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Original Research

Rectal administration of midazolam plus ketamine as conscious sedation for injured paediatric patients requiring Oral surgery

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ABSTRACT

Objective: Rectal sedation has been in use for many years in paediatric dentistry. The purpose of this study was to retrospectively investigate the incidence of rectal sedation with midazolam plus ketamine for oral minor surgery among paediatric patients in our department.

Methods: The incidence of rectal sedation for paediatric outpatients under the age 6 years requiring oral surgery of our department between January 2007 and December 2016 was retrospectively analysed. Rectal sedation was given to 10 paediatric patients (8 boys and 2 girls) and consisted of a 0.1 mg/kg dose of midazolam and a 5 mg/kg dose of ketamine.

Results: Every case was a traumatic injury, the most common region was the tongue, and the most frequent type of wound was a laceration. With respect to sedative effects, approximately 30 min after rectal administration of the two drugs, good anxiolysis and cooperation were obtained, and few adverse effects were seen in all 10 cases although there were some cases that were difficult to treat.

Conclusions: Rectal administration of midazolam plus ketamine provides a safe and reliable method for paediatric outpatients requiring an oral surgery procedure.

1. Introduction

Oral surgery in the case of injured paediatric patients is difficult because it provokes instinctive anxiety due to their immature condition. When behavioural management methods fail to achieve treatment acceptance, as often happens, the use of appropriate pharmacological agents has been recommended [1,2].

Midazolam, a relatively short-acting benzodiazepine, is the most appropriate drug for sedation [3]. Its properties include anxiolytic, hypnotic, anticonvulsant, and anterograde amnesic, but not analgesia [4–6]. In fact, in oral treatment of uncooperative children, midazolam is a widely used drug as a well-documented method for the management of anxiety and has been proven to give a rapid and reliable sedative effect [1–8]. Ketamine is a phencyclidine-like anaesthetic agent, which, in subanaesthetic doses, has sedative, amnestic, and analgesic properties. Although these drugs have also been used for sedation and analgesia in children who must undergo painful procedures, low doses of ketamine have been recommended to decrease the incidence of undesirable side effects, including cardiovascular-stimulating, neuromuscular, and psychic side effects. When combined, midazolam and ketamine may interact to improve on the desired effects, as well as to reduce certain adverse effects, leading to more efficient relief of anxiety and prevention of pain [3,8].

The routes of administration of pharmacological agents are also worth considering with regard to their sedative effects and treatment acceptance. Although there are various routes, such as intranasally, orally, and rectally, not to mention intravenously, oral and rectal routes are generally noninvasive, which makes them advisable for children who are afraid of injections. In particular, rectal administration of drugs for premedication has been in use for many years and has been shown to be particularly useful in paediatric patients [2,4,7].

In this study, the incidence of rectal sedation was retrospectively analysed among paediatric patients requiring minor oral surgery in our department over the past decade, and the acceptance and treatment possibilities of rectally administered midazolam plus ketamine were assessed.

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2. Methods

2.1. Patients

A retrospective analysis was performed of paediatric patients under the age 6 years in our department between January 2007 and December 2016. The subjects were 10 paediatric patients who underwent rectal sedation when requiring minor oral surgery. The study was approved by the Clinical Research and Ethics Centre of Fukuoka University (No. 2018M050).

2.2. Drugs and treatment procedures

For rectal sedation, the paediatric patients received a 0.1 mg/kg dose of midazolam and a 5 mg/kg dose of ketamine. Suitably diluted parenteral midazolam and ketamine solutions were administered through a 10-ml syringe connected to a lubricated 3.5-mm outside-diameter paediatric feeding tube inserted 3–4 cm into the rectum. Subsequent flushing of the appropriate quantities of saline ensured complete rectal deposition of the drugs. After injection, the buttocks were apposed tightly for about 1 min to avoid loss of the drugs. This was followed by a 15 to 30-min waiting period for the sedative effect to appear. Oxygen saturation and pulse rate were continuously recorded using a biological information monitor (BP-88S, OMRON Colin, Tokyo, Japan).

2.3. Sedative assessment

The level of sedation was assessed according to Wilton's sedation scale [9]: Drowsy, sitting or lying comfortably with tired or half-closed eyes, responds to minor stimulation; Calm, sitting or lying comfortably with open eyes, relaxed; Alert, not clinging to parent, may whimper but not cry; Agitated, clinging to parent and/or crying.

2.4. Acceptance of oral surgery

Each oral surgery procedure was performed to end within 15 min after confirming the appearance of sedative effects. At the end of each procedure, the acceptance of oral surgery was assessed by each operator according to the criteria indicated as follows [3,7]: Impossible to treat, with resistance and no treatment; Difficult to treat, possible to treat, although treatment was disturbed by whimpering and/or some movement; Good to treat, with no whimpering and movement during treatment; and Excellent to treat, well sedated without side-effects and treatment completed.

3. Results

3.1. Patients' characteristics

Ten patients were enrolled. The whole list is shown in Table 1 and their summary of clinical characteristics is shown in Table 2. Their mean age was 2.5 years (range, 1–4 years). There were 8 boys and 2 girls (boy-to-girl ratio 4:1). The age distribution of the paediatric patients was: age 1–2 years, 5 patients; age 2–3 years, 3 patients; and age 3–4 years, 2 patients. No cases were in the age group under 1 year of age or 4–6 years of age. Diagnosis (region and type of wound), the cause of the injuries, and treatment methods are listed, and the most common was a lacerated tongue wound due to a fall, and wound suture was mostly performed.

Table 2
Patients' clinical characteristics.

Characteristic	n = 10
Mean age, y (range)	2.5 (1-4)
Sex (male/female)	8/2
Diagnosis	
Lacerated wound	8
Tooth luxation	1
Tooth breakage	1
Cause of injury	
Fall	9
Collision	1
Part injured	
Tongue	7
Teeth	2
Lower lip	1
Treatment methods	
Suture	8
Fixation of teeth	1
Tooth extraction	1

3.2. Sedative effect

As shown in Table 3, Drowsy and Calm, which indicate adequate sedative effects, were found in 80%, and Alert, which showed a slight tendency to be related to difficulty to treat, in 20% of the paediatric patients, while Agitated was seen in 0%. From a safety perspective, deep sedation with blood oxygen saturation below 95% did not occur, and side effects such as hypoxemia, vomiting, nausea, and headache were not detected. In all cases, the preoperative waiting time was set aside 15–30 minutes. Postoperatively, all patients rested 1 h.

3.3. Operating conditions

In all cases, the treatment was finished within 15 min. As shown in Table 4, operating conditions were assessed and rated as "Excellent to treat" in 20% and "Good to treat" in 60%, while "Difficult to treat" was seen in 20%, and "Impossible to treat" was seen in 0% of the paediatric patients.

Table 1
The list of the patients enrolled in this research.

No.	Age	Sex	Body weight (kg)	Diagnosis	Surgery time (min)
1	1 year 1 month	F	7.0	Laceration of the tongue	5
2	1 year 3 months	M	11.0	Laceration of the tongue	5
3	1 year 6 months	M	8.0	Laceration of the tongue	5
4	1 year 6 months	M	9.0	Laceration of the tongue	5
5	1 year 9 months	M	10.0	Laceration of the tongue	5
6	2 years	M	11.0	Laceration of the tongue	5
7	2 years 3 months	M	11.0	Laceration of the tongue	5
8	2 years 4 months	M	13.5	Tooth breakage	3
9	3 years 6 months	M	20.0	Tooth luxation	15
10	3 years 11 months	F	30.0	Laceration of the tongue	5

Table 3
Level of sedation according to Wilton assessed 15–30 minutes after rectal administration.

Assessments	Number of children
Drowsy	3
Calm	5
Alert	2
Agitated	0

Table 4
Acceptance of treatment assessed by the same oral surgeon at the end of each oral surgery.

Assessments	Number of children
Impossible to treat	0
Difficult to treat	2
Good to treat	6
Excellent to treat	2

3.4. Sample cases

Excellent to treat (Case No.7): A two years three months old boy weighting 11 kg presented with a 2-cm-long lacerated wound on the superior surface of the tongue with penetration into the muscular layer due to a fall (Fig. 1A). It was thought to require suture repair by absorbable sutures, with accompanying procedural sedation and local anaesthesia. After discussing the procedure with the patient's guardian, wound closure by absorbable suture and rectal sedation with use of local anaesthesia was determined to be the most appropriate treatment method. This patient received 1.1 mg of midazolam and 55 mg of ketamine rectally, and the waiting time before treatment was 30 min. Injection of 0.9 ml of 2% lidocaine solution containing 1:80,000 adrenaline and 5 stitches on the tongue using absorbable sutures were fully completed within 5 min of surgery time (Fig. 1B and C). Assessment by the oral surgeon was "Excellent to treat".

Difficult to treat (Case No.4): A one year six months old boy weighing 9 kg presented with 1-cm-long lacerated wound on the posterior dorsum of the tongue due to a fall (Fig. 2A). Wound closure by absorbable suture was planned under rectal sedation. As in the case of "Excellent to treat" described above, this patient also received 0.9 mg of midazolam and 45 mg of ketamine rectally, and the waiting time before treatment was 30 min. The patient became sedated and drowsy. A total of 1.0 ml of 2% lidocaine solution containing 1:80,000 adrenaline was injected at the tip and the vicinity surrounding the wound of the tongue. The operator pulled the tongue by traction suture at the tip of the tongue, and the patient then awakened slightly with whimper. The level of sedation was suddenly changed to "Alert". Although light restriction of his head was needed, 2 stitches on the tongue using absorbable sutures were fully completed within 5 min of surgery time (Fig. 2B). Assessment by the oral surgeon was "Difficult to treat".

4. Discussion

Paediatric patients requiring oral surgery pose technical and economic issues. Generally, treatment under general anaesthesia is needed for such patients, even for minor injuries, but a high level of proficiency and resources is required [3]. As alternative methods, conscious sedation with various routes (oral, intranasal, and rectal) of administration of pharmacological drugs combined with local anaesthesia is offered [2,4]. Although a higher number of paediatric patients showed acceptance of the oral administration of drugs, they may resist drinking drugs due to the pain of the injured oral region and the bad taste of the drugs. From this perspective, rectal drug administration as a kind of conscious sedation has been well accepted in paediatric populations for a long time [3,4]. Moreover, no significant differences in the acceptance of local anaesthesia injection, operating conditions, level of amnesia, and adverse effects were observed between oral and rectal applications of midazolam [4], leading to the rectal route being more advantageous. In fact, in our cases, deep sedation with blood oxygen saturation below 95% did not occur, and side effects such as hypoxemia, vomiting, nausea, and headache were not detected. All patients rested for 1 h postoperatively then they went home without any trouble. With respect to the kind of pharmacological drugs, combined use of psychotropic drugs (i.e., benzodiazepine and ketamine) rather than single-use only leads to good sedative effects (fast onset, relief of anxiety, and prevention of pain), as well as reduction of certain adverse effects (drowsiness and amnesia) [3,8]. As in the present report, the combination of midazolam and ketamine made oral surgery safer and more reliable for all traumatically injured paediatric patients, although there were some cases in which treatment was disturbed by some movement. The two drugs act by different mechanisms. The combination of midazolam and ketamine seems to be appropriate because: 1) both drugs have sedative and amnestic properties; 2) ketamine adds an analgesic component; 3) midazolam counteracts the psychic side-effects of ketamine; and 4) ketamine counteracts the depressive effects of midazolam on vital body functions (respiration and circulation). Among paediatric outpatients who need treatment acutely, it is essential to perform first-aid treatment most often with these pharmacological approaches with combined conscious sedation while avoiding exaggerated general anaesthesia. Therefore, these two drugs tend to be more efficient and improve the desired sedative effects, while reducing certain adverse

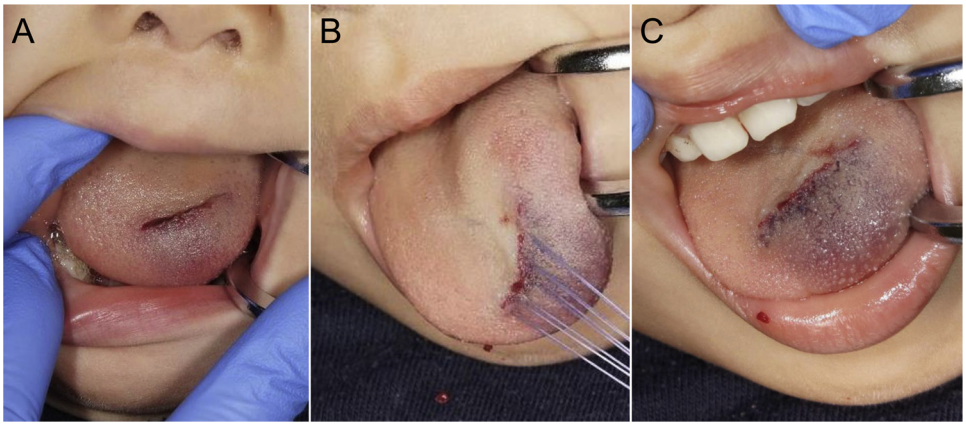

Fig. 1. Intraoral photos of the "Excellent to treat" case.
A: The tongue laceration on the anterior dorsum with penetration into the muscular layer at the initial emergency department visit.
B, C: Wound closure using absorbable sutures.

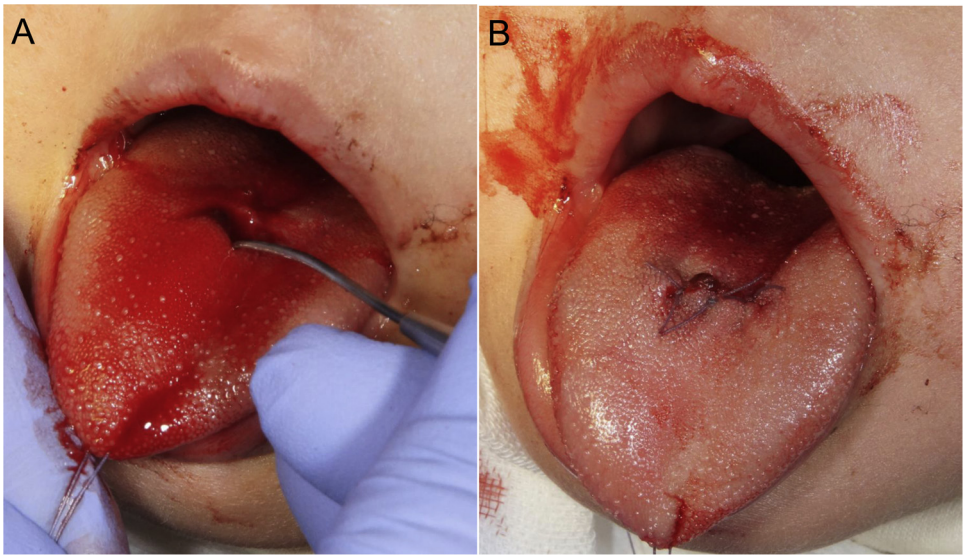

Fig. 2. Intraoral photos of the "Difficult to treat" case.
A: The tongue laceration on the posterior dorsum with penetration into the muscular layer. The operator pulls the tongue by traction suture at the tip of the tongue.
B: Wound closure using absorbable sutures.

effects [3,8].

In the present study, the most commonly injured region by trauma in paediatric patients was the tongue. It is well known that the most common region of the tongue to be lacerated is the anterior dorsum, and the frequency decreases from anterior to posterior on both surfaces [10,11]. Of note, many reports suggested that there is no need to suture small lacerations of the tongue, and primary healing with minor scar occurs because of the rich vascular supply to the tongue [10–12]. However, the wound margins of paediatric patients are often not in proper proximity because they move around a lot [12]. In deep lacerations, or in the setting of active bleeding, the muscular planes must be closed with absorbable sutures to stop the haemorrhage and prevent hematoma formation [10,11]. Furthermore, the parents often worry excessively about and are not satisfied with no treatment. The need for repair and accompanying procedural sedation, risks included, should be discussed with the patients and their parents. Rectal administration of midazolam plus ketamine is advisable for children who are afraid of injections [2,4]. When combined with local anaesthesia, conscious sedation with rectal midazolam plus ketamine made oral treatment possible for most of the children referred for treatment under general anaesthesia [3]. However, it is important to recognize that treatment under this sedation should be limited to single and light treatment [2]. Like the sample case (Case No.4) that was "Difficult to treat", when the tongue is lacerated in the posterior dorsum, treatment may be difficult because of some movement and whimpering/crying, even if the combined sedation with the rectal route works well. The cause of the difficulty in the present case was thought to be the pulling of the tongue that was necessary. In the case of a laceration located on the posterior dorsum, this sedation method might be insufficient.

5. Conclusions

In conclusion, conscious sedation by rectal administration of midazolam plus ketamine is very useful and convenient in uncooperative, traumatically injured paediatric patients requiring oral surgery.

Competing interests

None.

Role of the funding source

None.

Ethics approval

The study was approved by the Clinical Research and Ethics Centre of Fukuoka University (No.2018M050).

Patient consent: Written consent was obtained from the patients' guardians.

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