Original Article

Investigating the Effect of Chewing Gum on Head, Neck, and Facial Edema in Burn Patients: Doubled-blinded Randomized Controlled Trial

Abstract

Background: Burns are a sort of trauma that may cause life-threatening consequences, including edema, which delays recovery. So, the aim of the present study was to investigate the effect of chewing gum on reducing edema of burns in the head, face, and neck areas after second-degree burns. **Materials and Methods:** In 2024, a double-blind, randomized clinical trial was conducted on 64 second-degree burn patients, who were randomly allocated into two groups using permuted block randomization. The 32 participants in the intervention group received head elevation and chewed mint gum every 3 hours for 20 minutes until 3 days after hospitalization. However, the 32 participants in the control group only did head elevation. The Edema Size Detector was completed before and after the intervention. Statistical tests included paired t, independent t, Chi-square, and difference-in-difference regression, which were analyzed in SPSS V.16 at a significance level of less than 0.05. **Results:** The mean (SD) of burn percentages was 31.86 (2.71). Before the intervention, there were not any significant differences between the two groups for frontal, maxillary, and superior–inferior diameters ($p > 0.05$). However, after the intervention, these differences were significantly meaningful ($p < 0.001$). Additionally, assessing the group effect and time effect and adjusting the model showed that in the intervention group, frontal ($T = -15.33$, $p < 0.001$), maxillary ($T = -12.88$, $p < 0.001$), and superior–inferior diameters ($T = -19.20$, $p < 0.001$) have statistically significant variation. **Conclusions:** Chewing gum for 20 minutes three times a day can reduce burn edema in the head, face, and neck after second-degree burns.

Keywords: *Burns, chewing gum, edema, face, head, neck, randomized controlled trial*

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Introduction

Burns are recognized as a physical injury and, depending on the type and extent of the burn, impose a high cost and burden of care on individuals. Burns are the fourth leading cause of injury in the world, after traffic accidents, falls, and physical assaults. They are caused by fire, hot liquids, hot objects, chemicals, and electricity, with electrical and chemical burns being the most severe.[1,2] Based on a statistical study, more than 50% of burns are related to burns of the head, face, and neck, which cause esthetic changes, a reduced range of motion of joints, hypertrophic scars, oral cavity disorders, and nutritional disorders.[3] According to the World Health Organization, more than 265,000 people worldwide die each year from burns.[4] In Iran, more than 150,000 people suffer burns annually, causing varying degrees of disability, which poses a mental and physical challenge to these individuals.[5] According to scientific resources, burns are divided into three degrees based on the depth of skin damage, each with a different treatment period and supportive measures.[3] In first-degree burns, the epidermis is involved, resulting in red skin without edema or blisters. Treatment includes painkillers and cold compresses and usually heals within a few days.[3] In second-degree burns, the epidermis, dermis, and some connective tissues are involved, resulting in a pink or mottled appearance of the skin, accompanied by blisters, swelling, severe pain, and discharge. Edema is a characteristic of this type of burn.[3] Treatment also includes fluid therapy, debridement, elevation of the burned limb, antimicrobial medications, and skin grafts.[3] This burn usually heals within 2 to 3 weeks, and scarring is inevitable. In a third-degree burn, the skin is completely destroyed and may damage

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underlying tissues, such as fat, muscle, and even bone. The skin color after a burn may be white, yellowish brown, black, or completely transparent. In this type of burn, there is no pain due to the loss of sensory nerve endings, severe edema occurs due to the destruction of the vascular wall, and myoglobinuria is also common. The use of diuretics along with fluid therapy is vital to resolve this complication.[3] Supportive treatments for this type of burn include fluid therapy, debridement, surgical procedures, and limb amputation. The duration of treatment for this type of burn is more than 8 weeks.[3]

Edema, a main complication that is severely visible during second- and third-degree burns, delays wound healing and reduces the performance of burn areas.[6] During the burn affair, two main physiologic phenomena occur. First, when burning happens, substances are released from the nearest cells in response to the burn, including histamine, cytokines, bradykinin, and catecholamine, which change capillary permeability, leading to edema. Created edema delays the tissue healing process and speeds up cellular damages.[7] One of those important released material which accelerates the edema process is reactive oxygen species (ROS), a short-lived, highly reactive compound, metabolic toxins for remaining healthy cells.[8] Its release during musculoskeletal accidents causes massive injuries to cell membranes and changes in DNA structure, especially after burning.[9,10] Second, burnout is considered a stressful situation that causes the secretion of cortisol from the adrenal glands, which causes the body to respond to stress. Cortisol, by increasing sodium reabsorption, accelerates edema in the tissues, which leads to organ damage and decreases in vascular fluid volume in the salivary glands, the bloodstream, and the urinary system. Recommendations for reducing the accumulation and hazardousness of ROS and cortisol were included, with physical movement (chewing gum) leading to a decrease in their accumulation in the jaw muscle through mitochondrial activity in the cellular surface assessments.[10,11]

Based on the burn types guideline, there are two approaches for managing post-burn edema complications, which are categorized as mechanical (wound debridement, pressure dressing, physiotherapy, electrical stimulation, reconstructive surgery, and skin grafts) and nonmechanical (drug therapy and wound irrigation) curative managements.[12] As an example, one of the new methods used in the treatment of burn edema is the use of electrical stimulation to stimulate angiogenesis (revascularization) and improve inflammatory processes to reduce edema and accelerate the delivery of necessary substances to cells.[13] Edwick *et al*.[14] used electrical stimulation in their study on patients with burns in various body areas. The results showed that electrical stimulation reduced edema and wound healing time. In addition, using electrical stimulation improves blood flow in the areas damaged by burns, reduces the thickness of the burned tissue and the depth of the burn wound, and promotes angiogenesis after 14 days of the burn.[15] On the other hand, the use of a modified compression bandage and diuretic drugs reduces edema after burns in the hands and limbs.[16]

According to common approaches for managing post-burn edema in second- and third-degree burns, a few studies have aimed to implement novel methods for post-burn edema management. Thus, the current study aimed to investigate the effect of chewing gum on reducing edema in the head, face, and neck areas after second-degree burns.

Materials and Methods

This was a double-blinded randomized clinical trial (IRCT20211110053030N4) which conducted in 2024 and implemented permission from the Ethics Committee of Ilam University of Medical Sciences and Iranian Clinical Trials Center code. The study population was selected among burnt patients referring to the Burning ward of Emam Khomeini Hospital in Ilam province using a convenience sampling method considering inclusion criteria: age 18 years and higher; ability to speak; obtaining a score above 24 in the Mini-Mental Status Examination (MMSE); 24 hours having passed since hospitalization in the burn ward; second-degree burns on the head, face, and neck; burn percentage between 15 and 50%; having molars one to three on both sides; and a hospitalization period of at least 4 days. Exclusion criteria included unwillingness to participate or continue in the study, being under a No Per Oral (NPO) order, presence or history of addiction, electrical burns, need for surgery and grafting on the face and neck, use of various diuretic drugs, antihypertensive drugs, and patient death. According to the study that showed the mean (standard deviation) of edema intervention scores before and after the intervention were 36.19 (6.79) and 30.11 (8.56), respectively, considering an alpha error of 0.05, a test power of 0.80, and a sample dropout probability of 25% based on the sample size calculation formula for comparing means, the final number of samples in each study group was determined to be 32.[14] Participants were randomly assigned to control and intervention groups using four permuted block randomizations. The researchers used eight identical sealed envelopes, each containing two letters in four sequences (I for intervention and C for control). When the first participant entered the study based on criteria, one of the eight sealed envelopes was chosen and given to a specific nurse to note the four letters written on the paper inside, corresponding to participants' numbers 1 through 4. After that, the selected envelope was removed from the remaining envelopes, and the fifth participant chose another one from the seven remaining identical sealed envelopes to continue the randomization sequence. This allocation continued until the last participant entered the study. This method ensured that both participants and the research team were unaware of the allocation. Only the designated nurse was responsible for measuring the edema

size twice a day. Three outcomes were included frontal, maxillary, and superior–inferior diameters assessed by ESD.

The first tool was the demographic form which included age, gender, marital status, burning percentage, burning types, burning grade, education, and job. The second tool was Mini-Mental Status Examination (MMSE), which was developed by Folstein *et al*.[17] to assess cognitive function for interventional procedures. Each question has a total score ranging from 1 to 30. A score of 24 or above signifies the absence of cognitive errors, indicating sufficient mental performance. The original version of this tool for burn patients had acceptable validity (0.81), and its reliability was measured to be (0.94) using Cronbach's alpha internal consistency in people with burning.[18] For the Iranian version of this tool for burning patients, its validity was suitable (0.90), and its reliability was measured to be 0.77 using Cronbach's alpha internal consistency in the burning department on 611 patients.[19] The third tool was Edema Size Detector (ESD), which was designed by the research team to examine the frontal, maxillary, and superior–inferior diameters, which scored from 1 cm to 80 cm. First, by examining hospital equipment, packs of 100 single-layer cotton pads, each measuring 80 * 40 cm^2 (based on morphometric studies for those diameters in the Iranian population, which were 68 (4.18), 53 (2.67), and 66 (3.85), respectively (21–23)), were prepared.[20-22] Then, using a scalpel blade, a small cut was made every 10 cm of the length of the cotton pad so that the values could be measured more accurately when measuring the mentioned diameters. Next, three of these cotton pads were placed on top of each other in four layers to measure each of the three diameters separately, and the dimensions of each cotton pad were considered to be 20 * 10 cm^2 for placement in the autoclave for sterilization. To measure Content Validity Ratio (CVR) and Content Validity Index (CVI),[23] a panel of experts was used, which included 15 nurses with at least 5 years of experience working in the burn department. After making the necessary corrections and making the relevant comments, the CVR and CVI were reported as 0.92 and 0.97, respectively. Additionally, Cronbach's alpha internal consistency coefficient was used to check the reliability of the study. Thirty patients who met the inclusion criteria were tested, and the final coefficient was found to be 0.86. Also, the research team analyzed the sensitivity and specificity of this tool, which showed 0.83 and 0.87, respectively. (It is important to note that the people who were in the study for the reliability assessment were not considered as samples in the control or intervention groups.)

First, the general surgeon assessed the criteria, and after a 24-hour hospitalization, the intervention started. The participants in the intervention group chewed two pieces of mint gum every 3 hours for 20 minutes, four times over a period of 3 days, from 9 AM to 9 PM on the second day of hospitalization, like similar previous clinical trial studies.[24,25] The scientific reason for choosing mint flavor was related to its substances, including types of chemical materials that conducted pain relief, improved salivary gland secretion, prevented nausea, and had less sensitive reactions than other gum flavors (e.g., cinnamon or strawberry).[26,27] In the intervention group, each nurse who took care of their patient carried on the duty of supervision for chewing the gum (by doing nursing reports near the bedside and checking their catheters, diapers, drug administration, and setting the mobile alarm for 20 minutes for each patient in each separate and specific individual room in the burn department) twice in each daily work shift and four times in night shifts. In addition, these participants received routine head and neck elevation. In the control group, participants received routine head and neck elevation in individual, separated rooms without any communication or data leakage to the intervention group. Diet considerations included avoiding any stimulating agents like caffeine, spices, and cigarettes during the study. Additionally, a constant oral diet was provided, which contained a high amount of minced animal protein based on soup shape for all participants. For data completion, the ESD tool was completed before starting chewing gum (24 hours after hospitalization), twice a day (9 AM and 9 PM) for 3 days after the first day of hospitalization by a constant nurse who was blinded to the type of intervention in each group. Finally, data were imported into SPSS V.16 for outcome analysis [Figure 1].

The demographic data were analyzed using descriptive statistics, with the variables being presented as mean, standard deviation, frequency, and percentage. The statistical methods used in the analysis were Shapiro–Wilk (S-W), independent *t*-test, Chi-square, paired *t*-test, and difference-in-difference regression (DID). The analyses were conducted using SPSS V.16, with a significance threshold of less than 0.05.

Ethical considerations

The research complied with ethical norms, including securing ethical approval from Ilam University of Medical Sciences (IR.MEDILAM.REC.1403.081), registering with the Iranian Registry of Clinical Trials, acquiring informed permission, ensuring anonymity, and following the Declaration of Helsinki.

Results

The Shapiro–Wilk normality test confirmed the presence of total variables. The mean (SD) of the age and burn percentage of participants were 44.20 (4.59) and 31.86 (2.71), respectively [Table 1].

The majority of participants were male, burnt by a thermal agent, and employed. Doing the Chi-square test, there was no meaningful variation between the gender ($p = 0.329$), burn types ($p = 0.066$), education ($p = 0.591$), and job ($p = 0.403$) [Table 2].

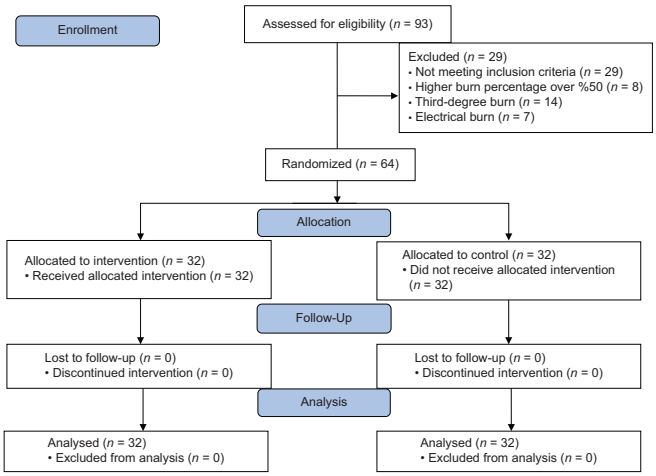

Figure 1: The sequence of choosing and study protocol related on two groups

Table 1: Distribution of age and burn percent based on two groups

Variable	Mean (SD)		
	Intervention	Control	Total
Age	43.12 (3.31)	45.29 (5.87)	44.20 (4.59)
p	0.174*	0.293*	0.701#
Burn percent	32.57 (3.24)	31.16 (2.19)	31.86 (2.71)
p	0.682*	0.439*	0.097#

*: Shapiro-Wilk. #: Chi-square

The paired *t*-test investigation showed there were not any statistically significant variations in the mean score of frontal, maxillary, and superior–inferior diameters before and after the intervention in the control group ($p = 0.074$, $p = 0.098$, $p = 0.055$). However, there was statistically significant variation in the intervention group ($p < 0.001$) [Table 3]. Also, the result of the independent *t*-test manifested that before the intervention, there were not any significant differences between the two groups ($p = 0.143$, $p = 0.607$, $p = 0.822$). But, after intervention, these differences were significantly meaningful. ($p < 0.001$) [Table 3].

To explore the group effect and time effect in two groups, DID was performed and depicted that in the intervention group, frontal ($T = -15.33$, $p < 0.001$), maxillary ($T = -12.88$, $p < 0.001$), and superior–inferior diameters ($T = -19.20$, $p < 0.001$) have statistically significant variation. In the extended insight, chewing gum has switched the frontal, maxillary, and superior–inferior diameters in the intervention group significantly ($p < 0.001$) [Table 4].

To find out how demographic factors might have affected the intervention, DID was used. It showed that the intervention was carried out independently and was not affected by any demographic factors ($p < 0.001$). To give a complete explanation, the DID results showed how chewing gum changed the study results by looking at demographic variables and changing the values before the intervention with this model at a level of significance less than 0.05. In this approach, chewing gum had a significant effect on frontal, maxillary, and superior–inferior diameters; this value was controlled by demographic variables and values before intervention ($p < 0.001$) [Table 5]. Also, after running this model and getting rid of variables that were not useful, chewing gum had a significant impact on the frontal ($T = -3.88$, $p < 0.001$), maxillary ($T = -3.30$, $p < 0.001$), and superior–inferior diameters ($T = -1.82$, $p = 0.048$) [Table 5].

Discussion

This research sought to investigate the impact of chewing gum on alleviating edema in the head, face, and neck regions after second-degree burns. The research demonstrated statistically significant variations in the mean scores of frontal, maxillary, and superior–inferior diameters between the control and intervention groups post intervention. Inexplicably, chewing gum has alleviated the frontal, maxillary, and superior–inferior diameters in second-degree burn patients.

The findings of the present work coincide with those of the clinical experiment carried out by Zal *et al*.,[28] which examined the efficacy of virtual reality-based face and neck exercise training after burns. Their research revealed that the post-burn chewing ability and range of motion were enhanced by virtual reality-based fitness training. Both studies have as their commonality the favorable effect of motor rehabilitation treatments on post-burn problems in the face and neck regions. The main difference, however, is that the current research used a straightforward, affordable intervention that could be readily carried out without further expenditures, whereas Zal *et al*. used an advanced technical method needing specialist equipment and training. Furthermore, Zal *et al*.'s research lacked particular evaluation of edema reduction; therefore, direct comparison of the efficacy of both treatments is challenging.

Likewise, the current investigation validates the conclusions of the study by Froutan *et al*.,[29] a quasi-experimental study on the impact of rehabilitation and motor therapies on pain and anxiety in the head and neck regions after burns. After second- and third-degree burns, their findings showed that motor activities enhanced functional recovery. Both research studies have as their common use the use of jaw and chewing muscle ability to minimize post-burn effects. Whereas the current research scientifically examined changes in face dimensions, Froutan *et al*. mostly focused on subjective outcomes, including discomfort and anxiety. This difference emphasizes the need for integrating objective and subjective assessments in future studies to provide a more complete knowledge of post-burn recovery.

After the second- and third-degree burns in insensitive limbs, Edwick *et al*.[14] conducted a clinical experiment looking at the impact of pressure treatments on edema management

Table 2: Participants' frequencies by demographic variables in two groups

Variables	Categories	Intervention (*n*=32)	Control (*n*=32)	*p* (Chi-square)
Gender	Male	18 (%56)	21 (%65)	0.329
	Female	14 (%44)	11 (%35)	
Burn types	Thermal	25 (%78)	20 (%63)	0.066
	Chemical	7 (%22)	12 (%37)	
Education	Elementary	2 (%7)	2 (%7)	0.591
	Secondary School	1 (%3.50)	0 (%0)	
	Diploma	19 (%60)	17 (%53)	
	Above Diploma	10 (%31)	13 (%40)	
Job	Free	14 (%44)	15 (%47)	0.403
	Employed	16 (%50)	17 (%53)	
	Retirement	2 (%7)	0 (%0)	

Table 3: Comparison of the mean scores of frontal, maxillary, and superior–inferior diameters in participants before and after the intervention in two groups

Variables	Groups		Independent *t*-test
	Control Mean (SD)	Intervention Mean (SD)	
Frontal diameter			
Before	72.02 (1.06)	70.69 (0.55)	p=0.143
After	70.43 (1.17)	63.87 (0.50)	p<0.001
Mean difference	−1.59	−6.82	p<0.001
Paired *t*	p=0.074	p<0.001	–
Maxillary diameter			
Before	61.09 (0.72)	60.75 (0.65)	p=0.607
After	57.65 (0.66)	52.96 (0.61)	p<0.001
Mean difference	−3.44	−7.79	p<0.001
Paired *t*	p=0.098	p<0.001	–
Superior-inferior diameter			
Before	73.03 (0.71)	74.25 (0.51)	p=0.822
After	70.78 (0.62)	67.09 (0.45)	p<0.001
Mean difference	−2.25	−7.16	p<0.001
Paired *t*	p=0.055	p<0.001	–

Table 4: Comparing of the of main outcomes by considering time and group effects in the intervention and control groups

Variables	Coefficient	*t*	*p*
Frontal diameter	−5.44	−15.33	<0.001
Maxillary diameter	−4.34	−12.88	<0.001
Superior–inferior diameter	−5.00	−19.20	<0.001

and found that controlled pressure dressings significantly helped to lower edema. Although their work concentrated on mechanical pressure applied via dressings, the current work adds the idea of internal, dynamic pressure driven by masticatory action. The two methods differ mainly in that whereas external pressure dressings require continuous administration and professional monitoring, chewing gum offers a self-administered, noninvasive alternative that could be more practical for long-term edema management. On the other hand, the lack of direct comparison between external pressure therapy and chewing-induced pressure highlights a subject of future study need. Moreover, the findings of the current research coincide with those of Edwick *et al*.,[30] who examined how electrical stimulation affects hand and abdomen edema control after burns. Low-voltage electrical stimulation for 14 days effectively reduced edema, according to their results. Although both research studies aim to lower edema via creative treatments, electrical stimulation depends on outside equipment.

Notwithstanding these similarities, with other investigations, the current work provided fresh understanding of the function of mastication in post-burn edema control. Unlike current treatments depending on pressure dressings, external devices, or formal rehabilitation programs, this research proposed that chewing a basic, habitual motion might provide a fresh, easily available approach for controlling edema. This study highlighted the potential of internally generated biomechanical forces to facilitate post-burn recovery, in contrast to previous studies mostly focused on external treatments.

The limitations of the present study include the small sample size, the use of patients with less than 50% burn degree, and the limited study duration, which reduce the generalizability of the results to the population. The strengths of the present study include its innovativeness, accessibility, cost-effectiveness, and applicability.

Conclusion

Chewing gum for 20 minutes three times a day can reduce burn edema in the head, face, and neck areas after second-degree burns. This intervention decreased the frontal, maxillary, and superior–inferior diameters after the second-degree burn. The present study demonstrated that chewing gum significantly improved the frontal, maxillary, and superior–inferior diameters in burnt patients. Future studies should be conducted with larger sample sizes, longer durations, different gum flavors, electrical burns, and higher percentages of third-degree and full-thickness burns in other areas of the body.

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Table 5: Effect of intervention on frontal, maxillary, and superior–inferior diameters by considering demographic variables using difference in difference regression (DID)

Variables	Coefficient	*t*	*p*
Frontal diameter	−4.86	−3.88	<0.001
Maxillary diameter	−2.94	−3.30	=0.001
Superior–inferior diameter	−1.44	−1.82	=0.048

Conflicts of interest

Nothing to declare.

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