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ELECTRICAL BURNS OF THE ORAL CAVITY (REVIEW)

Problem statement. Electrical burns are a fairly rare variant of damage to the oral cavity organs, but their complications are accompanied by a significant deterioration in the quality of life and persistent disability. This problem is practically not covered in modern available domestic sources. **Purpose of the study.** To highlight the main etiological, diagnostic and therapeutic features of electrical burns of the oral cavity. **Materials and methods of the study.** Obtaining scientific literature information was performed using the information search systems Scopus, CrossRef, Google Scholar and PubMed. **Results and their discussion.** Worldwide, electrical burns of the oral cavity account for 2.2% of electrical injuries and only 0.12% of all burns; usually occur in infants who are teething; mostly observed in children due to biting, chewing or sucking electrical conductors and other elements of electrical appliances. Severe cases with hospitalization and surgical treatment are rare. Despite

their rarity, treatment and long-term rehabilitation make these injuries an important problem in burn care. In severe cases, damage extends to the gums, alveolar process of the chin, oral mucosa and tongue. Early surgery is characterized by an aggressive approach to nonviable or questionable tissue; another tactic is to wait until the extent of the damage is fully determined with subsequent planning of the optimal treatment option. The purpose of oral commissure splinting is to provide a counterforce to the tendency for wound contracture in order to reduce scarring, maintain function, and reduce the need for reconstructive surgery. An important role in preventing a negative functional outcome is played by attention to the rehabilitation of swallowing and speech, and the prevention of all possible consequences depending on the damage to the dental structures. A thorough interdisciplinary approach is important, which is carried out with the participation of an maxillofacial surgeon and a speech therapist. **Conclusions.** Oral electrical burns are a specific problem in modern pediatric dentistry, and the right diagnostic and treatment option will reduce the possibility of developing long-term complications and disability.

Key words: electrical trauma, oral electrical burns, conservative and surgical treatment, recovery.

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ЕЛЕКТРИЧНІ ОПІКИ РОТОВОЇ ПОРОЖНИНИ (ОГЛЯД)

Постановка проблеми. Електричні опіки є досить рідким варіантом ураження органів ротової порожнини, проте їх ускладнення супроводжуються значним погіршенням якості життя та стійкою інвалідизацією. В сучасних доступних вітчизняних джерелах дана проблема практично не висвітлена. **Мета дослідження.** Висвітлити основні етіологічні, діагностичні та лікувальні особливості електричних опіків ротової порожнини. **Матеріали і методи дослідження.** Отримання наукової літературної інформації було виконано із використанням інформаційних пошукових систем Scopus, CrossRef, Google Scholar та PubMed. **Результати та їх обговорення.** В усьому світі електричні опіки ротової порожнини становлять 2,2% електротравм і лише 0,12% усіх опіків; зазвичай трапляються у немовлят, в яких ріжуться зуби; здебільшого спостерігаються у дітей через кусання, жування або смоктання електричних провідників та інших елементів електроприладів. Важкі випадки з госпіталізацією та хірургічним лікуванням трапляються рідко. Незважаючи на їх рідкісність, лікування та тривала реабілітація дозволяють означити ці травми як важливу проблему лікування опіків. У важких випадках пошкодження поширюються на ясна, альвеолярний відросток підборіддя, слизову оболонку рота та язык. Рання хірургія характеризується агресивним підходом до нежиттєздатної або сумнівної тканини; інша тактика – це очікування до повного визначення межі пошкодження з подальшим плануванням оптимального варіанту лікування. Метою шинування ротової спайки є забезпечення протидіючої сили тенденції до контрактури рани з метою зменшення рубцювання, підтримки функцій та зменшення потреби в реконструктивній хірургії. Важливу роль в запобіганні негативного функціонального результату відіграє увага до реабілітації ковтання та мовлення, та попередження всіх можливих наслідків, що залежать від ураження зубних структур. Важливим є ретельний міждисциплінарний підхід, який проводиться за участю цілєпно-лицевого хірурга та логопеда. **Висновки.** Електричні опіки ротової порожнини являють собою певну проблему сучасної дитячої стоматології, а правильно обраний варіант діагностики лікування дозволить знизити можливість розвитку тривалих ускладнень та інвалідизації.

Ключові слова: електротравма, електричні опіки ротової порожнини, консервативне та оперативне лікування, відновлення.

Problem statement. Electrical burns are a fairly rare variant of damage to the oral cavity organs, but their complications are accompanied by a significant deterioration in the quality of life and persistent disability. This problem is practically not covered in modern available domestic sources.

Research objective. Based on a very limited number of available foreign literary sources, to highlight the main etiological, diagnostic and therapeutic features of electrical burns of the oral cavity.

Materials and methods of the study. Obtaining scientific literary information was carried out using the information search systems Scopus, CrossRef, Google Scholar and PubMed and supplemented by a manual search of the used articles using the terms: electrical trauma, electrical burns. Selected literary sources were published in Ukrainian, English and Spanish, of which 94.5% – in the last 10 years.

Results and their discussion. The incidence of electric shock in developed countries reaches 2-3 episodes per 100,000 population per year. In Ukraine, electrical burns account for 4-5% of hospitalizations in burn units [1, p. 19]. Electrical burns of the oral cavity (EOB) represent a surgical reconstructive problem, in particular due to the frequent involvement of several different tissues and anatomical structures. In the USA, approximately 20% of all electric shock injuries occur in children [2, p. 3]. In Europe, electrical injuries account for 3-8% of all burns, and among them, the incidence of EOB is estimated to be between 2.2 and 3.5% [3, p. 43]. Severe cases with hospitalization and surgical treatment are rare and, fortunately, are decreasing in developing countries. Despite their rarity, treatment and long-term rehabilitation make these injuries an important problem in burn care [3, p. 44]. The prevalence of EOB, especially among infants, is poorly understood [4, p. 13].

Many cases of injury to young children are associated with the ingestion of various objects from the environment into the oral cavity [5, p. 3; 6, p. 907; 7, p. 3; 8, p. 5]. EOB usually occurs in infants who are teething. Electrical burns are most often observed in children due to biting, chewing, or sucking on electrical conductors and other elements of electrical appliances [2, p. 3; 3, p. 43; 9, p. 44; 10, p. 4; 11, p. 138; 12, p. 6]. Most of these injuries involve electrical sockets or plug connectors (10.8%), extension cords (18.5%), and electrical wires (21.5%) [13, p. 96]. Mild EOB can occur in infants when sucking on galvanic cells. Lithium-ion and lithium-cadmium batteries are much more dangerous in this regard [14, p. 2]. Cases of EOPR in adults are extremely rare and are associated with casuistic cases of safety violations when the hands are busy and the electric wire is held in the teeth.

Labial, or oral, adhesion is the site of a separate childhood injury, which usually occurs as a result of an electrical discharge, which can primarily damage the mucous membranes due to the electrolyte-rich surrounding saliva and the relatively low resistance of the tissues. Saliva acts as a contact medium through which the electric current passes, leading to

EOB [3, p. 43; 4, p. 13]. EOB is the most common electrical injury in children, occurring mainly in the age group from 6 months to 4 years, with the lips, mouth or tongue being disproportionately affected. In all children presenting with electrical burns, the mouth was the most common site of injury, with almost all patients being under 4 years of age (93%), and most patients being under 2 years of age at the time of injury (65%). Worldwide, EOB account for 2.2% of electrical burns and only 0.12% of all burns; thus, the incidence of oral electrical burns is relatively low [3, p. 43; 4, p. 13; 11, p. 138; 15, p. 38]. In the United States, emergency department visits for oral electrical burns in children average approximately 65.1 cases per year. Overall, 59.6% of patients were male. Almost half of emergency department visits were for patients younger than 3 years of age, and more than three-quarters of emergency department visits were for patients younger than 5 years of age. Overall, 77.2% of patients were evaluated, treated, and discharged from the emergency department, while 19.2% were hospitalized [13, p. 96]. EOB has also been described as an iatrogenic complication of piezoelectric surgery or electrosurgical devices [16, p. 17].

Previous estimates of the incidence of EOB in children vary considerably in the literature and range from small case reports to one-year studies [13, p. 96].

There are 2 major mechanisms of injury associated with electrical burns: arc and contact. Contact burns, which are less common around the mouth, usually require 2 points of contact, such that current from the electrical source passes through the body part and exits through the ground through the path of least resistance, forming "current traces" [1, p. 20].

The manifestation of damage depends on many factors, such as the duration of contact, electrical voltage, and insulation. It is especially important to know the magnitude of the voltage, which directly correlates with the spread of damage, even for the Joule effect, than for the induction of tetanic muscle contraction with subsequent increase in exposure time [3, p. 43]. Electrical burns of the oral cavity in children are more often (67.74%) caused by low voltage [10, p. 4].

Arc burn, the most common type of EOB, occurs when electrolyte-rich saliva, which acts as a good electrical and thermal conductor, closes a circuit between two conductive wires, initiating an arc or flash that generates temperatures of up to 3000°C. The low electrical resistance of moist mucous membranes makes them particularly susceptible to severe injury by this mechanism. The most common site of dental

injury is the oral commissure, the areas of the upper and lower lips adjacent to the commissure. Although these injuries are rare, damage to the oral commissure is a common complication of EOB, and knowledge of its proper treatment is essential to achieving acceptable functional and cosmetic results [2, p. 3; 3, p. 43; 11, p. 138].

The electrical arc is formed from one edge of the lip to the other. This can lead to damage to the orbicularis oculi and potential lip deformity if the burn crosses the oral commissures, i.e. the corners of the mouth. There is immediate burning sensation in the mouth and numbness around it, protrusion of the tongue and drooling [17, p. 174]. Damage to the deciduous teeth sometimes occurs [12, p. 6]. In severe cases, damage extends to the gums, alveolar process of the chin, oral mucosa and tongue [3, p. 43]. The lower lip and oral commissure are more commonly affected than the upper lip, and patients may initially present with complaints of impaired salivary control. It is important to note that it is very difficult to assess the true extent of the lesion at first presentation, and the actual area of the lesion may be larger than initially thought.

The clinical manifestations of EOB range from whitish-red erythema to necrotic patches. Most electrical burns of the lip adhesions affect the mucosa, submucosa, muscles, nerves, and vessels. Significant edema and scab formation may occur within two to three days. At initial presentation, oral adhesion burns are usually gray or white in color with signs of charring. The wounds are often painless and bloodless due to the nature of the thermal injury caused by high temperature with the death of nerve structures [11, p. 138]. As the burn injury develops, the patient develops a rim of erythema and edema in the surrounding tissues, and after the first 24 hours, a clear separation of inflammation usually forms, indicating the presence of an area of tissue necrosis due to thrombosis of blood vessels. Scab and coagulative necrosis develop as the wound heals, eventually sloughing off after 1 to 4 weeks. The resulting scar tends to sclerose as the soft tissues remodel over time. Bleeding occurs when the burned tissue spontaneously begins to loosen or delaminate, usually 3 to 4 days after the burn injury. Although bleeding at first presentation is rare, there is some delayed risk of bleeding due to labial artery erosion, which may occur 2 to 3 weeks after the injury in 25% of cases of EOB [2, p. 3; 10, p. 4; 11, p. 15, p. 38; 17, p. 174].

Several classification systems have been proposed to describe the degree of tissue damage in children with oral adhesions, but none have been widely

accepted. The scheme developed by *Ortiz-Monasterio* classifies injuries according to the percentage of damage to the upper or lower lip, which divides the damage into mild, moderate and severe. A more recent classification system proposed by *Al-Qattan* defines burns of the oral cavity according to the depth and degree of damage [3, p. 43; 11, p. 138]. In any case, a valid classification of EOB is still lacking, especially in pediatric cases; it is particularly difficult to define due to the wide variability of manifestations and unpredictable dynamics of the damage [3, p. 43].

Electrical burns of the mouth are the most common electrical injury in children and can have serious long-term functional and aesthetic consequences, and even lead to permanent disability. Electrical burns of the lip adhesion are disfiguring injuries to the child [15, p. 38; 18, p. 27]. Therefore, such patients should be carefully monitored and examined by burn specialists and pediatric dental or plastic surgeons [2, p. 3; 9, p. 44; 10, p. 4]. The timing and appropriate treatment of burns of the oral adhesion, lips and tongue are currently controversial, with a wide range of treatment strategies and surgical techniques proposed, performed at different intervals from the time of injury, but without a general consensus. Treatment approaches can be divided into two different forms. The first is early surgery, which is characterized by an aggressive approach to nonviable or questionable tissue, which is especially advisable to prevent edema, inflammatory response, and necrosis; the second is waiting until the extent of the injury is fully defined and then planning the optimal option [3, p. 43]. To facilitate discussion of available treatment options, interventions can be classified according to the timing of their implementation: early intervention, which occurs within a few days of injury; intermediate intervention, which occurs at a time when necrosis can already be distinguished from normal tissue (usually 1 to 4 weeks); and delayed intervention, when recovery begins after all tissues have healed (after several months). The choice of treatment strategy may vary depending on the time elapsed since the burn injury, the degree, and the extent of the injury [11, p. 138].

Regardless of the severity of the burn injury, the main treatment strategy includes analgesia, infection control, and accelerated wound healing. If the burn of the lips or floor of the mouth is severe, an aggressive approach is the best treatment, including early surgical debridement of the wound followed by mucosal repair. In contrast, milder electrical burns with limited anatomical involvement should be treated conservatively. Application of antibiotic ointments

to the burn site or systemic antibiotics to prevent wound infection is recommended [15, p. 38]. Early intervention advocates believe that the best results in the treatment of oral adhesion burns are achieved by early removal of the damaged tissue. This approach results in faster healing, shorter hospital stays, fewer general surgeries, and improved outcomes. Early removal of damaged tissue may result in a deficit of soft tissue around the mandible and subsequently impair the development of the mandibular bone base. The main disadvantage of this approach is that the extent of tissue damage and necrosis may not be apparent *a priori*, and underestimation of the area of the lesion may lead to the resection of viable tissue. Some authors prefer an intermediate course of intervention, preferring to remove damaged tissue and scab as soon as the extent of necrosis becomes apparent and can be distinguished from the surrounding healthy tissue (usually 1 – 4 weeks after injury). This approach minimizes scarring, reduces the amount of bleeding from the labial artery due to scab rejection, prevents secondary infections during wound healing, and allows for better reconstructive results [11, p. 137].

Proponents of conservative or delayed treatment argue that surgery before the scar has matured may increase the risk of hypertrophic contracture because, once the scar has formed, the extent of the damage is more apparent when functional and aesthetic deficits are more apparent, and that reconstruction should be more successful. Most experts favor conservative treatment with oral or topical antibiotic prophylaxis with or without vigorous scar massage with steroid creams or vitamin E [11, p. 138].

Injuries ranging from superficial burns to severe multiple tissue damage can occur. In order to obtain the best and most stable functional outcome in pediatric cases, attention should be focused on the reconstructive option and a multidisciplinary approach. Regarding reconstruction options, several different techniques are proposed for each specific case to obtain satisfactory results in terms of aesthetics and function [3, p. 43].

The organization of scar tissue in the early stages of maturation tends to contract and contract the wound unless counteracted by opposing forces. Microstomia, defined as a marked reduction in the size of the oral opening due to cicatricial contracture of the perioral tissues, with cicatricial retraction results in alveolar deformity, reduced mouth opening, impaired speech and mastication, and limited the patient's ability to receive optimal dental care and maintain proper oral hygiene [4, p. 43; 15, p. 38]. If splinting is not used in severe electrical burns, facial

disfigurement occurs [3, p. 43]. Current treatment involves the use of a splint fixed in the oral cavity to maintain the lip adhesions in the correct position during healing. Without the aid of a microstomia appliance, the resulting contracture and associated functional deficits are difficult to reverse and restore. Thus, the correct timing and sequence of treatment are critically important [15, p. 37; 18, p. 27].

The purpose of oral adhesion splinting is to provide a counterforce to the tendency for wound contracture to reduce scarring, maintain function, and reduce the need for reconstructive surgery. There are many different devices that have been used for this purpose, including both intraoral and extraoral devices, as well as devices where the tensile force is applied vertically across the oral adhesion, horizontally, or around the mouth [11, p. 137]. Splinting must be performed for a long period of time to be effective. The splint is worn continuously except when the patient is eating or caring for the oral cavity. Because the process of scar maturation and reorganization can take up to 1 to 2 years, the device is worn for a long period of time, at least several months. The overall data, although limited and retrospective, suggest that oral adhesion splinting is a useful treatment for children with EOB and may reduce the need for future surgical commissuroplasty. Before the introduction of routine splinting, 8.4% of patients required surgery to correct microstomia, whereas after the introduction of routine splinting in 1974, only 3.5% of patients required surgery [11, p. 138]. After one year of wearing the appliance, the question of whether plastic surgery is appropriate is addressed [15, p. 37; 18, p. 27]. If surgical reconstruction is necessary, the goals include both maintenance of normal function and cosmetic effect. A number of different techniques have been proposed for reconstruction of oral adhesions, each with its own advantages and disadvantages that make them suitable for a particular injury [11, p. 137].

Oral adhesion burns remain a problem in pediatric reconstruction. In most cases, a delayed approach to repair is used, allowing time for the initial wound to manifest itself. The goal of oral adhesion reconstruction should be to restore normal structures to their normal position and to recreate a thin lip segment that moves dynamically and symmetrically with facial expression. Unfortunately, resection of the mature scab followed by careful skin grafting to recreate the oral adhesion does not always prevent the development of further narrowing of the oral adhesion. A variety of surgical approaches have been described, ranging from mucosal flaps, advancement and rotation of composite flaps to the buccal mucosal tissue, or rotational flaps from

the lower lip [3, p. 44]. This method was originally described as follows: the scar around the oral adhesion is removed, and banner flaps using the existing red membrane are advanced to a lateral position that approximates the natural position of the oral adhesion. Because the erythema and mucosa are mobile, this technique has the advantage of producing a more natural appearance than simple excision and skin grafting. A significant disadvantage of this technique is that it may result in reduced mouth opening on the affected side. A modification of this technique involves leaving all scar tissue intact and forming flaps from the existing erythema that are advanced to a more lateral position [3, p. 43; 11, p. 138]. The use of a ventral tongue flap has been described in small series for the reconstruction of electrical burns of the oral commissure. The advantage of this technique is that the flap can include muscle to replace the orbicularis oris defect, and it also provides increased vascularity and strength. This allows for the mobilization of a large volume of tissue to repair large defects that are not amenable to closure by other methods. But the tongue tissue often retains its papillary appearance, which is a definite disadvantage of this method [11, p. 139].

An important role in preventing a negative functional outcome is played by attention to the rehabilitation of swallowing and speech, and the prevention of all possible consequences depending on the damage to the dental structures. A thorough interdisciplinary approach is important, which is carried out with the participation of an maxillofacial surgeon and a speech therapist [33, p. 45].

Conclusions. Thus, EOB is a certain problem of modern pediatric dentistry, and a correctly chosen diagnostic and treatment option will reduce the possibility of developing long-term complications and disability.

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