

Cold Application Versus Aloe Vera Gel to Reduce Pain, Periorbital Edema, and Ecchymosis Post Craniotomy

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Abstract

Background: Craniotomy is a fundamental approach for managing traumatic brain injuries globally. Patients recovering from craniotomy often experience moderate to severe pain, along with periorbital swelling and bruising. Cold therapy and Aloe vera gel are non-pharmacological methods that may help alleviate pain and reduce edema after the procedure. The aim of this study is to compare the effectiveness of cold therapy versus Aloe vera gel in decreasing pain, periorbital swelling, and bruising following craniotomy. The study involved a convenient sample of 90 patients admitted to the neurosurgery ICU, employing a quasi-experimental design with both study and control groups. **Setting:** Neurosurgery ICU at Menoufia University Hospital, Shebin EL-Kom, Egypt. **Instruments:** (1) Demographic and medical data sheet; (2) Visual Analog Scale (VAS) for pain used to measure pain intensity post craniotomy; (3) modified Surgeon Periorbital Rating of Edema and Ecchymosis (SPREE) used to assess periorbital edema and ecchymosis post craniotomy; (4) Glasgow Coma Scale used as screening tool to assess conscious level. **Results:** There was a statistically significant difference between study groups who received cold applications compared to the group who received Aloe vera gel regarding pain intensity post intervention ($p < 0.001$). Periorbital edema and ecchymosis were significantly reduced in the study group who received cold application compared to the group who received Aloe vera gel ($p < 0.001$). **Conclusion:** Cold application is superior to Aloe vera gel in reducing pain intensity, periorbital edema, and ecchymosis post craniotomy. **Recommendation:** Encourage critical care nurses to create practice guidelines for managing pain after craniotomy, incorporating cold therapy as a non-pharmacological option.

Keywords: Aloe vera gel, cold application, ecchymosis, periorbital edema, post craniotomy

INTRODUCTION

Craniotomy is a key procedure in the treatment of traumatic brain injury (TBI) globally, with estimates suggesting that over 60,000 craniotomy surgeries are conducted each year in the United States. This common neurosurgical operation can be performed either in emergency situations or electively. A craniotomy involves the surgical excision of a portion of the skull to gain access to the intracranial areas [1].

Postoperative complications following craniotomy may include hematoma formation, cerebral swelling, periorbital edema, infections of the wound or bone flap, epidural abscesses, and herniation. It is difficult for patients to have a pupillary examination due to periorbital edema, a typical post-craniotomy consequence that develops

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during the first 24–48 hours and lasts for 3–7 days [2]. A patient with periorbital edema may experience pain, ecchymosis with or without hematoma formation and blurred vision because of a buildup of liquid between the galeal aponeurosis and subgaleal collection. The prevalence of periorbital edema is 36.8%–100%, the incidence of ecchymosis is 62.5%, and the pupillary testing is not possible for 30% of patients with edema during the first 36 hours after craniotomy [3].

Despite advances in neurosurgical approaches, subgaleal fluid collection and the formation of periorbital edema cannot be prevented. Therefore, there is no standard of care or strategy for controlling periorbital edema and ecchymosis [4].

Additionally, 60%–90% of patients report feeling pain after a craniotomy, with 64%–84% reporting moderate to severe pain. The subgaleal collection, fewer pain receptors in the dura, brain pain insensitivity, decreased pain fiber density along the incision lines, or emergency auto analgesia are the causes of this pain [5].

The critical care nurse has a crucial role in minimizing or relieving pain, decreasing the degree of periorbital edema and ecchymosis related to surgical intervention, and keeping patients safe while raising patient satisfaction [6]. There are various pharmacological and non-pharmacological methods for reducing pain and periorbital edema, such as steroids, positioning, cold application, and using *Aloe vera* gel [7].

Cold applications have localized anti-inflammatory, anti-spasmodic, and analgesic effects as well as slowing down tissue metabolism and nerve conduction velocity, they are widely utilized as a safe, noninvasive, and non-pharmacological nursing intervention to reduce edema and relieve pain. In addition, cold therapy reduces the temperature of the injured area, increases capillary constriction, stimulates blood vessel vasoconstriction, promotes cellular survival, and treats aberrant skin tissue. It is also frequently used to lessen tissue deterioration, hemorrhage, and muscular soreness, as well as to change how pain is transmitted from damaged tissues [1].

Aloe vera gel also reduces the signs and symptoms of inflammation, particularly in cases of subcutaneous hematoma and sports injuries. Moreover, it reduces fibrinolysis and blood coagulation, which increases tissue metabolism and absorbs surface inflammatory exudate [8, 9]. *Aloe vera* gel has over 70 physiologically active ingredients and has anti-inflammatory, antioxidant, immune-boosting, anti-cancer, anti-aging, and anti-diabetic qualities. Despite having a water content of 99%, *Aloe vera* gel also contains compounds known as polysaccharides and glycoproteins [10]. While polysaccharides promote the absorption of the exudate from the surface inflammatory process, glycoprotein inhibits pain and inflammation. Also, it works well as a moisturizer [11, 12].

Cold application and *Aloe vera* gel can be a potential approach for the management of pain, periorbital edema, and ecchymosis post craniotomy. It has been demonstrated that applying cold therapy is a safe, affordable, and simply accessible way to reduce pain [13].

SIGNIFICANCE OF THE STUDY

Periorbital edema and ecchymosis after craniotomy are common discomforts to patients, which start to appear during the first 24–48 hours and remain for three to seven days. Critical care nurses could apply various therapeutic approaches for patients to relieve pain and reduce periorbital edema and ecchymosis. Cold therapy and *Aloe vera* gel are straightforward and cost-effective treatments that have long been recognized as effective non-pharmacological options for managing pain and swelling [1].

Cold applications are recognized for their ability to enhance capillary contraction, control edema, and modulate pain transmission by reducing permeability, hemorrhage, and metabolism in the

damaged area. Additionally, *Aloe vera* gel has a positive impact on the degree of pain and swelling post operation [9, 14].

Although cold therapy has demonstrated beneficial effects in alleviating pain and reducing periorbital swelling and bruising, there is a need for further evidence to establish the optimal techniques for preventing such complications after craniotomy. This information will assist critical care nurses in making informed decisions about best practices and enhancing postoperative recovery. Therefore, the aim of the current study was to compare the effectiveness of cold therapy and *Aloe vera* gel in reducing pain, periorbital edema, and facial bruising following craniotomy.

DEFINITION OF VARIABLES

Pain is theoretically described as “an unpleasant sensory or emotional experience linked to actual or potential tissue damage.” In this study, pain was operationally defined by the score assigned on the Visual Analog Scale (VAS). The scoring system was interpreted as follows: 0 indicates no pain, 1–3 indicates mild pain, 4–6 indicates moderate pain, 7–9 indicates severe pain, and 10 indicates extreme pain.

- *Periorbital edema*: It is theoretically defined as “swelling in the tissue around the eyes” [13]. In this study, periorbital edema was operationally defined by the individual score received on the modified Surgeon Periorbital Rating of Edema and Ecchymosis (SPREE). The scoring system for periorbital edema: 0 represents no edema, 1 represents minimal edema, 2 represents edema outspreading on the iris, 3 represents edema covering the iris, and 4 represents massive edema with a swollen locked eyelid.
- *Ecchymosis*: It is theoretically defined as “discoloration in the tissue around upper and lower eyelids caused by blood tracking into periorbital tissue” [13]. In this study, ecchymosis was operationally defined by the individual score achieved on the modified SPREE. The system for spotting ecchymosis is as follows: 0 denotes the absence of ecchymosis, 1 indicates less than 2 cm², 2 indicates less than 4 cm², 3 indicates ecchymosis under 6 cm², and 4 represents ecchymosis equal to or beyond 6 cm².

PURPOSE OF THE STUDY

The aim of the current study was to compare the effect of cold application versus *Aloe vera* gel to reduce pain, periorbital edema, and ecchymosis post craniotomy.

Hypotheses

1. Patients who receive cold applications will experience less pain intensity than the patients who receive *Aloe vera* gel.
2. Patients who receive cold application will experience less periorbital edema and ecchymosis than patients who receive *Aloe vera* gel.

METHODS

Research Design

Quasi experimental (study/control) design was utilized to test the hypotheses.

Setting

The present study was conducted at Neurosurgery ICU at Menoufia University Hospital, Shebin EL-Kom, Menoufia Governrat, Egypt.

Sample

A convenience sample of 90 critically ill adult patients was selected from the neurosurgery ICUs at Menoufia University Hospital. After 24 hours of post craniotomy, patients were able to participate in the study if they met the study inclusion criteria which include: (a) adult patients aged from 18 to 65 years old; (b) able to understand the VAS; (c) having stable hemodynamic status. Patients were

excluded from the study if they had any of the following conditions (a) GCS score lower than 8; (b) presence of postoperative ptosis; (c) peripheral vascular disease and Raynaud's disease which causes blood vessels to narrow excessively in response to cold or stress may be more prone susceptible to complications like frostbite; (d) hypersensitivity to cold or cold urticarial can lead to allergic reactions; and (e) open surgical wound or active wound infection because ice application may exacerbate these conditions. These criteria led to the exclusion of 15 patients from the study during enrolment. Additionally, during the follow-up, 15 patients were dropped from the study: two patients who refused cold application, four patients who refused *Aloe vera* gel, five patients who were discharged on the second postoperative day, two patients who were transferred to another hospital, and two patients who died. Patients who met the study's inclusion criteria were allocated randomly into three equal groups, (each 30 patients). The control group received standard hospital care, which included covering the periorbital area with saline soaked gauze and change every shift. The study group (I) received cold application with cooling gel pack along with routine care and the study group (II) received *Aloe vera* gel along with routine care.

Sample Size Calculation

The G power software analysis was used to determine the sample size. A 5% significant level of difference between the percentage of patients receiving cold application versus *Aloe vera* gel could be detected with 85% power. The sample size was determined using a 0.05 and medium effect size to account for the attrition rate in these populations, an additional 10 patients were added to the calculated sample size to compensate for the attrition rate in this patients population. Therefore, 90 patients made up the total sample size.

INSTRUMENTS OF DATA COLLECTION

Instrument (I) Demographic and Medical Data Sheet

The sheet used to collect data about patient's age, gender, and clinical data such as medical diagnosis, type, and duration of surgery. Data were extracted from the patient's medical record.

Instrument (II) Pain

VAS

The VAS, as adopted by Cline et al. (1992), is utilized to evaluate pain severity. Participants complete the VAS independently, drawing a line perpendicular to the scale to indicate their pain level [15, 16]. The score is determined by measuring the distance on a 10-cm line between the endpoints marked 0 and 10. The grading system is interpreted as follows: 0 indicates no pain, 1–3 indicates mild pain, 4–6 indicates moderate pain, 7–9 indicates severe pain, and 10 indicates excruciating pain. Alghadir [17] investigated the VAS's reliability and found that it was the most dependable scale with the fewest measurement errors for acute pain, as well as having good test-retest reliability. Retest reliability, they discovered, was $r = 0.84$.

Instrument (III) Modified SPREE

It was developed by Kara & Gokalan (1999) [18] to evaluate eyelid edema and ecchymosis. The scale of ratings goes from 0 to 4. The eyelid edema grading method is as follows: 0 denotes no edema; 1 denotes minimal edema; 2 denotes edema outspreading on the iris, 3 denotes edema covering the iris, and 4 denotes significant edema with a swollen locked eyelid. The ecchymosis scoring system is 0 represented absence of ecchymosis; 1 represented ecchymosis $< 2 \text{ cm}^2$, 2 represented ecchymosis $< 4 \text{ cm}^2$, 3 represented ecchymosis $< 6 \text{ cm}^2$, and 4 represented ecchymosis $\geq 6 \text{ cm}^2$. The reliability of the SPREE has strong internal consistency with an alpha of 0.94 and high test-retest reliability [18].

Instrument (IV) Glasgow Coma Scale

The Glasgow Coma Scale (GCS) was used as a screening tool. Its purpose was to evaluate the extent and length of compromised consciousness and coma. Three behavioral dimensions are assessed separately: verbal performance, eye opening, and motor response [19]. The GCS is a representation of

verbal, motor, and visual responses. Fifteen was the highest rating, while 3 was the lowest. A serious brain injury is indicated by a score of 8 or less, which implies poor consciousness, 9–12 being moderate, and 13–15 being high consciousness. The eye reaction ranges from not opening at all (scoring 1) to opening spontaneously (score 4). There are differences in the verbal response (score 1) to orientated (score 5) and motor reaction, ranging from no motor response (score 1) to accepting commands (scoring 6) [20].

According to Gill et al. (2004), the overall GCS had a reported inter-rater reliability of 0.86. When used to TBI patients, the validity of GCS was demonstrated to be high ($r^2 = 0.0233$, $P < .0001$) [21]. In this study, the internal consistency and Cronbach's Coefficient Alpha ($\alpha = 0.98$) were used to test and retest the GCS's reliability. The GCS's validity was investigated using Pearson Product Moment Correlations based on the internal consistency ($r = 0.72$, $p\text{-value} < 0.05$) and the significant value (Sig (2-tailed) < 0.05).

Ethical Consideration

Approval of the study was obtained from both the Faculty of Nursing at Menoufia University and the Research Ethics Committee (Approval Number ERCNMA 1000/11/1/4/23). Participants provided written consent to take part in the research, after being informed about the study's benefits and methods. Data were securely stored, and participation was entirely voluntary. The participants were aware that their level of care would not change if they chose not to participate in the study.

Pilot Study

A pilot study was carried out on 10% of the participants (9 patients) before data collection to assess the feasibility and applicability of the instruments. Those involved in the pilot study were excluded from the final analysis.

Data Collection Procedure

Data were collected over a nine-month period, from early February 2023 to the end of September 2023. Participants were evaluated based on the criteria for research enrollment. From the sample of 90 patients who underwent craniotomy, 30 patients were randomly selected for each of the three groups (Study I, Study II, and the control group). To prevent data contamination, the researcher began with the control group. The first time the researcher met the participants and collected demographic data and medical data considered the baseline measure by using instrument (I) and instrument (IV). Instruments (II) and (III) were used to measure the level of pain, eyelid edema, and ecchymosis in the participants of all groups after 24 hours post-surgery. Following craniotomy, all patients were positioned supine with their heads 30° elevated. The severity of pain, as well as periorbital edema and ecchymosis was measured every day for three consecutive days for both the study and control group.

Study Group (I) Cold Application

Participants who were assigned to the experimental group (I) received cold applications using a cold gel pack. After being frozen for at least two hours at 14°C, glasses-shaped cold gel packs were wrapped in gauze and applied around the periorbital region and the surgical site for 20 minutes every hour starting from the second day after the craniotomy for three days, with an exception of the hours between 10 pm and 7 am (to give the patients time for rest and sleep). To lower the temperature around the periorbital area, cold gel packs were utilized. It was found that applying cold application for at least 15–20 minutes, this duration is often sufficient to achieve the desired vasoconstrictive and anti-inflammatory effects without risking damage to the skin or tissues [22]. Separate glass-shaped cold gel packs were used for each patient, and after the application, the gel packs were cleaned by washing with soapy water.

Study Group (II): Aloe vera Gel

Patients who were assigned to receive *Aloe vera* gel application around the periorbital region and the surgical site. At the site of ecchymosis or swelling, a 98% pure *Aloe vera* gel (in a pure form) was

applied topically and covered with sterile eye dressing. The gel from an *Aloe vera* plant was intended for human consumption. The base, apex, and margins of the *Aloe vera* leaves were carefully cut off after being thoroughly washed to make it easier to slice the leaves and disclose the transparent mucilage. The transparent mucilage was carefully removed, and a greenish gel-like liquid was obtained and a thick coated layer of *Aloe vera* gel was directly applied around the periorbital region and the surgical site. For 20 minutes every hour starting from the second day after craniotomy, for three days, with an exception of the hours between 10 pm and 7 am (to allow the patients to sleep and rest) as this duration has proven to be effective and has a significant impact on reducing pain intensity and periorbital edema and ecchymosis.

Control Group

Participants in the control group got standard hospital care, including changing dress every shift and covering the periorbital region with saline-soaked gauze.

The pain intensity, periorbital edema, and ecchymosis were evaluated after 24 hours (as a baseline data) and after three days post intervention for both the study and control group.

Data Analysis

A statistical analysis was performed on the data using SPSS version 25 (SPSS Inc., Chicago, IL, USA). For quantitative data, square was utilized. For parametric data, one-way ANOVA (F test), repeated measures ANOVA test, and Pearson's correlation were employed. P-value < 0.001 is highly significant; P-value ≤ 0.05 was significant.

RESULTS

Characteristics of the Sample

A total of 90 patients were admitted to the Neurosurgery Intensive Care Unit of the hospital at Menoufia University, Menoufia Governorate, Egypt. Patients were divided into three groups (study I, study II, and control).

Table 1. Demographic and medical data of the studied groups (N = 90).

Demographic and Medical Data	Study Group I (Cold Application) (n = 30)		Study Group II (<i>Aloe vera</i> Gel) (n = 30)		Control Group (n = 30)	
	No	%	No	%	No	%
Age ▪ Mean ± SD	48.70 ± 14.15		46.55 ± 14.12		51.37 ± 11.32	
Sex ▪ Male ▪ Female	8 22	26.7 73.3	9 21	30.0 70.0	12 18	40.0 60.0
Diagnosis ▪ Brain tumor ▪ Cerebral aneurysm ▪ Aneurysmal SAH	14 12 4	46.7 40.0 13.3	14 7 9	46.7 23.3 30.0	15 11 4	50.0 36.7 13.9
Type of surgery ▪ Aneurysm clipping ▪ Tumor resection	16 14	3.3 46.7	16 14	53.3 46.7	15 15	50.0 50.0
Duration of the surgery/hour Mean ± SD	3.80 ± 2.25		3.70 ± 1.8		.40 ± 2.69	

Note: (P-value > 0.05): not significance.

Table 1 shows that the mean age of the participants in study I, study II, and the control group is 48.70 ± 14.15, 46.55 ± 14.12, and 51.37 ± 11.32 years old, respectively. Concerning gender, about two-thirds of patients in study I, study II, and control groups are female (73.3%, 70.0%, and 60%, respectively). Regarding the type of surgery, aneurysm clipping was performed on 50% of participants in the control group and (53.3%; 53.3%) in the experimental groups I and II. The mean

surgery duration for patients in the control group was 4.40 ± 2.69 hours, while it was 3.80 ± 2.25 and 3.70 ± 1.8 hours for participants in the experimental groups I and II, respectively. There was no significant variation between the samples studied regarding their demographic and medical data.

Table 2. Effect of cold application versus *Aloe vera* gel on pain intensity post intervention (N = 90).

Pain Intensity	Cold Application Study Group I (n = 30)	<i>Aloe vera</i> Gel Study Group II (n = 30)	Control Group (n = 30)	P-value
	Mean \pm SD	Mean \pm SD	Mean \pm SD	
▪ Pre intervention	8.25 \pm 1.45	8.35 \pm 1.22	8.42 \pm 1.32	P = 0.478
▪ Post intervention	3.45 \pm 1.24	4.93 \pm 1.57	6.43 \pm 1.01	P < 0.001
ANOVA P-value	8.56 <0.001	9.64 <0.001	9.20 <0.001	

Note: (P < 0.001): high significance.

Table 2 illustrates that there was a highly statistically significant decrease in the total mean score of pain intensity in the study group I which received cold application intervention compared to the study group II which received *Aloe vera* gel and the control group (p < 0.001), which indicated that cold application is more effective to reduce pain intensity than *Aloe vera* gel.

Table 3. Effect of cold application versus *Aloe vera* gel on periorbital edema and ecchymosis post intervention (N = 90).

	Experimental Group I (Cold Application) (n = 30)	Experimental Group II (<i>Aloe vera</i> Gel) (n = 30)	Control Group (n = 30)	P-value
	Mean \pm SD	Mean \pm SD	Mean \pm SD	
<i>Periorbital edema</i>				
▪ Pre intervention	4.35 \pm 1.98	4.40 \pm 1.09	4.45 \pm 1.33	P = 0.972
▪ Post intervention	1.00 \pm 0.63	2.83 \pm 0.74	3.37 \pm 0.45	P < 0.001
<i>Facial ecchymosis</i>				
▪ Pre intervention	3.05 \pm .65	3.35 \pm .66	3.06 \pm 0.66	P = 0.782
▪ Post intervention	1.70 \pm 1.47	2.01 \pm 1.57	3.43 \pm 1.01	P < 0.001
ANOVA P-value	#48.97 <0.001	22.30 <0.001	0.43 >0.05	

Note: (P < 0.001): high significance.

Table 3 shows that, there was a highly statistically significant decrease the mean score of periorbital edema and ecchymosis in the study group I who received cold application intervention compared to the study group II who received *Aloe vera* gel and the control group post intervention (P < 0.001), which indicated that cold application is more effective to reduce periorbital edema and ecchymosis than *Aloe vera* gel.

DISCUSSION

Cold application and *Aloe vera* gel are commonly used as a non-pharmacological, safe, and noninvasive nursing intervention to reduce pain, periorbital edema, and ecchymosis after craniotomy through slowing down tissue metabolism have locally anti-inflammatory, anti-spasmodic and analgesic effects, reduce the rate of blood coagulation and fibrinolysis, which increases tissue metabolism and absorbs inflammatory exudate from the skin, improve cell survival, and treat abnormal skin tissue [1, 23].

PAIN INTENSITY POST INTERVENTION

Patients post craniotomy experience moderate to severe pain and there is evidence that cold application as a non-pharmacological method for reducing pain intensity post craniotomy [24]. The present study hypothesized that patients who receive cold applications will experience less pain intensity than those who receive *Aloe vera* gel. This hypothesis was supported by the results of the current study, which revealed a statistically significant decrease in the total mean score of pain intensity in the group who received cold application intervention compared to the groups who received *Aloe vera* gel and the control group. This result was like Yuiksel and Akyolcu (2020) [25] who found that cold application group experienced significantly less pain intensity than *Aloe vera* gel and the control groups.

This finding agreed with Santos et al. (2021) [5], who investigated the impact of cold therapy on the severity of pain following craniotomy and found that cold therapy was more effective than utilizing *Aloe vera* gel in reducing pain intensity. Also, this finding is consistent with Handayani et al. (2021) [8], who noted that cold therapy was more effective than *Aloe vera* gel in decreasing postoperative pain intensity. This effectiveness was related to reducing blood flow, leading to decreased inflammation and swelling at the surgical site, resulting in decreased pain intensity.

The study's findings also correspond to those of Agha et al. (2020) [24], who assessed the effectiveness of various non-pharmacological methods, including cold therapy and *Aloe vera* gel on the severity of pain following craniotomy and found that the patients who received cold therapy experienced a 74% lower prevalence of mild pain, 56% lower in those who received *Aloe vera* gel, and 36% lower in those who received routine care, which indicate that cold application is more effective in reducing pain intensity than *Aloe vera* gel post craniotomy.

The findings of this study align with those of Panigrahi et al. (2022) [3], who observed a significant reduction in pain intensity post craniotomy in ice application than *Aloe vera* gel group. This finding may be attributed to several effects, including cold-induced vasoconstriction, limited blood flow and reduced swelling, while slow nerve conduction temporarily diminishes the transmission of pain signals and provides local anesthesia by numbing nerve endings. Additionally, ice's anti-inflammatory effects help inhibit inflammatory processes by reducing the production of inflammatory mediators and limiting the influx of immune cells to the affected area. Additionally, Koc et al. (2022) [7] highlight that ice application is a safe and effective method for managing pain following craniotomy.

This result was in line with Fernandes et al. (2019) [26], who mentioned that the patients experienced severe pain with in the first postoperative hour and post intervention the cold therapy group exhibited less pain intensity than the *Aloe vera* gel group. This result was corroborated by Derina and Nirmala (2022) [1], who found that the pain was reduced more quickly in the cold application group than in the *Aloe vera* gel 1 group. Moreover, this result was consistently reported in their studies; participants were experiencing pain reduction in the intervention group which received cold therapy compared to the *Aloe vera* gel group.

However, the results of the present study are different from what was reported by Kaviani et al. (2015) [27], who found that cold application did not significantly reduce the pain intensity. A possible explanation of Kaviani's results may be attributed the short duration of intervention of only 10 minutes, whereas the recommended timeframe for demonstrating an effect on pain intensity is 20 minutes.

Periorbital Edema and Ecchymosis Post Intervention

Periorbital edema is a consequence complication of craniotomy during the immediate postoperative phase. Cold therapy is commonly used to decrease bleeding, swelling, inflammation, and control periorbital edema and ecchymosis through vasoconstriction effect [23]. The results of the present

study demonstrated a statistically significant decrease in the total mean scores of periorbital edema and ecchymosis in the group who received cold application compared to the group that received *Aloe vera* gel and the control group post intervention. The study's findings supported the hypothesis of the present study. Also, Bui et al. (2023) [23] observed that cold application is more effective than *Aloe vera* gel for decreasing periorbital edema and ecchymosis after intervention. In addition, this result was in the same line with Wang et al. (2023) and Kim et al. (2021) [28, 29], who compared the effects of cold application versus *Aloe vera* gel on decreasing periorbital edema and ecchymosis, which indicates that cold application was more effective than *Aloe vera* gel for decreasing periorbital edema and ecchymosis.

Like the study by Derina and Nirmala (2022) [1], which reported that cold application was effective on craniotomy-induced periorbital edema, the periorbital edema and ecchymosis score of the patients in the cold application group was significantly lower than the scores of those in the control group in all the measurements. Yuksel and Serpil (2020) [27] reported that cold therapy decreased periorbital edema and ecchymosis persisting from nine hours to seven days after craniotomy, with the cold therapy group experiencing less periorbital edema than the control group.

However, Kayiran and Calli (2016) [30] investigated the impact of applying ice to decrease periorbital edema after craniotomy and found that there was no statistically significant difference in the periorbital edema and ecchymosis score between the cold application group and the *Aloe vera* group. The explanation for Kayiran and Calli's result was the lower frequency of the intervention, demonstrated once every shift. The recommended practice suggests repeating ice application every 1–2 hours within the initial 24–48 hours after craniotomy for optimal vasoconstriction and inflammation reduction benefits.

CONCLUSION

Cold application is superior to *Aloe vera* gel in reducing pain intensity, periorbital edema, and ecchymosis post craniotomy.

Recommendations

Encourage critical care nurses to create practice guidelines for managing pain and periorbital edema following craniotomy, emphasizing the use of cold application as a non-pharmacological treatment option.

Implications for Nursing Practice

Provide critical care nurses with periodic in-service education about the importance of cold application as a non-pharmacological measure to reduce pain, periorbital edema, and ecchymosis post craniotomy.

Implications for Future Research

The study's replication is suggested with design modifications, including a large sample size, randomized selection, and larger-scale multicenter inclusion.

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