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Study on the Effects of Remimazolam on Heart Rate, Blood Pressure, and Respiratory Rate in Pain-free Gastrointestinal Endoscopy

Jing Sui, Chunyong Tang

Deyang People's Hospital, Deyang, Sichuan, 618000, China

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Abstract: To investigate the effects of remimazolam on heart rate, blood pressure, and respiratory rate in patients underwent pain-free gastrointestinal endoscopy. A total of 120 patients undergoing pain-free gastrointestinal endoscopy were included in this study and randomly divided into experimental group and control group, with 60 cases in each group. The experimental group was given remimazolam for sedation, while the control group was given conventional sedatives. The heart rate, blood pressure, and respiratory rate of the patients were measured before the examination, during the examination, and at 15 and 30 minutes after the examination. The heart rate and blood pressure of the experimental group during the examination were significantly lower than those of the control group ($P < 0.05$); however, there was no significant difference in respiratory rate at each time point ($P > 0.05$). The sedation effect of the experimental group was significantly better than that of the control group ($p = 0.006$), but there was no significant difference in the scores at 15 and 30 minutes after the examination ($p > 0.05$). There was no significant difference in adverse reactions between the two groups ($p > 0.05$). Remimazolam can effectively reduce the heart rate and blood pressure of patients during pain-free gastrointestinal endoscopy, provide good sedation effect, and have minimal impact on respiratory rate, thus demonstrating good safety.

1. Introduction

With the development of medical technology, pain-free gastrointestinal endoscopy has gradually become an important means of clinical diagnosis of gastrointestinal diseases. The use of sedative drugs in this process can alleviate patients' pain and discomfort, improve the success rate of examinations, and increase patient satisfaction. Remimazolam, as a novel short-acting benzodiazepine sedative, has been widely used in pain-free gastrointestinal endoscopy due to its rapid onset, short duration of action, and high safety. In recent years, the application research of remimazolam in pain-free gastrointestinal endoscopy has been increasing, and some studies have shown that remimazolam can effectively reduce patients' anxiety and pain, improve the comfort and safety of examinations. However, there are relatively few systematic studies on the effects of remimazolam on patients' heart rate, blood pressure, and respiratory rate. This study aims to explore

the effects of remimazolam on patients' heart rate, blood pressure, and respiratory rate in pain-free gastrointestinal endoscopy, in order to provide a more comprehensive safety assessment for clinical application.

2. Materials and Methods

2.1 Study Population

A total of 120 patients requiring pain-free gastrointestinal endoscopy were included in this study and randomly divided into an experimental group and a control group, with 60 cases in each group. The patients ranged in age from 18 to 65 years old and weighed between 50 and 90 kilograms. All patients met the American Society of Anesthesiologists (ASA) classification I to II. Patients who were allergic to remimazolam or other sedative drugs, had heart disease, liver or kidney dysfunction, were pregnant or lactating women, or had severe respiratory diseases were excluded. After obtaining informed consent, the patients' basic information was recorded, including age, gender, weight, disease type (such as gastritis, gastric ulcer, colitis, etc.), medical history, and medication use. In addition, the ASA classification of each patient was recorded to assess the patient's overall condition and anesthetic risk. Before the start of the experiment, all patients underwent routine examinations such as electrocardiography, blood routine, and liver and kidney function to ensure that they met the inclusion criteria and exclude interfering factors that might affect the study results[1]. To ensure the objectivity and accuracy of the experiment, the researchers randomly assigned the patients to the experimental group and the control group to ensure comparability in basic information such as age, gender, and weight.

2.2 Study Methods

2.2.1 Randomization and Intervention

This study adopted a randomized controlled trial design. After obtaining informed consent from the patients, 120 patients were randomly divided into an experimental group and a control group, with 60 cases in each group. The patients in the experimental group were given remimazolam for sedation, while those in the control group were given conventional sedatives (midazolam). All operations were performed by professional anesthesiologists.

2.2.2 Drug Administration

Baseline physiological parameters (heart rate, blood pressure, and respiratory rate) were measured in all patients 30 minutes before the examination. The patients in the experimental group were given an initial dose of remimazolam of 0.03-0.05 mg/kg, with the maintenance dose adjusted according to the patient's response and examination requirements. The patients in the control group were given the corresponding dose of conventional sedatives. The administration of sedative drugs was carried out under the monitoring of professional medical staff to ensure patient safety[2].

2.2.3 Monitoring of Physiological Parameters

During the gastrointestinal endoscopy, the patient's heart rate, blood pressure, and respiratory rate were measured every 5 minutes, and the patient's consciousness and sedation depth were recorded. After the examination, the patient's physiological parameters were continued to be monitored until the patient regained full consciousness. The above parameters were measured again at 15 minutes and 30 minutes after the examination[3].

2.3 Study Indicators

2.3.1 Changes in Heart Rate

The main focus is on the effect of remimazolam on the heart rate of patients undergoing pain-free gastrointestinal endoscopy. By comparing the changes in heart rate of patients in the experimental group and the control group 30 minutes before the examination, during the examination, and 15 and 30 minutes after the examination, the impact of remimazolam on heart rate and its safety can be evaluated.

2.3.2 Changes in Blood Pressure

The study examines the effect of remimazolam on the blood pressure of patients. By monitoring and recording the changes in blood pressure of patients in the experimental and control groups at different time points, the effect of remimazolam on blood pressure during sedation and its safety for the circulatory system of patients can be analyzed.

2.3.3 Changes in Respiratory Rate

The study evaluates the effect of remimazolam on the respiratory rate of patients. By comparing the respiratory rates of patients in the experimental and control groups 30 minutes before the examination, during the examination, and 15 and 30 minutes after the examination, the safety and impact of remimazolam on the respiratory system during pain-free gastrointestinal endoscopy can be explored.

2.3.4 Sedation Effect

Using a standardized sedation scoring scale (such as the Ramsay Sedation Scale) to assess the sedation status of patients throughout the examination. The Ramsay Sedation Scale is generally divided into levels 1-6, where level 1 indicates extreme anxiety or agitation in the patient, and level 6 indicates complete sedation with no response to stimuli. Doctors choose the appropriate level based on the patient's performance to score the overall performance of the patient under sedation[4].

2.3.5 Adverse Reactions

Recording and analyzing adverse reactions that occur in patients in both the experimental and control groups throughout the study, such as respiratory depression, nausea, and vomiting, will evaluate the safety and tolerability of remimazolam.

2.4 Data Processing and Analysis

This study uses SPSS software to process and analyze the collected data, with a p-value less than 0.05 indicating statistical significance.

3. Results

3.1 Heart Rate Indicators

Table 1 shows the effect of remimazolam on heart rate during painless gastrointestinal endoscopy. The data indicate that there was no significant difference in heart rate between the experimental and control groups 30 minutes before the examination, suggesting that the heart rates of the two groups

were similar before sedation. However, during the examination, the heart rate in the experimental group was significantly lower than that in the control group, indicating that remimazolam had a better sedative effect and could effectively reduce the heart rate of patients during the examination, thus reducing their tension and anxiety. At 15 and 30 minutes after the examination, the difference in heart rate between the two groups was not significant, indicating that the effect of remimazolam faded quickly after the examination, and the patient's heart rate could return to normal levels in a short time.

Table 1: The Effect of Remimazolam on Heart Rate during Painless Gastrointestinal Endoscopy

Time Point	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	t-value	p-value
30 minutes before examination	72.5 ± 8.2	73.1 ± 7.9	0.46	0.645
During examination	78.3 ± 10.4	82.7 ± 11.2	2.44	0.016
15 minutes after examination	74.2 ± 9.1	75.8 ± 8.7	1.08	0.281
30 minutes after examination	72.8 ± 8.4	73.4 ± 7.8	0.44	0.66

3.2 Blood Pressure Indicators

Table 2: The Effect of Remimazolam on Blood Pressure during Painless Gastrointestinal Endoscopy

Time Point	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	t-value	p-value
30 minutes before examination	125/80 ± 10/6	126/81 ± 11/7	0.58	0.562
During examination	130/85 ± 12/8	135/88 ± 13/9	2.37	0.019
15 minutes after examination	127/82 ± 11/7	128/83 ± 12/8	0.62	0.536
30 minutes after examination	125/80 ± 10/6	126/81 ± 11/7	0.58	0.562

Table 2 compares the effects of midazolam on patient blood pressure during painless gastrointestinal endoscopy. It was found that the blood pressure of the experimental group was significantly lower than that of the control group during the examination, indicating that midazolam can effectively reduce patient blood pressure during painless gastrointestinal endoscopy, thereby alleviating patient tension and discomfort. The blood pressure measurements taken 30 minutes before the examination and 15 and 30 minutes after the examination showed no significant differences between the experimental and control groups, indicating that the effect of midazolam on patient blood pressure is mainly concentrated during the examination. This may be related to the pharmacological effects of midazolam, which has a transient sedative and hypotensive effect, helping patients maintain a stable physiological state during the examination.

3.3 Respiratory Rate Indicators

Table 3 observes the effect of midazolam on patient respiratory rate during painless gastrointestinal endoscopy. It was found that there were no significant differences in respiratory rate between the experimental and control groups at each time point, indicating that midazolam has minimal effect on patient respiratory rate and does not cause significant respiratory depression. The measurements of respiratory rate taken 30 minutes before the examination, during the examination,

and 15 and 30 minutes after the examination all showed no statistically significant differences between the experimental and control groups. This result indicates that the use of midazolam in painless gastrointestinal endoscopy is safe and does not adversely affect patient respiratory function due to its sedative effect.

Table 3: The Effect of Remimazolam on Respiratory Rate during Painless Gastrointestinal Endoscopy

Time Point	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	t-value	p-value
30 minutes before examination	16.2 ± 2.1	16.3 ± 2.2	0.29	0.773
During examination	18.5 ± 2.8	19.2 ± 3.1	1.41	0.161
15 minutes after examination	16.7 ± 2.4	17.1 ± 2.5	1	0.319
30 minutes after examination	16.3 ± 2.2	16.4 ± 2.3	0.29	0.773

3.4 Sedation Effectiveness Indicators

Table 4: The impact of remimazolam on the sedation effect of patients during painless gastrointestinal endoscopy

Indicator	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	t-value	p-value
Ramsay score (during examination)	4.2 ± 0.8	3.8 ± 0.9	2.78	0.006
Ramsay score (15 minutes after examination)	2.5 ± 0.7	2.3 ± 0.6	1.85	0.066
Ramsay score (30 minutes after examination)	2.1 ± 0.5	2.0 ± 0.5	1.22	0.224

Table 4 evaluates the sedative effect of midazolam during painless gastrointestinal endoscopy using the Ramsay Sedation Scale. The results show that the Ramsay Sedation Scale scores of the experimental group during the examination were significantly higher than those of the control group (P=0.006), indicating that patients in the experimental group achieved a deeper sedation state during the examination. This is important for alleviating patient discomfort and ensuring the smooth progress of the examination. At 15 and 30 minutes after the examination, although the Ramsay Sedation Scale scores of the experimental group were slightly higher than those of the control group, the difference did not reach statistical significance, indicating that the sedative effect of midazolam gradually diminishes after the examination, and patients can recover consciousness in a relatively short time. This is important for ensuring the safety and comfort of patients after the examination.

3.5 Adverse Reaction Indicators

Table 5: Adverse reactions of patients during painless gastrointestinal endoscopy with remimazolam

Adverse Reaction	Experimental Group [n (%)]	Control Group [n (%)]	χ^2-value	p-value
Respiratory depression	2 (3.3%)	1 (1.7%)	0.37	0.543
Nausea and vomiting	4 (6.7%)	5 (8.3%)	0.22	0.639

Table 5 compares the adverse reactions of patients in the experimental group and the control group during sedation. The results show that there is no significant difference in adverse reactions such as respiratory suppression and nausea and vomiting between the two groups (p>0.05),

indicating that remimazolam has a high safety profile and does not increase the risk of adverse reactions during painless gastrointestinal endoscopy. The incidence rates of respiratory suppression are 3.3% in the experimental group and 1.7% in the control group, and the incidence rates of nausea and vomiting are 6.7% in the experimental group and 8.3% in the control group, with no statistically significant differences between the groups.

4. Conclusion

In this study, it was found that remimazolam significantly reduces the heart rate of patients during painless gastrointestinal endoscopy. This result indicates that remimazolam has a good sedative effect, which can reduce patients' anxiety and tension, thereby lowering the heart rate. This is important for improving the safety and comfort of the examination, especially for patients with poor cardiac function or high cardiac requirements. However, the effect of remimazolam on heart rate was only significant during the examination, and there was no significant difference in heart rate before and after the examination, which may be related to the duration of drug efficacy and the physiological recovery of patients.

Remimazolam can significantly reduce the blood pressure of patients during painless gastrointestinal endoscopy. This finding, in conjunction with its effect on heart rate, further confirms the sedative and soothing effects of remimazolam. Lowering blood pressure can help reduce vascular tension and cardiovascular risks during the examination, which is particularly advantageous for patients with hypertension. Similar to heart rate, the reduction in blood pressure mainly occurs during the examination, and there is no significant change in blood pressure before and after the examination, suggesting that the effect of remimazolam is time-limited.

Remimazolam had no significant effect on the respiration rate of patients during painless gastrointestinal endoscopy ($p>0.05$), indicating that while providing sedative effects, remimazolam does not cause significant respiratory suppression. This is crucial for ensuring patient safety. The stability of the respiration rate indicates that remimazolam can effectively sedate patients without affecting respiratory function, allowing them to remain comfortable and quiet throughout the examination, which is particularly important for patients who require long examinations or have special respiratory requirements.

In terms of adverse reactions, remimazolam has a high safety profile and does not increase the risk of adverse reactions in patients. Therefore, remimazolam is a safe and effective sedative drug for use in painless gastrointestinal endoscopy, capable of significantly reducing patients' heart rate and blood pressure during the examination, alleviating patients' tension and discomfort. Additionally, its minimal impact on respiration rate and low risk of respiratory suppression make remimazolam a safe and effective sedative drug for use in painless gastrointestinal endoscopy[5].

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