

Preemptive Analgesic Application of Compound Lidocaine Cream for Stereotactic Head Holder Fixing in Gamma Knife Treatment

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Abstract: Purpose: To compare patients' pain and stress reactions while fixing the stereotactic headstock for gamma knife treatment by applying compound lidocaine cream for epidermal anesthesia and lidocaine cream for local anesthesia, and applying lidocaine cream alone for local anesthesia. Method: 436 patients admitted to the Gamma Knife Center of the First Affiliated Hospital of Jinan University from February-September 2022 were randomly divided into a study group (n=216) and control group (n=219). In the study group, the lidocaine cream (5%) was applied at two nail positions behind the frontal pillow one hour before the stereotactic head holder was fixed, and the holder was installed following local anesthesia with lidocaine cream following local drug infiltration. In the control group, lidocaine injection was used for local anesthesia. The Visual Analogue Scale (VAS) score was used for self-assessment to objectively measure the degree of facial pain, and the revised Facial Pain Scale (FPS-R) was used for behavioral assessment. The pain was scored and graded before, during and after the fixation, recording changes of the mean arterial pressure and heart rate before and after the installation as the patients showed stress reaction. Results: There was no significant difference ($P>0.05$) in VAS score, FPS-R classification, mean arterial pressure and heart rate between the two groups before the stereotactic headstock fixation. During the fixation, the VAS scores of the study group and the control group decreased significantly, and the difference was statistically significant ($P<0.0001$). In the study group, the FPS-R showed more mild pain than in the control group, and the difference was statistically significant ($P<0.001$). Five minutes after the fixation, the VAS score of the study group was lower than that of the control group, with statistical significance ($P<0.001$). After the fixation, the mean arterial pressure was lower in the study group than in the control group, and the difference was statistically significant ($P<0.001$). Immediately after the fixation, the heart rate of the study group was lower than that of the control group, and the difference was statistically significant ($P<0.05$). Conclusion Applying 5% compound lidocaine cream to the stereotactic head holder nail positions prior to gamma knife treatment produces a good preemptive analgesia effect, with positive significance for reducing the occurrence of syncope and seizures caused by pain during head holder installation, making patients feel more comfortable during treatment.

Keywords: Gamma Knife, Stereotactic Head Holder, Compound Lidocaine Cream, Preemptive Analgesia

1. Introduction

Gamma knife, or stereotactic radiosurgery, causes less trauma, pain and side effects and is highly precise and effective in treatment of brain tumors, and been widely used in neurosurgery and other clinical applications [1]. Fixing the stereotactic head holder is the most important step in treatment

of brain diseases using gamma knife, but it often causes great pain to patients [2]. Local anesthesia is needed on the surface of the four nail positions to fix the holder, and the doctor must turn the screw with considerable force to fix it precisely and properly, so patients tend to feel extremely uncomfortable. Reducing pain in this process and making patients feel more comfortable in their treatment has become a focus of the

Gamma Knife Center. Fixing the head holder is the most critical step, so preemptive analgesia at the nail position can give patients a sense of safety and trust so they suffer less psychological trauma, and become more compliant and comfortable in the treatment process. When compound lidocaine cream (5%) is applied to the local skin of the nail position, with internal skin permeation, the drug will penetrate to the superficial vascular surface of the skin, relaxing the vascular smooth muscle, reducing the sensitivity of nerve cells, and reducing the excitability of nerve ending pain receptors, thus playing an analgesic role [3]. The Gamma Knife Center selected gamma knife treatment patients as the research objects, and applied compound lidocaine cream (5%) at the nail position of their heads for preemptive analgesia before fixing the head holder, achieving good results. The report is as follows.

2. Data and Methods

2.1. General Information

From February to September, 2022, 637 patients who were treated by gamma knife in the First Affiliated Hospital of Jinan University were selected as the research objects. The inclusion criteria: 1) Age between 17 and 72; 2) Patients are informed of relevant information and agree to cooperate with the study; 3) Patients are not allergic to local anesthetics or any other medicine; 4) No skin damage or rashes at the nail position; 5) Normal consciousness, perception, description and spirit.

Based on the inclusion criteria, 436 patients were randomly divided into two groups: the study group (216 patients), including 114 males and 102 females aged 19-72 (average age 51.20 ± 1.00); and the control group (219 patients), including 104 males and 115 females aged 17-72 years (average age 50.80 ± 0.90). There were no significant differences between the two groups in terms of basic information, such as age and sex ($P > 0.05$). This study was validated by the Ethics Committee of First Affiliated Hospital, and all patients were informed of relevant information and agreed to participate.

2.2. Methods

Before treatment, both patient groups were given psychological counseling and routine nursing intervention to avoid negative emotions such as tension and anxiety. In the control group, lidocaine injection was used for local anesthesia.

In order to achieve the best anesthetic effect, the local skin of the patients in the study group was cleaned, and the skin on the left and right sides of their foreheads and occipitalia was wiped with an alcohol cotton pad (75% alcohol) one hour before the treatment and left to dry, helping prevent grease dirt and dead tissue on the skin from affecting the penetration and absorption of the ointment. Compound lidocaine cream (5%) (Tongfang Pharmaceutical Group Co., Ltd.; 10g/ piece; each gram contains 25mg of procaine and 25mg of lidocaine; NMPN: H20063466) was applied to the skin (5cm*5cm in

size and 2mm in thickness) near the four nail positions. After the application, the skin around the nail position was covered with plastic wrap for about 1 hour. After natural absorption, the plastic wrap was removed, and the remaining cream wiped off. After that, lidocaine injection was used for local anesthesia, and then the fixed stereotactic head holder was installed [4].

2.3. Observation Indicators

2.3.1. Pain Evaluation

The patient's perception over the local anesthetic application process before fixing the head holder was judged through a combination of self-evaluation and behavioral evaluation. In the self-assessment portion, VAS score was used. The patients scored their pain perception in real time over the whole process on a scale of 0-10, with 0 indicating no pain and 10 indicating unbearable pain [5]. In the behavioral evaluation portion, the FPS-R scale is used to objectively judge the degree of pain patients experienced over the whole process, which is divided into no pain, mild pain, moderate pain and severe pain. No pain (0 point): no pain locally; Mild pain (1-3 points): no change in facial expression, no response to pain, and slight pain locally; Moderate pain (4-6 points): tense facial expression, frowning, and severe local tingling; Severe pain (7-10 points): Resistance motions in the upper and lower limbs, sweating, groaning, crying, and unbearable pain at the puncture point [3]. The VAS score and FPS-R pain rating were recorded before the head holder was fixed, during the local anesthesia as the holder was fixed, and 5 minutes after it was fixed.

2.3.2. Mean Arterial Pressure and Pulse

The mean arterial pressure and heart rate changes were measured for 5 minutes before fixing the holder and immediately afterward.

2.3.3. Adverse Reactions

During the fixing process, patients were observed for syncope, seizures, or other adverse reactions due to pain, fear or tension.

2.4. Statistical Methods

Graphpad 6.01 was used for analysis. The measurement data are expressed as "mean standard \pm deviation ($\bar{x} \pm s$). The comparison between groups is made by t test and variance analysis. The data are expressed as percentage (%), and the χ^2 test is used. The test level $\alpha = 0.05$, and $P < 0.05$ indicates statistically significant differences.

3. Results

3.1. Mean Arterial Pressure and Heart Rate

Before the head holders were fixed, there were no significant differences ($P > 0.05$) in mean arterial pressure and heart rate between the two groups. After the holder was fixed, the mean arterial pressure measurements in both groups

immediately increased, and the measured heart rate decreased. Comparison between the two groups shows that the mean arterial pressure in the control group was higher than that in the study group immediately after the holder was fixed, and

the difference was statistically significant ($P < 0.001$); the heart rate of the control group was higher than that in the study group immediately after the holder was fixed, and the difference was statistically significant ($P < 0.05$). See Table 1.

Table 1. Comparison of mean arterial pressure and heart rate before and after fixation of stereotactic head holder between the two groups ($\bar{x} \pm s$).

Group	n	Mean arterial pressure (MAP) (mmHg)		Heart rate (times/min)	
		5min prior to fixation	Immediately following fixation	5min prior to fixation	Immediately following fixation
Study group	216	97.96 \pm 0.83	100.20 \pm 0.99	83.57 \pm 0.88	79.86 \pm 0.89
Control group	219	98.10 \pm 0.88	107.00 \pm 1.09	85.44 \pm 0.89	83.07 \pm 0.94
t value		0.1194	4.655	1.499	2.480
P value		0.9050	<0.001	0.1347	0.0135

3.2. VAS and FPS-R Scoring Results

The fixed VAS and FPS-R of both groups were 0 (no pain). When local anesthesia was applied during fixation, the VAS score of the control group was significantly higher than that of the study group, and the number of patients suffering severe pain in the control group was significantly higher than that in the study group. There was a significant difference in VAS

scores between the two groups ($P < 0.001$). Five minutes after fixation, the VAS score in the study group was lower than in the control group, and the number of patients in the study group suffering no pain according to FPS-R was significantly higher than in the control group. The difference in VAS scores and in FPS-R between the two groups was statistically significant ($P < 0.0001$ and $P < 0.001$ respectively). See Tables 2 and 3.

Table 2. Comparison of VAS scores before and after fixation of stereotactic head holder between the two groups ($\bar{x} \pm s$).

Group	n	5min prior to fixation	During fixation	Following fixation
Study group	216	0	4.9 \pm 0.1	1.0 \pm 0.1
Control group	219	0	6.8 \pm 0.1	1.6 \pm 0.1
T			14.24	4.906
P			<0.0001	<0.0001

Table 3. FPS-R before and after fixation of the stereotactic head holder in the two groups [$n(\%)$].

Group	n	5min prior to fixation	During fixation				Following fixation			
		No	No	Mild	Moderate	Severe	No	Mild	Moderate	Severe
Study group	216	216 (100.00)	0	99 (45.83)	95 (43.98)	22 (10.19)	130 (61.11)	79 (36.57)	7 (3.24)	0
Control group	219	219 (100.00)	0	8 (3.65)	112 (51.14)	99 (45.21)	75 (34.25)	123 (56.16)	17 (7.76)	3 (0.14)
Z			11.174				5.376			
P			$P < 0.001$				$P < 0.001$			

3.3. Adverse Reactions

4 pre-syncope cases in the study group; 1 seizure, 3 pre-syncope cases, and 11 syncope cases in the control group; 2 male patients with syncope symptoms, 9 male and 9 female adolescent patients, mainly females.

4. Discussion

The Gamma knife is a non-invasive treatment of brain tumors, but installation of the fixed stereotactic head holder is an invasive operation. Free nerve endings in the body are widely distributed in epidermis and dermis, while nerve endings under the face and scalp are rich and sensitive, causing patients significant pain and discomfort during the puncture. After the needle pierces the epidermis, the peripheral receptors are activated, and the tissue releases pain-causing substances, which act on the free nerve endings to produce pain, and then are transmitted to the central nervous system, causing the patient pain and aggravating their nervousness, producing behavioral changes, which will affect

the operation process [6-8]. Intradermal injection of lidocaine for local anesthesia is a widely used analgesic method in clinical operation, but it ignores pain caused by the steel needle puncture. As an unpleasant feeling caused by potential or real tissue damage, pain is the fifth vital sign for humans. With the continuous improvement of medical technology, more and more patients have greater needs for more comfortable experience in diagnosis and treatment, and the negative effects of pain are attracting increasing attention. Relieving patients' pain in reasonable ways is extremely important [9]. Patients receiving gamma knife treatment are very nervous due to their fear of the disease, unfamiliarity with the treatment method, and the severe pain they will suffer during treatment, so they tend to have adverse emotions such as fear and tension. In the strange environment of the hospital, and being unfamiliar with the medical staff, their nerves and body fluids tend to be affected, and they have less tolerance for pain stimulation, causing adverse reactions such as syncope in a small number of patients due to pain [10]. Nurses must intervene in advance and take effective measures to alleviate the pain suffered during the head holder fixing process so that can patients feel more comfortable during

diagnosis and treatment.

Preemptive analgesia, also known as preventive analgesia, runs through the whole process before, during and after treatment. By preventing central and peripheral pain sensitivity, adverse reactions caused by pain can be reduced or avoided, and patients' pain tolerance can be improved [11]. With deepening clinical research, some studies have shown that unnecessary pain can be relieved by adequate preoperative preparation [12]. The combination of compound lidocaine cream and lidocaine local anesthesia can improve the analgesic effect and reduce pain to the largest extent, in line with the concept of preemptive analgesia [13].

This study shows that the mean arterial pressure and heart rate of the study group have smaller fluctuation ranges than those of the control group. The VAS score of the study group is lower than that of the control group, the FPS-R rating of the study group is higher than that of the control group, and the incidence of adverse reactions associated with pain is lower in the study group than that of the control group. These results demonstrate that compound lidocaine cream can relieve pain during the head holder fixing process. If patients are informed of the function of the ointment during the application process, they can get mental comfort, and suffer less negative emotions, and thus less pain. The application of compound lidocaine cream before the treatment to relieve local skin pain can alleviate pain caused by the needle puncture and intradermal injection of lidocaine, make patients more comfortable with the treatment process, and reducing adverse reactions caused by pain. However, compound lidocaine cream has a long application time (not less than 45 minutes), and the onset of anesthesia and analgesia takes 90 minutes. Of the two medicines, lidocaine takes effect more quickly and has better penetration effect, but its effect does not last more than 90 minutes. In contrast, prilocaine takes effect more slowly, but its anesthetic effect is four times that of lidocaine and lasts up to five hours. Therefore, if they are combined in the treatment, the two medicines will take effect more quickly, and their effect will last longer [14]. As a result, it is better to start the treatment 45-90 minutes after the ointment is applied. The current use of compound lidocaine cream for installation and fixation of the stereotactic head holder has a good advance analgesic effect. However, it is inconvenient to apply the ointment to the two nail positions on the occipitalia due to the scalp, so this method takes longer time and is inconvenient. Therefore, future related research should find a method that takes effect fast, is simple to use and produces good analgesic effect.

5. Conclusions

In summary, application of compound lidocaine cream for preemptive analgesia can relieve patients' discomfort and reduce their anxiety and adverse reactions caused by pain during fixation of the head holder for gamma knife treatment, so it should be promoted in the gamma knife treatment for brain diseases.

Conflicts of Interest

The author declares that there is no conflict of interest in this article.

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