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Liquid Nitrogen-Laced Biscuit Consumption Leads to Respiratory Distress: A Case Report and Review of Literature

Sıvı Nitrojen Katkılı Bisküvi Tüketimi Solunum Sıkıntısına Neden Oluyor: Olgu Sunumu ve Literatürün İncelenmesi

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Abstract

A recent trend is attracting consumers that take the form of smoky liquid nitrogen (LN2) food products. However, due to improper handling and a lack of knowledge of the potential health hazards, people are becoming prey to such repercussions as respiratory distress, skin necrosis and gastrointestinal injuries. We present here a case of a teenage boy with allergic rhinitis who was affected by the extreme cold generated during the consumption of "Nitrogen biscuit" who developed cough and exertional dyspnea, and who didn't respond to treatment in the local clinic and went on to suffer frequent bouts of illness. Upon presentation, his spirometry values were FEV1 65%, FVC 69% and FEV1/FVC 87.3 and a chest X-ray revealed prominent bilateral broncho-vascular marking. The patient was given an inhaler containing corticosteroid and bronchodilator to relieve the bronchoconstriction, and follow-up spirometry after four months showed improvement. Awareness of risks associated with LN2-infused food at the point of sale is needed.

Keywords: *Liquid nitrogen, respiratory distress, asthma, spirometry.*

Öz

Son zamanlardaki bir trend olarak piyasaya sürülen dumanlı sıvı nitrojen (LN2) içeren gıda maddeleri, tüketicileri cezbetmektir. Bununla birlikte, yanlış kullanım ve sağlık açısından tehlikeleri konusundaki bilgi eksikliği nedeni ile insanlar, solunum sıkıntısı, cilt nekrozu ve mide-bağırsak yaralanmaları gibi yan etkilerinin kurbanı haline gelebilmektedir. Burada, 'Azotlu bisküvi' tüketimi sırasında ortaya çıkan aşırı soğuktan etkilenen, öksürük ve efor dispnesi gelişen alerjik rinitli genç bir erkek çocuğunu sunuyoruz. Yerel klinikte verilen tedaviye yanıt vermiyor ve sık sık hastalanıyordu. Geliş spirometri sonucu FEV1 %65, FVC %69 ve FEV1/FVC 87.3 idi. Akciğer grafisinde iki taraflı bronko-vasküler yapılarda artış görüldü. Bronkokonstriksiyonunu hafifletmek için kendisine kortikosteroid ve bronkodilatör içeren bir inhaler verildi. Dört ay sonra yapılan takip spirometrisinde iyileşme görüldü. Satış noktalarında LN2 uygulanan gıdalarla ilgili risklerin farkında olunması gerekmektedir.

Anahtar Kelimeler: *Sıvı nitrojen, solunum sıkıntısı, astım, spirometry.*

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Liquid nitrogen (LN2) has long been used in the food and beverage sector for the flash freezing of food products (1), but to make food items more attractive, vendors seek to amuse consumers by applying liquid nitrogen to desserts and drinks just before consumption, providing the food with an enigmatic smokey look (2). Certain safety measures need to be applied when handling and consuming such food items, but as a result of a lack of proper knowledge and failures in judgment, such precautions are not always followed, placing customers in hazardous situations. Injuries resulting from LN2 consumption or inhalation have been reported mostly in gray literature rather than approved journals (2). While reports of respiratory distress developing alongside gastrointestinal injuries as a result of LN2 consumption can be found (3-14), there have to date been no studies reporting on respiratory distress alone. We present here the case of a teenage male whose respiratory health deteriorated after the consumption of LN2 (at the point of sale) in the form of a "Nitrogen biscuit" to raise awareness of the dangers of such acts among consumers. We hypothesize that the consumption of LN2-infused food and beverages can lead to respiratory distress depending on the health, dose and LN2 exposure environment of the individual.

CASE

A 13-year-old male student of Asian ethnicity presented to our clinic with significant complaints of intermittent dry cough from the past month, nasal blockage, throat irritation, headache and exertional dyspnea. He reported that he had consumed "Nitrogen biscuit" (biscuits coated with liquid nitrogen at the point of sale) at a funfair, providing an extreme cold sensation in his throat, nose and ears, and leading to numbness, irritation, trepidation and malaise. Upon eating the biscuit, fog emerged from his mouth and nostrils, breathing became unbearable due to the cold, and he had a severe coughing fit. A local clinician was consulted, and while his symptoms subsided temporarily, he was not completely relieved, and the frequency and extent of the respiratory attacks increased. Fifteen days before presenting to our clinic he was treated with antibiotics for a lower respiratory tract infection prescribed by another facility and was started on homeopathic treatment for the same condition. The patient had a history since childhood of frequent sneezing fits due to allergic rhinitis that were more prominent in the mornings, and made worse by weather and the reported LN2 consumption.

Upon presentation, the patient was afebrile (97.5 0F) and had a pulse of 96/minute with 99% SPO_2. A physical examination revealed a BMI of 13.4 kg/m^2. His throat was normal, but he had Deviated Nasal Septum (DNS) towards the right and Turbinate hypertrophy. Auscultation revealed bilateral rhonchi, and chest X-rays and serological tests were performed, revealing C-reactive protein (CRP) 1.92 and Total IgE -71.5 kU/L. A routine hematology report revealed iron-deficiency anemia, and bilateral prominent broncho-vascular marking was evident on a chest X-ray (Figure 1). A spirometry test produced the following results: FEV1-65%, PB-FEV1 -70% (+9% + 180 ml), FVC – 69%, FEF (25-75) – 58% and a FEV1/FVC ratio of 87.3, as well as partial bronchodilator reversibility. Based on his medical history and physical examination and investigation findings, the patient was diagnosed with asthma with partial reversibility and allergic rhinitis, and prescribed with inhalational corticosteroid and bronchodilator, along with antiallergics. The patient was advised to avoid exposure to dust, smoke and fumes and was called for regular follow-up, with follow-up spirometry results 4 months later of FEV1-82%, FVC-78% and FEV1/FVC ratio-105.

DISCUSSION

LN2 is a cryogenic compound that is often used in cryosurgery, cryotherapy, cryopreservation, culinary art and flash freezing, and in other applications in which extreme cooling is required (1). Its multiple uses have led it to be associated with different cryo-injuries (burns and frostbite) and asphyxiation (15,16). If inhaled in an enclosed space without proper ventilation, the oxygen concentration is critically lowered, leading to shortness of breath, dizziness and unconsciousness, and even death (17), and gastrointestinal injuries can occur if even a single drop is ingested (3-14).

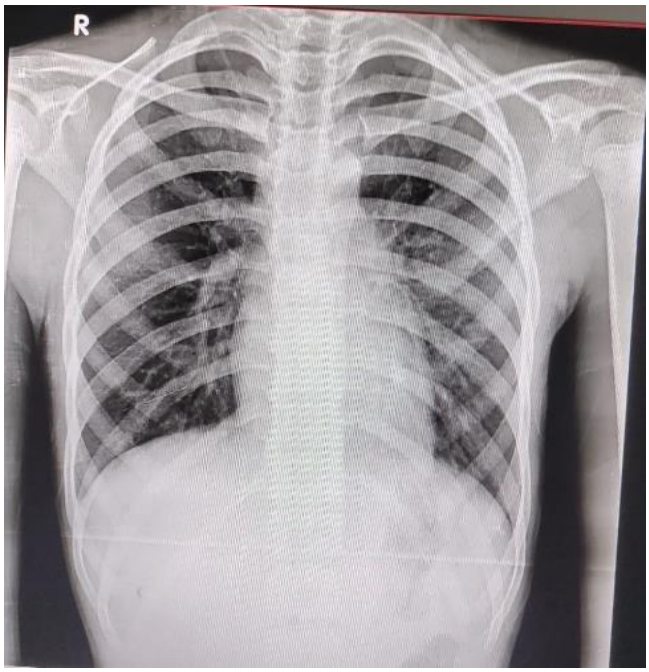

Figure 1: Chest X-ray showing bilateral prominent broncho-vascular marking

Table 1: Data extracted from original published case reports on LN2 consumption

First author	Yegashi Y	Pinilla Escobar VA	Koplewitz BZ	Guzman J	Knudsen AR	Kim DW	Zheng Y
Country/City	Japan	Miami FM	Ontario, Canada	Colombia	Arhus Sygehus, DK	Cheonan, Korea	Yinchuan, China
Year of report	2000	2022	2000	2019	2009	2018	2018
Sex	Male	Female	Male	Male	Male	Male	Male
Age	17	9	13	57	28	13	25
LN2 Food/beverage	Orange juice	Cereal puff	Orange crystals blend with LN2	LN2 ice cream	15 ml LN2	LN 2 added snack	Homemade drink with LN2
Symptoms	• Severe abdominal pain	• Abdominal pain • respiration difficulty	• Subcutaneous emphysema • Severe abdominal pain • Mild respiratory distress • Burning sensation in throat • Distended abdomen	• Abdominal pain • distension abdomen, mucocutaneous pallor, cryodiaphoresis, • progressive respiratory distress	• abdominal distension • subcutaneous emphysema	• Severe abdominal pain • shortness of breath	• Abdominal pain • respiratory distress • Distended abdomen • Breathing difficulty
Complication	• Mild peritonitis • small omental hemorrhage • Metabolic acidosis • longitudinal ulcer • gastrorrhexis	• peritonitis • gross pneumoperitoneum, • gastric perforation	• Gastric perforation	• Gastric perforation	• Gastric rupture at lesser curvature	• Pneumoperitoneum, • gastric perforation	• Gastric perforation • Barotrauma • pneumothorax • subcutaneous emphysema • Bilateral pleural effusion Severe pneumoperitoneum and pneumomediastinum
Respiratory distress	Nil	Yes	Yes	Yes	Yes	Yes	Yes
Treatment	• laparotomy	• Omental overlay	• Laparotomy	• exploratory laparotomy • esophagogastroduo-denoscopy • enteral feeding through advanced tube under endoscopic guidance	• laparotomy	• Intubation, • Omentopexy	• exploratory laparotomy
Length of hospital stay	26 days	13 days		• 8 Days		• 8 days	

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First author	Pollard JS	VC Divya	Zebulun BC	Berrizbeitia Luis D	Brown N	Walsh MJ
Country/City	Lancaster, UK	Chennai, India	India	New Jersey	Miami	California, USA
Year of report	2013	2018	2023	2010	2020	2008
Sex	Female	Female	Male	Male	Female	Male
Age	18	30	26	15	9	19
LN2 Food/beverage	Alcoholic drink with LN2	Cookie smeared with LN2	Biscuit with LN2	LN2 ingestion while doing ice cream making science experiment	Dragon's breath	LN2 ingestion
Symptoms	• Abdominal pain • shortness of breath	• mild burning associated with a tingling sensation on the inner aspect of her lower lip.	• mild respiratory distress • abdominal distension and pain	• respiratory insufficiency • abdominal pain	• Severe abdominal pain • shortness of breath	• Abdominal pain • Bloating • mild tachypnea and tachycardia, • mild respiratory difficulty
Complication	• necrosis • hemorrhage • erythema • tachycardiac • tachypnoeic • tympanic and peritonitic stomach • gastric perforation	• multiple ulcers in her lower lip • Intraoral frostbite	• low hemoglobin • massive pneumoperitoneum	• Barotrauma to GI tract • gastric perforation • tissue necrosis • contamination of peritoneal cavity • culture negative septic shock • acute respiratory distress syndrome	• Pneumoperitoneum • gastric perforation	• pneumoperitoneum
Respiratory distress	Yes	No	Yes	Yes	Yes	Yes
Treatment	• feeding jejunostomy • ventilation • vasopressure support • total gastrectomy with Roux-en Y reconstruction	• topical application of triamcinolone acetonide gel	• Exploratory Laparotomy	• laceration debrided • feeding jejunostomy • decompressing gastrostomy construction • Invasive ventilation • inotropic support with dopamine • laparotomy	• Open laparotomy • intubation	• laparotomy
Length of hospital stay	15 days	Nil	7 days	13 days	14 days	5 days

*Table 2: Safety measures for LN2 food and beverage consumption**

Sr. No.	Foods items	Common points	Drinks
1	Chew the LN2 snacks till all the vapors stopped coming out of the nostrils and mouth and then swallow.	Do not touch/ingest LN2 residue in the serving container or glasses.	Let all the fumes diminish from the glass then drink.
2	Do not keep LN2 coated treats for long in your mouth before chewing.	Food grade LN2 should be used.	Only adults should be permitted to drink LN2 mixed alcohol.
3	Do not let LN2 snack get stuck to your gums.	Do not try preparing LN2 food items/beverages at home without taking professional training.	Do not drink LN2 mixed beverages if it is bubbling.
4	Eat LN2 treat pieces one at a time	Purchase from licensed outlet.	No LN2 refill should be provided to the consumers.
5	Do not place these items on your palm before eating instead put it into mouth directly.	Follow the instructions given by the authorized and trained vendor before consuming it.	Blow on LN2 beverages until fumes are completely disappeared.
6	Use special skewers or toothpick like cutleries to eat LN2 infused snacks.	Seek immediate medical consultation in case of LN2 injuries.	LN2 infused drinks should be consumed with straws.
7	Do not use fingers to remove pieces from the serving cup.	Avoid consuming when pregnant.	Drink small fractions and do not gulp whole glass at a time.
8	Snacks dipped in LN2 should be packed in narrow-mouthed container so that accidental residual LN2 exposure should be avoided.		Do not lit cigarette.
9	Chew slowly.		Never mix LN2 with ice or water.

** This table summarizes the precautions to be taken for consuming LN2 food and beverages*

The treatment of food products with LN2 during manufacturing, packaging and preservation can increase their shelf life, and as it evaporates by the time the product reaches the end user, there is no risk during consumption (1). The unconventional use of LN2 in retail food and beverage outlets at the point of sale for fun and amusement is an emerging trend (Table 2). The food is presented with a surrounding fog that, if eaten before it evaporates, emerges from the consumer's nose like a dragon's breath (18). LN2 is tasteless, colorless and odorless (19), and so inhalation and ingestion are possible. When LN2 is added to food items at the point of sale, it is expected to evaporate before consumption, leaving the food safe for consumption. This is not always the case, however, as the consumer may inhale the vapor before it evaporates or ingest it along with the residual LN2 in the serving container. There is also the possibility that vendors do not give appropriate safety advice to their customers, or that their advice is not followed by the consumer. As a result, even healthy people can be affected if the appropriate caution is not applied to the handling and consumption of LN2.

While taking his history, the patient stated that after consuming the LN2-laced biscuits he felt a sudden blast of cold that irritated and numbed his airway, and the vapor came out of his nose and mouth but did not mention any of the blisters or gastrointestinal symptoms mentioned in other reports (Table 1). From then on, his respiratory symptoms exacerbated, and he started experiencing frequent bouts of illness, with the primary complaints of throat irritation, intermittent coughs and cold, weakness, runny nose, sneezing, nasal itching, aching body, headache and fever. He was started on antibiotics by his local clinic, which didn't help as he was affected by an extreme cold and not by any microbial infection. It is possible that the patient had an existing but undiagnosed compromised respiratory condition, or lack of knowledge of the symptoms of LN2 exposure could have led to the diagnosis and treatment being missed, and hence, over time, his condition deteriorated. Furthermore, the patient had low hemoglobin levels and a low BMI, which contributed to his weak health state. A previous study reported the potential effects on breathing of inhaling LN2 from a food item, and the dangers especially for asthma patients (20). Earlier, our patient was allergic but not asthmatic, but may have developed asthma-like symptoms after consuming the nitrogen-laden biscuit – asthma being known to be caused or exacerbated by cold. A peer-reviewed article by Ali et al. (2) reported the development of massive pneumoperitoneum, massive pneumomediastinum, shortness of breath, subcutaneous emphysema, mild respiratory acidosis, bilateral pneumothorax, bilateral pleural effusion, coughing and asthma attacks in people who were exposed to, or consumed LN2.

After being referred to our center due to the continued symptoms the patient was subjected to radiological investigation and spirometry, revealing symptoms of mild asthma. Under our clinical guidance, his condition was

brought under control through the prescribed medicines, and his spirometry test results were found to have improved at a 4-month follow-up visit. The patient's symptoms improved after the inhalational medication, and his BMI increased from 13.43 to 14.88, and then to 15.60 in the first and second follow-up visits after 2 and 4 months, respectively. Although the patient's health improved, his inhaler prescription continued as the asthmatic state persisted.

A review of literature reveals only 13 cases in the last 23 years reported in recognized journals (Table 1), although it is possible that most cases do not seek medical attention. Furthermore, the medical fraternity may not report on such cases due to the numerous reports in gray literature of LN2 consumption injuries and side effects all over the world, while clinical and follow-up studies and related studies are lacking. Furthermore, the long-term effects of such conditions are yet to be established. Such LN2-laden products are actively sold at funfairs and in shopping malls, and the vendors often operate without licenses. Regulatory norms should be established by government bodies responsible for food and safety, and proper guidelines should be drawn up for government agencies, vendors and consumers related to LN2-infused food and beverages, and those acting in contravention should be intervened and subjected to appropriate regulatory actions. In a bid to raise awareness of this issue, we have drawn up some safety measures to be applied related to the consumption of LN2-infused food products (Table 2). The U.S. Food and Drug Administration (FDA) has previously advised consumers to avoid food products with liquid nitrogen due to the potential health hazards, and has underlined that LN2 vapors are hazardous to asthma patients. Adding LN2 to food products immediately before consumption is dangerous. While LN2 evaporates over time, such food products should be avoided due to the extremely low temperature of the food. An article by the American Lung Association entitled "Dragon's breath? Not unless you have dragon lungs" (18) warns consumers to beware of the fun delivered by tasty and eye-catching LN2-coated treats, and the potential harm they can do to health.

CONCLUSION

This case study reports on how the consumption of LN2-infused food products can lead to respiratory distress in patients with existing respiratory conditions. Such food items should either be completely avoided, or safety measures should be followed when consuming them. Raising awareness by reporting such cases, and the creation of regulatory standards by governing bodies are the needs of the hour.

CONFLICTS OF INTEREST

None declared.

AUTHOR CONTRIBUTIONS

Concept - A.A., G.G., S.C., P.D., S.B.; Planning and Design - A.A., G.G., S.C., P.D., S.B.; Supervision - A.A., G.G., S.C., P.D., S.B.; Funding - A.A.; Materials - A.A., G.G., P.D., S.B.; Data Collection and/or Processing - G.G., S.C.; Analysis and/or Interpretation - A.A., G.G., S.C., P.D., S.B.; Literature Review - A.A., G.G., S.C.; Writing - S.C., G.G.; Critical Review - A.A., G.G., S.C., P.D., S.B.

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