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Efficacy of Cryosurgery in the Treatment of Mucocele due to Oral Extravasation in Adult Patients

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Abstract

Introduction: Nowadays, new non-invasive treatment alternatives are used to remove oral mucocele, resulting in cryosurgery as a therapeutic procedure that uses very cold temperatures to freeze and destroy unwanted pathological cells and tissues in a controlled manner at the cryotreated site.

Objective: The therapeutic results of cryosurgery in the enucleation of mucocele due to oral extravasation in adult patients were evaluated.

Material and Methods: A descriptive and cross-sectional study was carried out in 20 adults with a clinical diagnosis of mucocele due to oral extravasation, attended in the stomatology consultation of the Specialty Polyclinic of the "Saturnino Lora Torres" University Clinical-Surgical Hospital of Santiago de Cuba, in the period from October 2022 to the same month of 2023.

Results: The variables were analyzed: sex, age, number of applications, freezing/thawing time, clinical signs and symptoms and clinical evaluation of the repair, the ethical principles of the research were met. It was found that cooling between 20 and 30 seconds and thawing between 91 and 120 seconds were the most effective in destroying the affected oral mucosa. Tissue regeneration was achieved 14 days after the therapeutic session applying them one at a time three cycles. The absence of symptoms was the most significant in the post-surgical evolution.

Conclusions: This cryosurgical method was simple, economical, fast and harmless to eliminate injured oral tissues, achieving tissue repair and re-epithelialization in a minimum time, as well as excellent therapeutic results by preventing the formation of residual scars and avoiding the appearance of risks and complications postsurgical events such as infection and local bleeding.

Keywords: Cryosurgery; Oral Mucosa; Mucocele due to Extravasation; Re-epitelizacion

Abbreviations

OEM: Oral Extravasation Mucocele.

Introduction

Oral Extravasation Mucocele (OEM) is the most common benign cystic tumor of the minor salivary glands [1-3], it appears as a pseudocyst without a wall defined, filled with mucus mainly due to continuous trauma to the mouth and piercing placement in the lower lip [1,2]. Your diagnosis is clinical due to its location and history of mechanical trauma [1,2,4,5], it appears as a translucent nodular lesion, bluish in color, circumscribed, rounded, smooth surface, sessile base,

soft consistency, not painful on palpation and recurrent due to repetitive episodes of decrease and increase of volume [2,5], its duration being variable, from a few days to years without the presence of pain [5].

At its beginning, this pathology progresses rapidly, its size can vary from a few millimeters to reaching a large size, causing swelling, discomfort and affectation of aesthetics that interferes with speech, chewing and swallowing, which has an impact on the quality of life of the patients [2].

Oral extravasation mucocele mainly affects children and young adults [3-6], where the bite of the lower lip, the microtrauma due to incorrect orthodontic procedures or complications in surgical management are responsible for the rupture of the salivary duct [1,2,5].

Nowadays, new non-invasive therapeutic alternatives are described in the literature for the removal of mucocele due to oral extravasation of minor salivary glands [1,7], resulting in cryosurgery a treatment that uses very cold temperatures to freeze and locally destroy the cells and pathological tissues in an effective and controlled manner at the cryotreated site, allowing complete removal of the lesion and tissue repair [8-11].

Cold, as therapeutic element, has been known since prehistory. The term cryotherapy or cryosurgery comes from the Greek “Kryos” which means “very cold” which is used to obtain a therapeutic benefit [7,8]. The ancient Egyptians applied cold to reduce inflammation in trauma and infected wounds [9,11,12] and in ancient Greece they used it to reduce edema, hemorrhage and pain [7,11,12].

The english doctor James Arnott (1797-1883) was the first to use cold at very low temperatures, using a mixture of salt and crushed ice with a portion of sodium chloride to destroy malignant tumors, also verifying that freezing was effective for the treatment of neuralgia and migraines by inducing an analgesic effect; bringing with it pain relief [9,12,13].

In the decade of 1990, interest in cryosurgery increased, developing new technologies with the design of advanced cryosurgical equipment, achieving this technique great importance in the palliative therapy of inoperable tumors and in the cure of various medical and oral pathologies [7,9,14] for its simplicity, safety and no complications for the tissues [8,10,14,15]. Nowadays, its therapeutic possibilities are expanding due to its effectiveness, adaptation for outpatient surgery and its relative low cost, which makes it a valid option for treatment in the coming years [12].

Liquid nitrogen (N_2L) is the most used refrigerant due to its medical physiotherapeutic qualities, great freezing power (minus 196 degrees celsius) and variability, it is ideal for treatment of benign, premalignant and malignant conditions due to the removal of local tissue. This cryogenic agent has the following properties: odorless, colorless, insoluble, transparent, non-polluting and non-toxic [9,10,12,13].

Cryotherapy is the application of any cooling substance on the skin or mucosa of the body that generates a rapid transfer of heat to the cold source by rapid local cooling of the affected tissue [15-18], which induces a tissue response on blood circulation due to arteriolar vasoconstriction, reduction of blood flow [10,16,17] and edema in injured tissues [7].

The decrease in vascular permeability at the level of the capillaries is another deleterious effect of extreme cold that causes cellular damage due to a reduction in blood flow, causing a drop in hydrostatic pressure, which limits the entry of plasmatic fluid to the inflamed areas, creating a response less intense inflammatory with pain sedation. In addition, it reduces postsurgical tissue edema, releasing vasoactive substances in the blood vessels and shortening the transmigration of leukocytes that agglutinate in the endothelial wall, creating a small inflammation [7,10,15,18].

Local cold causes a small variation in the transmission of nervous impulses, slowing down chemical mediators (pain drivers) and neuronal stimuli; inducing local analgesia by reducing the activation threshold of tissue nociceptors that accelerate the release of endorphins, relieving pain and improving the functions of the immune system [7,15-17]. Finally, the reduction in cellular metabolism is due to low oxygen demand, preventing the production of free radicals in tissues and the release of pro-inflammatory substances that lead to their destruction [7,16].

For the above reasons, I carried out the present research, with the following scientific problem: What are the therapeutic results of cryosurgery in mucocele due to oral extravasation? To answer the above question, I designed the objective: to evaluate the therapeutic results of cryosurgery in the removal of mucocele due to oral extravasation in adult patients.

Material and Methods

A descriptive and cross-sectional study was carried out with a universe of 20 adults, of both sexes, with a clinical diagnosis of mucocele due to oral extravasation, assisted in the Comprehensive General Stomatology consultation of the Specialty Polyclinic of the “Saturnino Lora Torres” University Clinical-Surgical Hospital in Santiago de Cuba, during the period from October 2022 to the same month of 2023. In the clinical examination of the oral cavity, inspection and palpation were carried out, using a dental chair, artificial

lamp and oral mirror to directly and indirectly visualize the mucocele due to oral extravasation and apply the cryotherapeutic procedure to all patients with this condition to induce freezing and local tissue destruction.

For the information, collection and obtaining of primary data, a survey model was developed with the following variables of interest for the research: sex (male and female), anatomical sites (lower lip, cheek mucosa, ventral surface of the tongue and floor of the mouth), number of interventions in a therapeutic session (number of freeze/thaw cycles that were applied to the injured tissue with a wooden swab wrapped in cotton and saturated in liquid nitrogen), freezing time in seconds (cooling was calculated from the first direct contact of the applicator on the affected oral mucosa until the moment of its removal), thawing time in seconds (the duration of thawing was measured from the removal of the applicator from the oral mucosa until the disappearance of the white ice ball that occurs when the tissues recover their original color and texture), clinical signs and symptoms during the post-surgical evolution of cryosurgery: none (absence of clinical symptoms), pain (unpleasant response due to local cold), burning (sensation of pain), and pain in the affected area. burning), pain plus burning (unpleasant response to local cold, accompanied by a burning sensation) and presence of necrosis (blackish crust on the surface of the cryotreated oral mucosa); clinical evaluation in the repair and re-epithelialization of the oral mucosa at 3, 7, 14, 21 and 28 days of treatment: equal (absence of the repair process), improved (no appearance of objective and subjective symptoms evidencing the repair process) and cured (absence of objective and subjective symptoms, revealing the re-epithelialization of the oral mucosa).

Prior to the cryosurgical procedure, large cystic lesions were punctured and aspirated using a sterile 5-milliliter syringe and a No. 23 needle to empty their contents inside; while in small lesions, an incision was made at the edge of the cyst, compressing it with sterile gauze for three to five minutes until the contents of the cystic cavity were completely removed and bleeding decreased, facilitating the reduction of freezing time and penetration of cold into the damaged tissue for its total destruction. To perform the technique, pour the amount of liquid nitrogen to be used into a plastic container and inmerse the wooden applicators wrapped in cotton for five to ten seconds so that they are well impregnated. The cooling agent is applied quickly and immediately to the diseased tissue, producing a freezing effect on the entire surface of the cryolesion, which becomes whitish and hard, observing the ice ball and between 20 and 30 seconds a whitish halo of perilesional freezing of 1 to 3 millimeters forms outside the lesion.

Finally, the applicator is stopped until the ice ball disperses after 91 to 120 seconds, leaving an erythematous halo around the lesion, showing the thawing process, with the oral tissues gradually recovering their original texture and color.

Cryosurgery was applied from one to three cooling/thawing cycles in one therapeutic session. After the procedure, patients were instructed not to eat hot or highly seasoned foods to avoid irritation of the oral mucosa, to use saline mouthwashes after each meal, not to remove the scab to avoid infection and discomfort, and were warned about the presence of a clear exudate in the cryotreated area.

A database was created in the SPSS program for Windows, which allowed the processing and analysis of information, descriptive statistical methods were used in the organization of the quantitative indicators obtained and statistical tables were used to show the results, placing the data in absolute and relative frequencies.

The research always took into account ethical considerations regarding the principle of respect for the patient, the security and reliability of the data obtained was guaranteed, the disease they suffered was discussed using simple vocabulary, the characteristics of the study were provided verbally and in detail, as well as minor discomforts and complications that it could cause to their health, those who were not willing could stop the treatment and continue with the traditional method, they were kept informed during its duration, and the informed consent of the participants was obtained in writing, being approved by the Scientific Council of the hospital.

Results

With regard to the anatomical location of the mucocele due to oral extravasation and the sex variable in Table 1, it was shown that the most affected site was the lower lip with a total of 15 cases (75%), followed by the cheek mucosa with 15%, with men being slightly more affected (55%) than women (45%).

Anatomical location of the lesion	Sex					
	Male		Female		Total	
	No.	%	No.	%	No.	%
Lower lip	8	40	7	35	15	75
Cheek mucosa	2	10	1	5	3	15
Ventral surface of tongue	0	0	1	5	1	5
Floor of mouth	1	5	0	0	1	5
Total	11	55	9	45	20	100

Percentages calculated with respect to the total population (20 patients).
Table 1: Anatomical location of extravasation mucocele, by variable sex.

In Table 2, regarding the freezing/thawing time and the number of N2L applications in one therapeutic session, it was shown that a large part of the cryotreated cases (70%) received three freezing cycles and, of these, 73.3% achieved a cooling time between 20 and 30 seconds; however, when relating the thawing time and the number of applications, it was revealed that the thawing time between 91 and 120 seconds was the most effective with 80%, with three applications being performed in one therapeutic session.

Freezing/thawing time	Number of applications in one therapy session							
(in seconds)	1 application		2 applications		3 applications		Total	
	No.	%*	No.	%*	No.	%*	No.	%**
	a) Freezing time							
20-30	1	6,7	2	20	12	73,3	15	100
31-40	1	33,3	1	33,3	1	33,3	3	100
41-50	0	0	0	0	1	100	1	100
51-60	0	0	1	100	0	0	1	100
Total	2	10	4	20	14	70	20	100
b) Thawing time								
30-60	0	0	1	100	0	0	1	100
61-90	0	0	0	0	1	100	1	100
91-120	1	6,7	2	13,3	12	80	15	100
121 y más	1	33,3	1	33,3	1	33,3	3	100
Total	2	10	4	20	14	70	20	100

**Percentages based on total cases by freezing/thawing time.
Table 2: Relationship between freezing/thawing time and the number of applications in a therapeutic session.

In Table 3, when relating the appearance of post-surgical signs and symptoms and the number of applications in a therapeutic session, it was evident that 60% did not present symptoms and of them, 71.4% received three cycles in a therapeutic session; while 15% reported slight pain after applying the cryosurgical technique.

Post-surgical signs and symptoms	Number of applications in a therapeutic session							
	1 application (2 cases)		2 applications (4 cases)		3 applications (14 cases)		Total (20 cases)	
	No.	%*	No.	%*	No.	%*	No.	%**
None	1	50	1	25	10	71,4	12	60
Pain	1	50	1	25	1	7,1	3	15
Burning	0	0	1	25	1	7,1	2	10
Pain + burning	0	0	1	25	2	14,2	3	15

*Percentages based on total cases for post-surgical signs and symptoms .
Table 3: Appearance of post-surgical signs and symptoms and number of applications in a therapeutic session.

When describing in Table 4 the results of the clinical evaluation in the repair and re-epithelialization of oral tissues at 3, 7, 14, 21 and 28 days after the cryosurgical procedure was applied, it was observed that at three days of treatment, 65% of the lesions were in the process of repair; while the highest degree of repair and re-epithelialization occurred at 14 days with 70%.

Repair and re-epithelialization process	Days after cryosurgical treatment									
	3 days (20 casos)		7 days (20 casos)		14 days (20 casos)		21 days (20 casos)		28 days (20 casos)	
	No.	%*	No.	%*	No.	%*	No.	%*	No.	%*
Same	7	35	9	45	0	0	0	0	0	0
Improved	13	65	11	55	6	30	3	15	1	5
Healed	0	0	0	0	14	70	17	85	19	95

*Percentages based on total cases per day post cryosurgical treatment.
Table 4: Results of clinical evaluation in post-cryosurgical treatment repair and re-epithelialization.

Discussion

This research shows a slight predominance of mucocele due to oral extravasation in the male sex and the lower lip is highlighted as the anatomical site of greatest predilection due to being an area of high incidence of glands. These results coincide with those obtained by Essaket, et al. [1], Rodríguez, et al. [2], and Peña, et al. [3], who highlighted that the lower labial mucosa (80 to 90%) is the site of greatest risk of trauma and that it usually appears in the first and second decades of life, being less common after 25 years of age.

This study shows excellent therapeutic responses in the vast majority of cryotreated patients, when applying sudden freezing (20 and 30 seconds) and slow and spontaneous thawing (91 and 120 seconds) in a therapeutic session. These criteria are equal to the works carried out by Prajesh, et al. [8], Osorio, et al. [14] and Tsunoda, et al. [15], who claim that the direct effect of cryogenic temperatures induces ice crystallization inside and outside the cell due to the rapidity of cooling (a few seconds). Likewise, Estrada [12], Darias, et al. [13] and Prabhavathi, et al. [17], clain that as the slowness of the thawing increases, an excess of electrolytes is produced at the intracellular level that reaches high toxic levels causing the hydration of the cells that become lethal causing swelling and cell lysis. On the other hand, Jara, et al. [10], Estrada [12], Darias, et al. [13] and Prabhavathi, et al. [17], consider that tissue necrosis is effective when sudden cooling and slow thawing are used, intensely damaging the cells, but if repeated freezing and thawing are applied, the effect is doubly lethal since it is accompanied by recrystallization of ice at the intracellular level in each cycle performed, making the freezing shorter and more destructive, so that the cells swell, burst and die. This phenomenon has an immunological effect, activating leukocytes, mainly neutrophils that concentrate at the cryoinjury site, recognizing, engulfing and phagocytizing dead cells. Other authors such as Leguisamo, et al. [7], Prajesh, et al. [8] and Olmos [16], revealed that at the level of the vascular endothelium (indirect effect), freezing occurs on small blood vessels with the formation of ice crystals, which induce vasoconstriction due to a reduction in blood flow in the cryotreated area; also, there is an interruption of microcirculation due to an increase in blood viscosity in the frozen area, which causes an anti-edema effect and consequently a minimal production of free radicals in oral tissues.

In the consulted medical literature [8,9,14,15,18], reiterate that as the cryolesion site thaws and the temperature rises, circulation is restored due to arteriolar vasodilation, with a hyperemic reaction occurring within a few minutes that can last from one to three hours. Likewise, in the first 12 to 24 hours, edema is seen in the cryotreated area (collection of exudates immediately after thawing) due to obstruction of the lymphatic vessels and after 24 hours a blister appears that can break spontaneously after 48 hours, presenting a serosanguinous exudate without forming traces of residual scar and keeping the basement membrane intact. Subsequently, between three and seven days, a superficial crust begins to form on the oral mucosa, blackish or yellowish in color, which remains between seven and fourteen days until it falls off and gradually disappears over the following days.

Other scholars on the subject such as Estrada [12] and Tsunoda, et al. [15], report that the affected tissues are replaced by a clean and active granulation tissue that develops on the entire treated surface. Also, other alterations occur in the vascular endothelium such as increased capillary permeability, microthrombus formation, ischemia, blood cell rupture and tissue necrosis, so these vascular changes accelerate local tissue destruction. These results are similar to this research.

As in this study, Villarreal, et al. [9], Jara, et al. [10], Estrada [12] and Darias, et al. [32], report that cryosurgery is well accepted by patients, becoming an effective therapeutic alternative because it causes minimal damage to surrounding tissues, there is no discomfort or pain due to the decrease in nerve conduction velocity during surgery and in the postoperative period, there is no postoperative infection because liquid nitrogen reaches very low temperatures which makes it incompatible with any living form, there is preservation of the inorganic structures of the bone; In addition, the cryosurgical technique can be repeated as many times as necessary, leaving no permanent side effects.

Similarly, Leguisamo, et al. [7], Olmos [16] and Prabhavathi, et al. [17], emphasize that anesthesia is not dispensable because the direct action of extreme cold inhibits the conduction speed of nerve fibers, producing a low transmission of neural pain signals that creates an analgesic effect; likewise, no infections are observed at the cryolesion site. These published scientific articles are similar to the present study, with the exception of a tiny percentage of cryotreated patients who reported mild pain after the cryosurgical procedure.

In this casuistry, it was shown that the highest level of repair and re-epithelialization of oral tissues occurs 14 days after the therapy is applied, where a smooth, healthy surface remains, without traces of residual scars and a renewal of normal tissue that replaces the destroyed areas, obtaining excellent results. This work is similar to that of Estrada [12] and Darias, et al. [13], who achieved appreciable clinical changes in the evolution of the disease due to the postoperative repair of patients in an optimal time due to the physical, chemical and biological properties of this technique, such as: antiseptic, antibacterial, anti-inflammatory, anti-infectious, biostimulant, healing and immunological, which contributed to the regeneration of damaged structures and the restoration of the functions of the oral mucosal epithelium.

Cryosurgery is generally an easy method to learn; however, it is necessary that the technical and/or professional staff be well prepared in terms of knowledge of the basic theoretical foundations, skill and experience of the technique, since its main success will depend on its correct application, control of the operating parameters and the exposure time of the cryogenic substance (liquid nitrogen).

Based on the analysis of these results, it is concluded that cryosurgery is a safe, non-traumatic and effective treatment modality to regenerate damaged oral epithelial tissues caused by sudden freezing with slow and spontaneous thawing. This cryosurgical method proved to be simple, economical, fast and harmless for the treatment of affected oral tissues, achieving tissue repair and re-epithelialization in an optimal time, as well as excellent therapeutic results by preventing the formation of residual scars and avoiding the appearance of post-surgical risks and complications such as infection and local bleeding.

- **Conflict of Interest**

This research does not present any conflict of interest, as it is the responsibility of a single author.

- **Author's Contribution**

Gladys Aída Estrada Pereira: Conceptualization, methodology, research, formal analysis, project administration, supervision, data collection and interpretation, resources, validation, visualization, writing-original draft, writing-review and editing, qualitative variables of the work.

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