14 Year Follow-Up for a Severe Electrical Burn to Mouth and Lip: Case report.

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Introduction: *Electrical burns range from 4 to 7 % of the total burn accidents and many of them affect primarily children biting on a live wire. Great confusion exists in the literature about the proper management of electrical burns to the mouth in the acute and late phases.* ***Case report:*** *14 year results are shown in a severe electrical burn sustained in a 1 year 2 months old girl, involving 90% of the lips and commissures, tongue, alveolar ridges and teeth (primary central incisors and permanent dental germs). Two weeks after she was out danger, an active splint expansion device was built and used for 8 months to prevent secondary microstomia. Later, a new active splint device was used for a year after lip plastic surgery. At age 13, orthopedics and orthodontics were accomplished with a lip tattoo completed at age 15.* ***Conclusion:*** *No matter how good the final esthetic and occlusal results are, prevention is always the best option.*

Keywords: *electrical burn, mouth, children, alternating current, management*
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INTRODUCTION

Today, electrical burns in general are relatively rare, but may affect irreversibly patient's life. In adults hand injuries are the most common electrical injury while children experience oral burns as the most common site, because they start to explore their environment by grasping objects and inserting them into their mouths.[1, 2]

Seventy percent of burns in children occur before the age of two and over and 90% under the age of four.[3-12]

In most patients the injury occurs when children suck or bite the free end of a "live" extension cord. The current flows from the hot lead to the neutral path of least resistance. When distant resistance is high, the current flows only through the adjacent tissues. If distant resistance is low and the patient is well grounded, the current passes through the body across the chest to the point of exit.[13-15]

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Local tissue injury depends on the voltage, duration of contact, tissue resistance, type of current, and the path the current takes from entry to exit. The resultant wound is a combination of arc burn and contact burn. When electrolyte-rich saliva bridges the gap between two wires of opposing polarity, an arc is produced releasing flash heat in the order of 2500^{o} C (4500^{o} F) to 3000^{o} C (5500 °F). A contact burn occurs when the electrical current effectively passes through tissue planes to the point of exit, generating heat along its pathway. Household, alternative current produces more local tissue damage than direct current of the same voltage and generates massive muscle contraction, which prolongs for the duration of the electrical contact. [11, 14]

Blood vessels and nerve tissue are cauterized, causing frequently anesthesia or paresthesia with little or no hemorrhage. Lesions are painless and appear as a necrotic black/grey lesion with a surrounding rim of erythema. Within 4-6 hours there is increasing edema.[16-18] If such injuries are seen within the first 12 hours, some physicians believe that there is an easily identifiable definite line of demarcation present between healthy and burned tissue that allows immediate surgical debridement. However, most surgeons experience some difficulty to separate both tissues in early stages, prior to surgery.[19] Progressive tissue necrosis secondary to small vein thrombosis is uncommon but major bleeding from the coronary labial artery can occur as late as two weeks post burn. [20]

Oral soft tissues, mainly the lower lip and oral commissures are the most commonly involved structures in electrical burns, but can also affect teeth and supporting structures. This type of injury may result in varying degrees of malocclusion and can affect growth of the anterior alveolar

process. [21, 22] Associated burn of the tongue, even when extensive, heals spontaneously and has never been reported to disturb speech. [1, 13]

After eschar separation, secondary wound healing ensues, resulting in severe scarring, particularly if the burn has been compromised by infection, microstomia, and drooling from obliteration of the buccal sulcus.[10, 21, 23-30.]

Chemical accidents in children ingesting caustic liquids can also lead to serious upper aerodigestive and esophageal injuries in children. In both cases, the severity of injury from caustic ingestion or electrical burn depends on the type, quantity, concentration, and time of exposure. However, thanks to the legislative efforts compelling manufacturers to develop child proof containers, the incidence of caustic ingestion dropped from 500,000 to 200,000 prior to 1970, to 95,000 in 1973 to 26,000 cases in 1990, with 17,000 of these occurring in children. Electrical burn accidents have also been dropping due to the technological changes in electronics. Unfortunately, both problems have not been completely eliminated and in both cases they keep affecting developing oral tissues, producing edema and erythema of the lips, tongue, and palate. [31]

Edema, erythema and necrosis of the soft tissues and bone in a growing individual will invariably affect dentofacial growth and development.

Because muscle contains the genetic component of bone growth, appliances will generally be needed to restore function and induce growth.

This case shows step by step the long term follow up of a severe electrical burn sustained in a 1 year 2 months old girl, involving 90% of the lips and commissures, tongue, alveolar ridges and primary central incisors and their permanent dental tooth germs.

Case report

Jasmin, a one year and 2 months old Mexican female presented at the Intensive Care Unit at the Central Military Hospital Center on April, 1994 with an electrical burn to the mouth. The injury occurred when the child bit the male plug of an extension cord connected to a "bulb" television set, an uncommon injury where the accumulated energy came directly from inside the appliance. The injury involved more than 90% of the lips, tongue, floor of the mouth, central primary incisors, central permanent tooth buds and surrounding alveolar bone. Upon arrival, the patient was stabilized.

The burn was painless and involved deep muscle destruction. Tetanus vaccine and prophylactic antibiotic therapy were given for infection control. Topical antibiotic was used to prevent secondary wound infection working most likely for having soothing effect rather than its antibacterial action. [25, 31] After few hours the surrounding tissue became edematous and the previous well delineated wound margin became irregular due to inflammation. (Figs.1 and 2) Two weeks, after the patient's health improved, parents completed a consent form and under general anesthesia (GA), all scarring necrotic tissue was surgically removed in conjunction with the primary teeth, the permanent central tooth buds and the alveolar bone, resulting in a well defined clean area. (Figure 3)

Still under GA, a maxillary, mandibular arch and facial moulage impressions were made, poured in stone and immediately after surgery, a modified splint was made and inserted. The splint design was a combination from the Vancouver microstomia orthosis (VMO) and Wright´s removable splint. The primary maxillary lateral incisors which became necrotic required root canal therapy. This massive destruction of the dental and bone structures in conjunction with the lip damage and poor cooperation made conventional appliance approach difficult to complete. [11, 21, 26-31]

The main problem was to develop an appliance to stay in place for at least 8 months, allowing the organization of collagen fibers to craft a new mouth sphincter with a bucco mucosal fold.

The appliance support was obtained from a maxillary regular acrylic plate and tissue conditioning acrylic (Nic Tone Softy) to stretch, expand, create, maintain, hold and embrace the lost commissures. This plate expanded the tissue with a horizontal active extension, preventing wound healing and unwanted scar formation. The circum buccal fibers where laterally over expanded, giving an initial

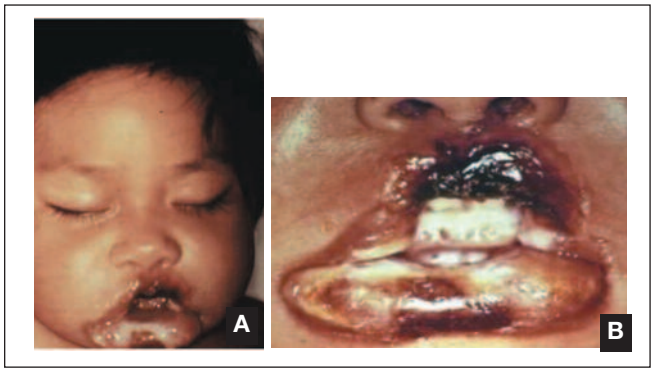

Figure 1 (A,B) Patient photographs at the Intensive Care Unit at the Central Military Hospital Center, 4 days after the accident. Injury extension shows a 90% burn extension, involving commissures, upper and lower lip. Tissue becomes edematous and margins are not well established.

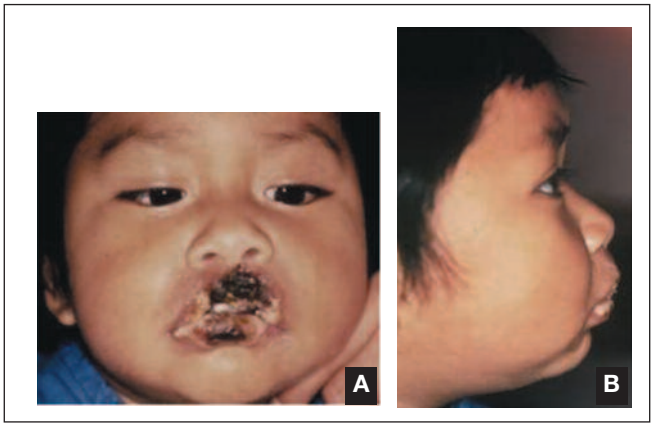

Figure 2 (A,B) 14 days after the accident. Delineated wound margins, prior to surgical procedure.

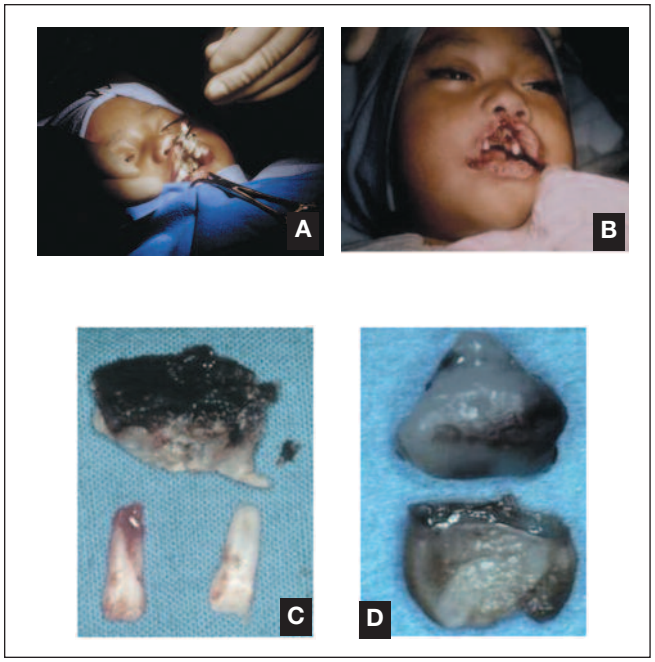

Figure 3 (A to D) Surgical procedure, with the necrotic tissue elimination. (Wound margins delineation, central primary incisor extraction and tooth buds with alveolar bone removal.

'macrostomia' appearance. This technique ensued future contraction success.

Due to loss tissue in the lips and commissures, the splint was easily dislodged, requiring the addition of lateral extensions preventing the patient from pulling the appliance out. Also to obtain the maximum tissue elongation close to the nose, a vertical screw (Hyrax screw) was placed and was activated once a week with a palatal support pushing the upper lip remnants downward (Fig 4).

Parents were instructed to make her child use the appliance full time, and be removed for meals and for oral hygiene purposes.

After 8 months the patient was ready for Conventional "Z" plasty surgery to elongate the contracted lip scar and rotate the scar tension line to allow maximum lip enlargement. In order to establish its length, a lateral to lateral incisor cast bridge was bonded prior to the surgical procedure (Figs 5 and 6). To avoid the commissures contraction a removable regular splint was made with a buccal fold extension to create a buccal sulcus (Fig 7).

The patient, then moved north of the country for the next 10 years, was not followed up and returned to complete her treatment. Orthodontic records were taken at age 11 which showed a restricted maxillary sagittal and transverse growth and a class III malocclusion.(Fig.8)

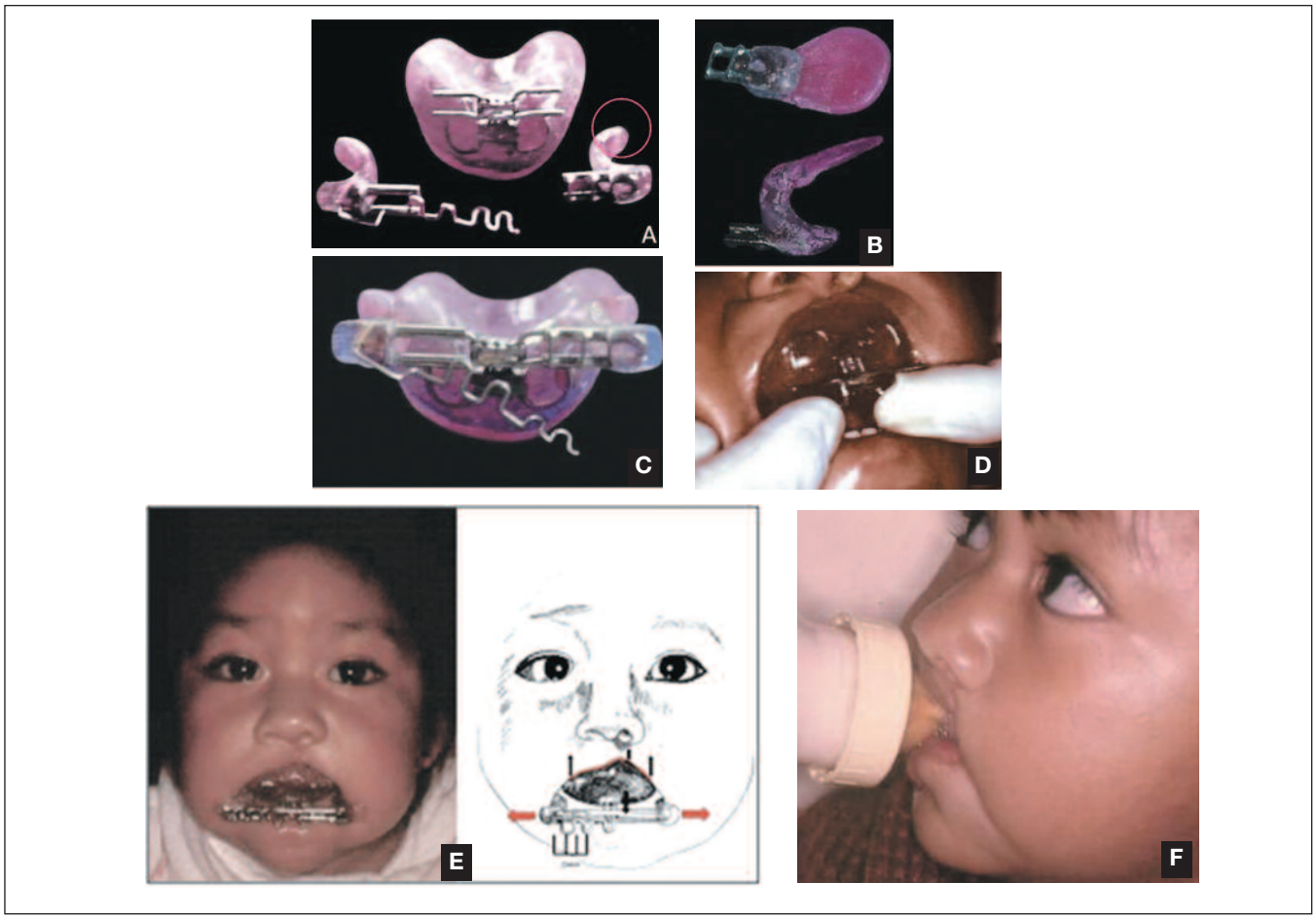

Figure 4 (A,B,C) Intraoral maxillary full acrylic coverage with a vertical hyrax screw and two acrylic sections (fits into mouth commissures) with a buccal extension joined by an adjustable stainless-steel bar. (D,E) The insertion and removal is easy. Should be worn full time and is removed at meal times (F) and for oral hygiene.

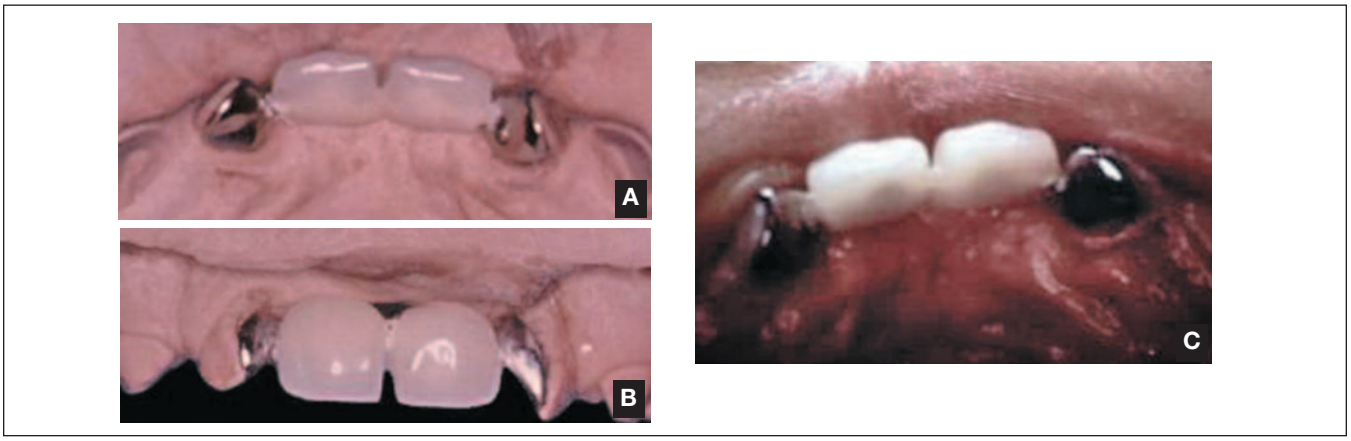

Figure 5 (A,B,C) 4 bonded metal cast unit bridge was made, after pulpectomy to primary maxillary laterals. The bridge was bonded prior to surgical procedure to direct the surgeon identify and establish the vertical lip length.

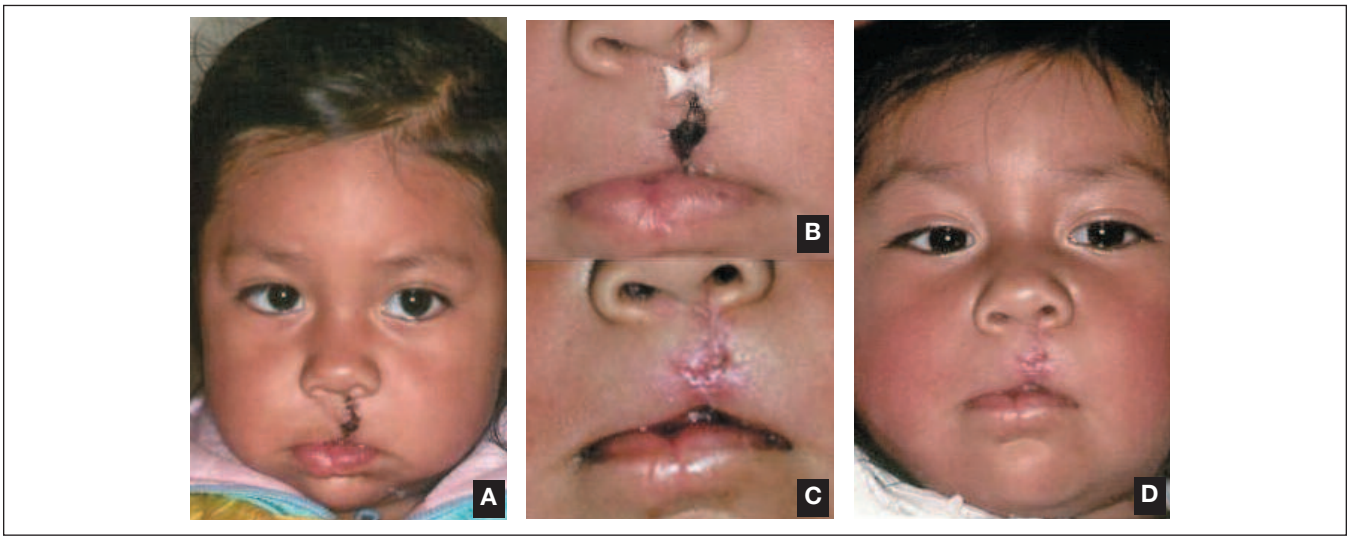

Figure 6. Face and lip photograph of the patient (A,B) one week after surgery. One can observe the increased lip size (C,D) two weeks after surgery.

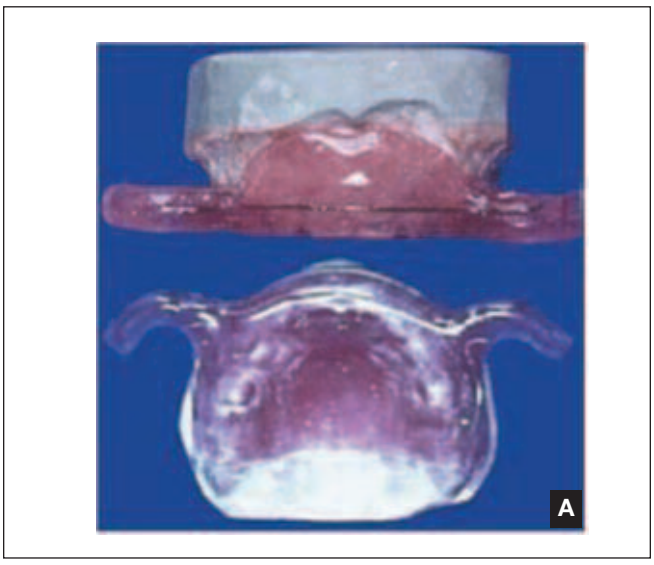

Figure 7 (A) After first eight months a second appliance for this patient was built to prevent commissures microstomia. The appliance was extended to the first primary molar, and the commissures acrylic extensions were placed perpendicular to the inter pupillary line.

Treatment plan included a Pettit protraction mask, with 16 ounce elastics and a fixed Hass appliance activated 3 times a week to achieve protraction and expansion (Fig.9). The appliance was worn for 12 hours a day for 8 months and treatment was completed with orthodontics. Prior to brackets' placement, the first lower bicuspids were extracted to balance occlusion, due to the early loss of the central incisors. Maxillary lateral incisors and cuspids were moved mesially and then remodeled as central incisors with composite resin and cuspids were modified as laterals (Fig.10). Finally at age 15, lips were shaped and permanently tattooed by a professional in the field (Fig 11).

DISCUSSION

Oral burns can be among the saddest, upsetting, and most difficult types of injury to correct. Unfortunately, these accidents keep happening when children, chew into any type of a live wire. [1, 13, 15, 23, 32]

Admission to the hospital is recommended. Prompt evaluation for patency of airway and adequate breathing is mandatory. Complete medical history, physical exam elec-

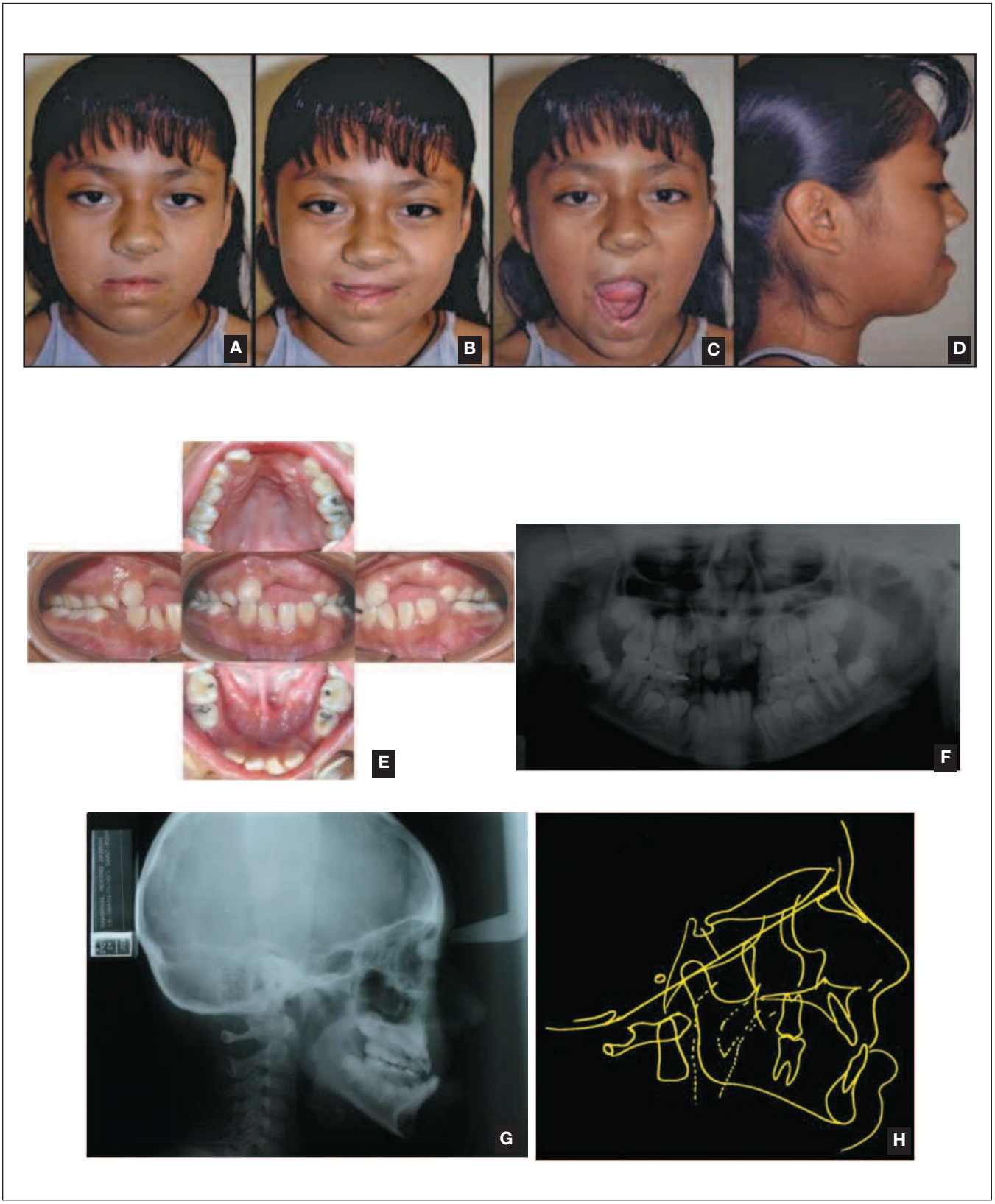

Figure 8. Extra and intra oral photographs, radiographs of the patient at the age of 12 (A,B,C,) Frontal view with lips closure, smiling and open mouth (D) Profile view (you may see a Class III profile) with a maxillary hypoplasia (E) Intraoral view with Class I molars and canines relationship, anterior maxillary collapse. (F, G) Panoramic and Lateral cephalogram radiograph of the patient. (H) Tracing of the analysis on the lateral cephalogram, shows a Class III malocclusion with a short maxilla.

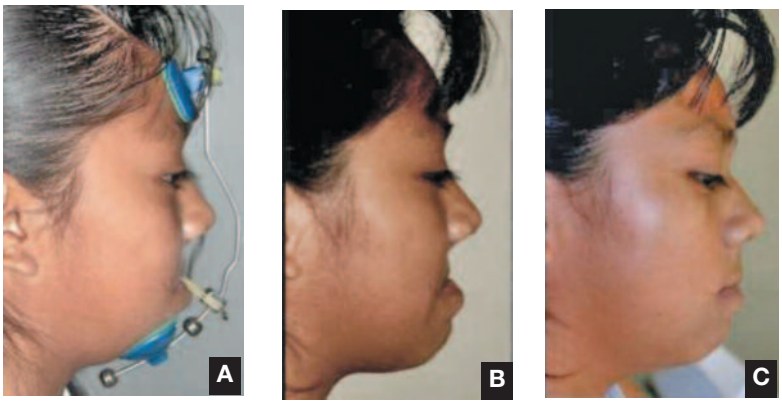

Figure 9. Lateral views (A) Initial view. (B) patient with a petit protracting mask appliance (C) Eight months after intense appliance use.

Figure 10. A) Intraoral view of the patient prior to orthodontics. Composite directly bonded to mesial surface of the maxillary central incisors and the cuspids where remodeled as lateral incisors.

Figure 11 (A,B,C,D) Patient differences before and after the tattoo was performed.

Figure 12 (A,B,C) Patient look one month after lip tattoo.

trocardiogram, hematologic evaluation, electrolyte determination, urinalysis, and coagulation profile should be done. The patient needs to be monitored for signs of shock, cardiorespiratory collapse, or late hemorrhage. Antibiotic and tetanus prophylaxis coverage should be assured in all cases of electric burns to the oral cavity. The same principles are also applied to chemically burned patients.[31] Proper nutrition is paramount for proper healing. Children represent a high risk group. Weight loss, can happen and should be carefully monitored. After the patient is stabilized, he could be treated on an outpatient basis. [1, 19, 20]

The local wound needs to be managed with warm saline rinses with sodium peroxide irrigation. Periodic microbiological cultures must be taken for careful infection control due to anaerobic bacterial growth, mostly resistant *pseudomonas* in these cases. Existing complications are not from the burn itself but from infection. [23,,33,]

The sloughing eschar should not be disturbed, but a splint placed as soon as the patient is stabilized to prevent wound contraction. Failure to do that could jeopardize the future surgical and esthetic results. [15, 22,34]

In partial thickness burns no surgery may be necessary. In more severe full-thickness circum-oral burns procedures should be limited to the least amount of operations to prevent the surgical scar formation. [5, 18]

Because craniofacial growth and development could be jeopardized, the placement of orthopedic appliances is needed to guide, generate and redirect growth. Different designs can be used, depending on the age and cooperation of the patient. Compliance is a major factor since the maturation of burn scars may last from few months to years.[18,25,27,32,34,35]

To reduce the damage of the disfiguring wound healing process, appliances must be constructed to prevent tissue contraction at the level of the commissures. This is of paramount importance; failure to do so, may create speech and nutritional impairment. Because muscles contain the genetic information of bone growth, the lack of balance between the tonic labial musculature and the phasic tongue function in a burned patient can alter irreversibly bi maxillary antero posterior skeletal development.

Wright *et al (*Fig.7) describe two types of appliances, fixed and removable. In either case the appliances are anchored on the maxillary arch, with two lateral posts to fit the region of the commissures to flare out the mouth. These extension posts are constructed to keep the commissures equidistant and with as little retraction from the midline as possible. The appliance must be worn continuously for at least eight months followed by alternating use for another six months. [26, 36]

Hartford CE. and associates at the University of Iowa Hospital and Clinics (UIHC) developed a microstomia prevention appliance (MPA) which has been used since 1972. The appliance consists of an adjustable stainless-steel bar with thumb closure screw between two acrylic sections that molds around the oral commissures. The appliance may be fitted with the possibility of expansion increments with a range from 3.8 to 9.0 cm with 2mm increments each for a finer fit. Its range accommodates mouths of small children to adults, and may be used as an active or passive appliance. Madjar *et al* reported a simplified, easily made widening device that consists of two labial commissures acrylic holders connected with an omega-shaped stainless-steel wire. The most common problem of these appliances is oral secretions because the lip borders are held apart. As it is an active appliance, there is the potential for breakdown of viable tissue if too much pressure is applied. [24, 33, 37, 38]

A similar device to the UIHC appliance is the Vancouver microstomia orthosis (VMO) developed by Vancouver General Hospital. The patient or parent can easily remove this device, is inexpensive, uncomplicated to adjust, requires no moulage for fabrication, and no anesthesia is required. [39]

Pressure to the commissures may be altered by increasing or decreasing the bar length. Vertical opening of the mouth may be broadened increasing the size of the commissural opening. The VMO appliance does not require the presence of teeth, pouring a mold, employ expensive materials, or professional fabrication. It applies gradual pressure in the horizontal and vertical directions. The main disadvantage is that it can be easily displaced. [33]

The loss of primary and permanent anterior teeth and its supporting alveloar bone, the loss of muscle tissue and muscle tone in the perioral area developed the class III malocclusion in this patient. A facemask with and internal fixed appliance with an acrylic extension to fit and stretch the commissures area was used (fig.9). Unfortunately, the patient left the city and could not be reached, complicating the dental and facial result. It has been shown, that the younger the patient, the better the skeletal and esthetic result. [41-43] Starting maxillary advancement with an orthopedic facemask at age 12, minimized its potential positive esthetic effect. [44] Fortunately, with orthodontics, denticure and a lip tattoo, the final outcome was acceptable.

In all cases, once patients start communicating, psychological support should be considered.

CONCLUSIONS

This manuscript shows the long term interdisciplinary approach of an electrical burn to the mouth sustained by an infant. The appliances used to prevent the microstomia generated by the contratacture of the perioral musculature are illustrated.

Because oral burns can be among the saddest, upsetting, lengthy and most difficult types of injuries to correct, prevention is still our best option.

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