and aspiration pneumonia.

Outcomes

The primary outcome was the symptoms and signs of patients undergoing RSI in the PED. Secondary outcomes were the final diagnosis of patients, the indications for RSI application, and adverse outcomes of drugs.

Statistical analyses

Statistical Package for the Social Sciences package program for Windows Version 28.0 (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. The variables were investigated using visual (histogram, probability plots) and analytical methods (Kolmogorov-Smirnov) to determine whether they were normally distributed. In descriptive statistics, categorical variables are expressed as number (*n*), percentage (%), and continuous variables are expressed as mean (±), standard deviation (SD) or median, minimum (min), and maximum (max) values.

RESULTS

During the study period, endotracheal intubation was performed on 30 patients with different indications in

Table 1. Demographic and clinical characteristics of the cases

	Gender	Age (year)	Symptom	Symptom duration	Examination findings	GCS	RSI
Case 1	Female	13	Syncope	30 minutes	Eyes: Right no light reflexes, fixed dilated, anisocoria. Left limp: Hemiparasia, hyperactive DTR, left babinsky +	8	Lidocaine Midazolam Rocuronium
Case 2	Male	3	Fall from height Vomiting	15 minutes	Lethargy, right-lateralized eyes	8	Lidocaine Midazolam Rocuronium
Case 3	Male	6	Speech disorder Vomiting	2 hours	Confusion, sign of meningeal irritation (neck stiffness)	9	Lidocaine Fentanyl Midazolam Rocuronium
Case 4	Female	2	Fall from height Seizure	15 minutes	Stupor, DTR areflexia, anisocoria	4	Lidocaine Midazolam Rocuronium
Case 5	Female	11	Headache Speech disorder	2 weeks	Lethargy, DTR areflexia	8	Lidocaine Ketamine Rocuronium
Case 6	Female	9	Altered mental status Contraction of the arms	15 minutes	Stupor, Babinski+, right-lateralized eyes	4	Midazolam Rocuronium
Case 7	Male	2	Sleep	12 hours	Stupor, DTR areflexia, anisocoria	4	Lidocaine Midazolam Rocuronium
Case 8	Female	3	Gait disturbance Involuntary beats in the left leg	24 hours	Hemiparesis of the lower left limb	15	Lidocaine Midazolam Rocuronium
Case 9	Female	3	Gait disturbance Vomiting	10 days	Ataxia, papilledema	14	Lidocaine Midazolam Rocuronium
Case 10	Female	14	Headache Syncope	30 minutes	Lethargy, DTR areflexia, Babinski +, right clonus	7	Midazolam Rocuronium
Case 11	Male	15	Headache Vomiting Amnesia	1 week	Change in consciousness at follow-up	8	Fentanyl Midazolam Rocuronium

GCS; Glasgow coma scale, RSI; Rapid sequence intubation, DTR; deep tendon reflex, CT; computed tomography, MRI; magnetic resonance imaging

the emergency room [cardiopulmonary arrest (n=9), deep coma (n=1), respiratory failure (n=4), shock (n=1), neurological emergencies (n=15)]. There were 11 patients who underwent RSI. RSI indications were trauma (n=5), intracranial mass (n=4), ventriculoperitoneal shunt dysfunction (n=1), and refractory status epilepticus (n=1). The median age of the patients was 6 years (min-max 2-15), and 7 of the patients were female (63.6%). The median time from the onset of symptoms to admission was 120 minutes (min-max 15 minutes-2 weeks). The clinical characteristics of the patients were given in a table (Table 1). All patients had focal neurological deficits during the examination. The median GCS score of the patients was 8 (min-max 4-15). Neuroprotective therapy was started, and RSI was administered to all patients in the emergency department. There were two cases with GCS above 13 [arteriovenous malformation (n=1) and medulloblastoma (n=1)]. They were referred to an external center for an emergency operation in neurosurgery. RSI was applied to prevent the risk of increased intracranial pressure and/or herniation and to provide stabilization during the transfer phase.

Table 2. Neuroimaging findings and management of the cases

	Neuroimaging	Neuroimaging finding	Diagnosis	Treatment
Case 1	CT	Subdural hematoma in right cerebral hemisphere, right lateral ventricle decompressed, tonsillar herniation	Intracranial hemorrhage	Neuroprotective therapy Surgical decompression
Case 2	CT	Hypodense area in the frontal region	Intracranial hemorrhage	Neuroprotective therapy
Case 3	CT	Hematoma in the right temporoparietal	Encephalitis Intracranial hemorrhage	Neuroprotective therapy Encephalitis treatment
Case 4	CT	Subdural hematoma, ventricular decompression	Intracranial hemorrhage	Neuroprotective therapy Surgical decompression
Case 5	CT MRI	Subdural empyema, meningoencephalitis	Complicated sinusitis Subdural empyema	Neuroprotective therapy surgical drainage Antibiotherapy
Case 6	CT	Normal	Refractory status epilepticus	Neuroprotective therapy Antiepileptic therapy
Case 7	CT	VP shunt, bilateral ventricular decompression	VP shunt dysfunction	Neuroprotective therapy Antibiotherapy
Case 8	CT	Hemorrhagic lesion of the supratentorial level, parasagittal area	Arteriovenous malformation	Neuroprotective therapy Surgical resection
Case 9	MRI	Cystic lesion with diffusion restriction in the cerebellar hemisphere, lateral ventricles are significantly dilated	Medulloblastoma	Neuroprotective therapy Surgical resection
Case 10	CT	Large area of parenchymal hemorrhage in the right frontal lobe	Intracranial hemorrhage	Neuroprotective therapy Surgical decompression
Case 11	CT	Hyperdense area of (30x28x33mm) in the left posterior parietal region, minimal shift to the right, right ventricle slightly faint	Intracranial abscess	Neuroprotective therapy Surgical drainage Antibiotherapy

CT; computed tomography, MRI; magnetic resonance imaging, VP; ventriculoperitoneal shunt

Drugs administered during RSI are shown in Table 1. Intravenous (IV) lidocaine was given to 8 patients (73%) at the premedication stage and IV midazolam was given to 10 patients (90.9%) at the induction stage. Intravenous rocuronium was administered to all patients for the stage of paralysis. Patients were hemodynamically stable at all stages of RSI. The gag reflex of one of the patients who was not given lidocaine was not sufficiently suppressed. One patient that brought in due to a fall from a height could not be intubated in the first 10 minutes after a paralytic agent. Positive pressure ventilatory support was provided to this patient, who was considered to have a difficult airway (short neck and micrognathia), with the help of a balloon mask. The patient was intubated by an experienced clinician during the follow-up. Patients with urgent neurosurgical pathology were referred to a neurosurgery center for surgery. Two patients died due to intracranial hemorrhage and shunt dysfunction. Neurological deficits such as hemiparesis, gait disturbance, and visual impairment were detected in 5 patients in the first month of control.

The first neuroimaging method was cranial CT in 10 (90.9%) patients. One patient underwent imaging with cranial CT and MRI, and one patient underwent imaging with only cranial MRI. Intracranial hemorrhage was present in 45.4% of the patients (5 patients). Neuroimaging methods and findings of the patients were given in Table 2.

DISCUSSION AND CONCLUSION

This retrospective study identified critically ill children who were admitted to the emergency department with acute neurological symptoms and underwent RSI to prevent increased intracranial pressure and further brain damage. A fall from a height and a change in consciousness were the main complaints of applicants. The median GCS score of the patients was 8 and all patients had at least one focal neurological deficit. In neuroimaging, 90.6% of patients had a neurosurgical pathology and these patients were operated on in a neurosurgical clinic.

Rapid sequence intubation reduces pain, suppresses the gag reflex, and prevents agitation in children requiring intubation (1,4). RSI increases intubation success and survival. Simultaneous use of paralytic agents with sedation in emergency departments is not as common as in intensive care units. Patient selection and management of RSI applications in the emergency department can be challenging for clinicians. Endotracheal intubation in the emergency department can be performed in many different clinical situations (3). Many reasons require intubation, such as lack of oxygenation and ventilation, inability to maintain and/or protect the airway, potential for clinical deterioration, and securing the airway during referral. Except for one patient in our study, all cases had intracranial emergent pathology requiring surgical intervention; intracranial hemorrhage (n=5), subdural empyema (n=1), intracranial abscess (n=1), arteriovenous malformation (n=1), ventriculoperitoneal shunt dysfunction (n=1) and medulloblastoma (n=1). Patients had different altered states of consciousness and intracranial pathologies. Intracranial lesions, mainly trauma (abscess, tumor, hematoma, cyst, etc.) increase the intracranial pressure and can cause herniation (5). Improper management of increased intracranial pressure can also result in morbidity and mortality. RSI was applied to our patients to provide respiratory control and prevent neurological complications.

It has been emphasized in the literature that RSI can be applied in all patients who are not in cardiac arrest or deep coma, and there are no definite contraindications (6). In contrast, sedation and paralysis eliminate spontaneous breathing and protective airway reflexes, which can cause aspiration and hypoxemia if the patient cannot be intubated (7). Considering the current risks, clinician experience and appropriate patient selection are important in RSI practice. The clinician should be skilled in alternative choices in cases that cannot be intubated. Sugammadex, which reverses the effect of neuromuscular blockade, can be used in the use of rocuronium (8). In our study, a patient with malformation could not be intubated after sedation and paralysis, and positive pressure ventilation could be provided with a balloon mask for a short time. Although alternative methods can be successful in cases where difficult intubation or difficult airway risk is predicted, the decision not to perform or postpone RSI should not be forgotten due to the possible risks.

Atropine, lidocaine, and opiate derivatives may be preferred at the premedication stage of rapid consecutive intubation to regulate bradycardia, and hemodynamic changes, reduce intracranial pressure, and prevent gag reflex (9-11). Lidocaine is often preferred for children over the age of one year, and atropine is often preferred in infants. Lidocaine was the preferred premedication agent according to the age of our patients in this study. It was effective in preventing vagal stimulation and gag reflex. Lidocaine was not administered in three patients, and the gag reflex was not sufficiently blocked only in one. Suppressing the gag reflex is an important step to prevent secondary brain damage in patients with intracranial pathology. Although the number of patients in this study is insufficient, we think that routine administration of drugs such as lidocaine at the premedication stage will be more useful.

While etomidate, midazolam, ketamine, propofol, and thiopental were recommended at the induction stage; etomidate, which is associated with a decrease in the risk of hypotension, was considered the first agent to be preferred (12,13). Especially etomidate, midazolam, and ketamine are preferred in the emergency department. Midazolam was the first-choice induction agent in 90.9% of patients in this study, because etomidate was not available in our hospital. The drug must be accessible in the department for the drug preference. Rocuronium was used for all patients at the stage of paralysis. A recently published meta-analysis compared the efficacy of succinylcholine with rocuronium and concluded that succinylcholine is superior in providing appropriate intubation conditions, but it has more contraindications and side effects in children (14,15). Considering this report, the use of rocuronium may be safer in these patients.

One of the noteworthy situations in the studies conducted on the RSI ratio and success in the literature is the knowledge and experience of the clinician on this issue (3,16). In these studies, it has been shown that less experienced clinicians have a low number of successful intubations and a high tendency to avoid paralytic agents (due to their possible complications). We believe that the experience of clinicians with pre-

medication, induction, and selection of paralytic agents will increase the success of RSI.

This study had some limitations. It reflects single-center data, and the number of patients is limited. Although there is an RSI protocol in our hospital, the choice of drug in the premedication phase belongs to the clinician, causing some differences according to the clinician in charge.

This retrospective study identified critically ill children who underwent RSI in the PED. It can be safer to provide airway management with RSI, especially in critically ill patients who have acute changes in consciousness, require urgent intubation, and have a high risk of complications due to increased intracranial pressure. Multicenter prospective studies are needed to evaluate the diversity of indications and possible side effects in RSI application.

Conflict-of-interest and financial disclosure

The authors declares that they have no conflict of interest to disclose. The authors also declare that they did not receive any financial support for the study

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