Electrical Burns of the Oral Commissure

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A discussion of the clinical management of electrical burns involving the mouth, with illustrative case reports.

KEY WORDS: • BURNS • SCARRING •

Electrical burns about the mouth in small children are more common than we might expect. They occur most frequently between one and four years of age. The burn center at Riley Hospital for Children, in Indianapolis, has examined or treated approximately forty cases in the last three or four years. THOMPSON ET AL. (1965) report sixty-five cases of treatment for electrical burns, of which forty-three involved the mouth. Children under 2yrs of age comprised 65% of those victims, and 28% were between 2 and 4yrs old.

Burn victims are usually seen in hospitals, which accounts for much of the limited awareness of orthodontists of the frequency of this injury. Nevertheless, orthodontic management of this critical muscular environment of the dentition can be a major contributor to the successful treatment of these injuries.

— Etiologic and Pathologic Considerations —

Electrical burns are most usually reported as being caused by placing the female receptacle at the end of a live extension cord into the mouth. The Author recently examined a patient burned by electrical contact with a hairdryer being used following a bath.

Electrical burns are commonly classified into two types — *direct contact* and *arc.*

A *contact burn* requires two-point contact, so that the current passes through a part of the body. One of the contacts in accidental burns is often a ground.

Arcing burns are the most common around the mouth. These are usually caused by an arc initiated by saliva, which is rich in electrolytes. This completes a circuit between the two conductive wires or terminals, initiating an arc, or flash, which has been reported to generate temperatures as high as 3000°C. This can cause extensive damage, depending on the voltage, amperage, resistance, and duration. The low electrical resistance of mucous membranes makes them very susceptible to severe injury.

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Fig. 1 Full thickness injury (third degree burn) of an 18mo-old boy.

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Partial-thickness tissue injuries are classified according to the degree of penetration as either first or second degree burns. Second degree burns, which affect underlying tissues, are further divided into superficial and deep burns.

Superficial second degree burns are characterized by erythema, blister formation, edema, and pain. They may heal spontaneously in 7 to 10 days, with only mild scarring. Deep second degree burns result in destruction of the epidermis as well as the upper levels of the corium, and surface repair may occur in about 3 to 4 weeks. Scarring in these injuries may be severe.

Full thickness injuries are referred to as third degree burns (Fig. 1). These burns involve destruction of the skin as well as its appendages, including the full depth of the corium, and may include vascular thrombosis and neural destruction.

Clinical Features

The initial clinical picture of the burned area is a gray-white color with some possible charring. The center may be depressed, outlined by a slightly elevated narrow erythematous rim. The typical oral injury involves the commissure, with the lower lip and the area inferior and lateral to the contact site most severely involved. Control of saliva is usually diminished because the defect in the

injured commissure is usually the most inferior point of the orifice at rest.

The lesion is bloodless, and within a few hours edema will increase and cause noticeable protrusion of the lips. An eschar or coagulum of necrotic tissue will soon develop. This may be black in color, and will slough within one to four weeks. Because of the vascular changes, it is difficult initially to differentiate between viable and non-viable tissues. The involved area is essentially painless because of the destruction of free nerve endings.

Histologic Characteristics

These could be described as heat necrosis, protein coagulation, and fat liquefaction. If the epithelization continues undeterred, it will be completed grossly in about 4 to 5 weeks. In the absence of appliance therapy or surgical procedures, the oral commissure will migrate toward the midline with the centripetal scar contraction. The microstomia that may become evident in varying degrees can be prevented by consistent wearing of a therapeutic splint (Fig. 2).

Dentists are familiar with the continuum of healing, starting with the inflammatory phase, migratory phase, and maturation phase, which are observed clinically in the healing process in large open burns. The processes of inflammation, fibroplasia, and collagen maturation ultimately form scar tissue. Fibroplasia overlaps in time with inflammation, and scar maturation may begin while collagen production continues, so burn contraction can already be in progress during the fibroplastic phase.

Collagen synthesis and scar maturation are so important that further expansion on some aspects of the process is desirable. The following quotations from BRYANT (1977) cover some important highlights of collagen synthesis:

"The biochemical events relating to fibroplasia are the major function of fibroblasts. By an unknown mechanism, collagen formation is initiated, and the series of events familiar to protein synthesis is enacted.

"The collagen molecule is a complex helical structure whose mechanical properties are largely responsible for the strength and rigidity of scar tissue. The units of collagen protein manufactured by the fibroblasts are triple helical chains called tropocollagen. The three chains are bonded by hydrogen bonds in the newly-formed molecule. Subsequent to tropocollagen synthesis, stronger chemical bonds between the chains on the tropocollagen unit form by modification of certain amino acid residues. Of the three intertwining amino acid chains in human collagen, two are identical (the $alpha_1$ chains) and one is distinct (the $alpha_2$ chain). The helix of three strands is further coiled into a right-handed superhelix. Outside the fibroblasts, the tropocollagen units unite with one another into chains of increasing length and diameter.

"The ground substance is an amorphous milieu comprised of water, ions, and complex protein-polysaccharide polymers. It is thought that the extracellular ground substance has some influence over the combination of tropocollagen units into collagen fibrils, filaments and fibers."

And further, regarding scar maturation:

"The scar that is formed during fibroplasia is an enlarged, dense structure of collagen. The collagen fibers, however, are randomly oriented and highly soluble, thus the union established is fragile. Remodeling is a spontaneous process and may continue for years. The extent to which a scar remodels varies among individuals and also within the same individual according to his age at the time of injury. The biochemical mechanisms responsible for remodeling have not been conclusively identified but may be related to collagen turnover to which there is

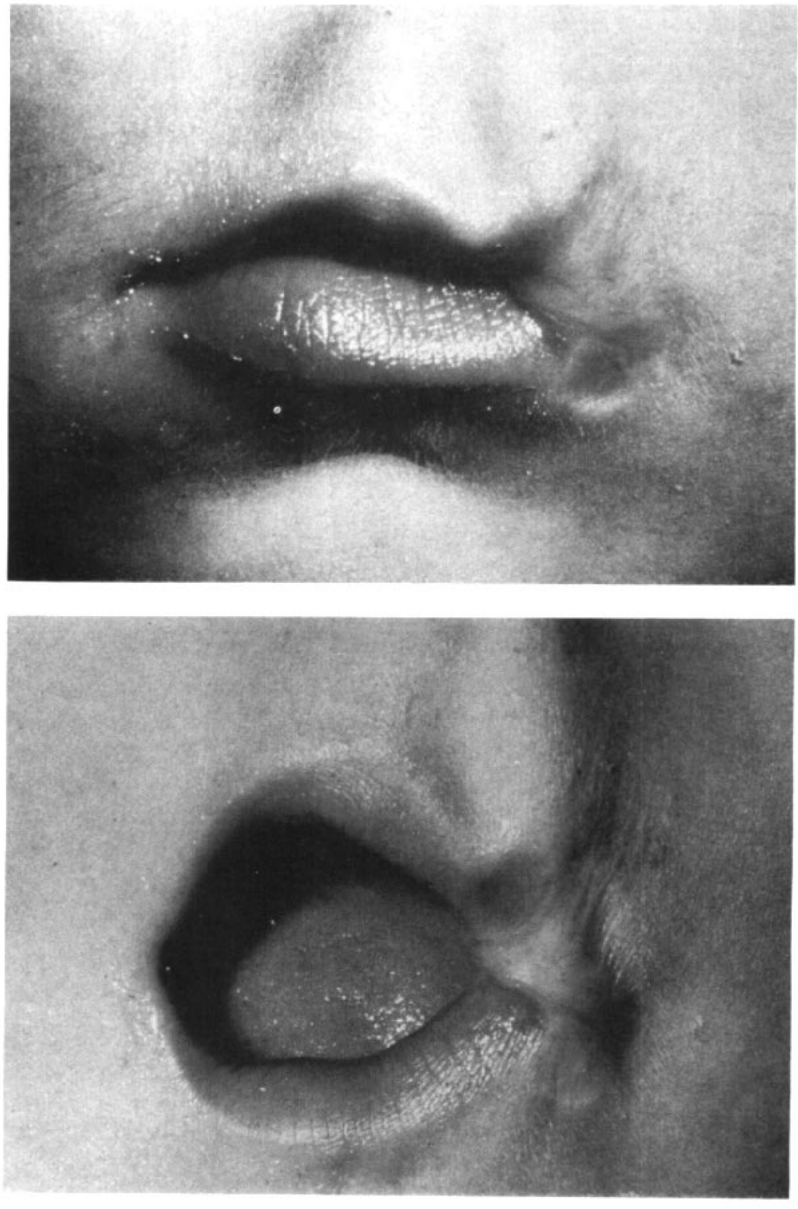


Fig. 2 Natural healing, without benefit of appliance therapy. Note microstomia and philtrum displacement.

continuous and simultaneous collagen production and collagen breakdown. If the rate of breakdown exceeds production, the scar becomes softer and less bulky. If, on the other hand, the rate of production exceeds breakdown, then a keloid or hypertrophic scar may result."

Contraction of wound margins does not begin until about five days after injury. The movement of wound margins toward the center of the defect appears to be an active phenomenon in wound repair tissue; specifically, the mechanism by which contraction occurs appears to be active movement of fibroblasts in the wound bed.

Previous theories attributing wound contraction to changes in collagen fibers appear to be invalid. Electron micrographs of wound fibroblasts have shown ultrastructures within the cytoplasm that resemble the contractile protein found in smooth muscle. In addition, it has been found that wound contraction can be inhibited by the topical application of smooth muscle relaxants. The cells responsible for wound contraction have therefore been termed *myofibroblasts.*

Dr. Sally ABSTON (1976), formerly chief of general surgery at the Shriners Burn Institute, relates that "During the healing or maturation period the scar is elevated, hyperemic, and rigid. This period of hypertrophy continues for six months or more (up to two years). At this point clinically, the scar is no longer hyperemic, has become flattened, and is mobile. Hypertrophic scar formation can be minimized or prevented by applying constant uniform pressure to the scar. Pressure should be applied for 6 to 12 months following skin grafting or healing by epithelization."

Dental Effects

Where microstomia is present, gross morphological dental deformities may be present as well. Concomitant with contracture, undesirable denture changes may become apparent over a period of time. THOMPSON ET AL. (1965) note that of 43 burn cases, seven manifested dentition changes. Other reports in the literature, usually of individual cases, mention such changes as crossbite, crowding, retrusion, palatal arch contraction, lingually inclined mandibular teeth, and mandibular arch contraction.

— Treatment —

Burn centers utilize various devices to apply the needed uniform pressure to these healing tissues. Among these have been thermoplastic isoprene, foam rubber, elastic wraps, and skeletal pins.

Historically, the treatment for electrical burns of the mouth has usually been surgery, which often involves multiple operations. Opinions have varied over the years whether it is better to perform surgery shortly after the injury, or wait until after scar contraction to aid in evaluating the extent of the permanent deformity. The majority of plastic surgeons have been inclined toward delaying initial surgical intervention.

Revision surgery has been most successful in increasing the size of the oral stoma, but somewhat less successful in improving symmetry.

COLCLEUGH AND RYAN (1976) describe a procedure of splinting for the treatment of electrical burns of the mouth in children. This procedure involves constructing an acrylic overlay over the crowns of the maxillary teeth, with clasps to augment retention, to support an acrylic splint that protrudes past the commissures and extends bilaterally to hold width of the orifice against the advances of scar contraction. This appliance is worn full time, except for eating, for a period of about six months, followed by

part-time wear for an additional period of six months or more.

As mentioned previously, collagenous tissue reorganization is a process that may continue for two years or more, so it is important that the splint not be abandoned too soon.

Splint Techniques

Many techniques have been tried, including orthodontic bands for fixation, with wires soldered to them to support flanges for holding the commissures apart during the healing process. Many of these procedures have been discarded through the filter of experience.

Very young patients have very active hands. To help keep appliances clean, and to prevent patients from misplacing them, various attachments or hooks may be fabricated at the end of each flange. Strings, yarn or chains are attached to these hooks to form a necklace. A fixed headgear may also be attached at this location where retention is desirable.

A different mechanical device developed at the University of Iowa Hospital features flanges that are adjustable along a rail. Both flanges move laterally with increasing tension, so the pressure is equal and bilateral if an elastic is worn between the locks; or, it can locked at a fixed distance. This device is designed for those cases where massive burns of the face or body dictate that life-saving procedures take precedence over treatment of local oral injuries. In these cases, the scar contracture is rapid and a dental impression may not be taken because of the microstomia. One objective of this appliance is to widen the labial opening sufficiently over a period of time to make an impression possible.

The burn shown in Figure 3, treated by the Author, illustrates an injury to the oral commissure caused by the female end of a live extension cord placed in the mouth of a 5yr-old girl. This picture was taken by the referring plastic surgeon during his examination on the day following the electrical burn.

The first orthodontic examination (Fig. 4) showed a need for a an appliance, so a impression was made of the upper arch. Fear is likely to be important in these very young patients, so the detailed clinical examination and records were delayed until the following appointment two days later.

Pain was not a factor, since the nerve endings had been destroyed. The standard trays used originally have now been replaced by 3mm bioplast trays customized from plaster casts of patients with similar arch form. These can be folded to some extent to protect the damaged tissue and vulnerable vessels.

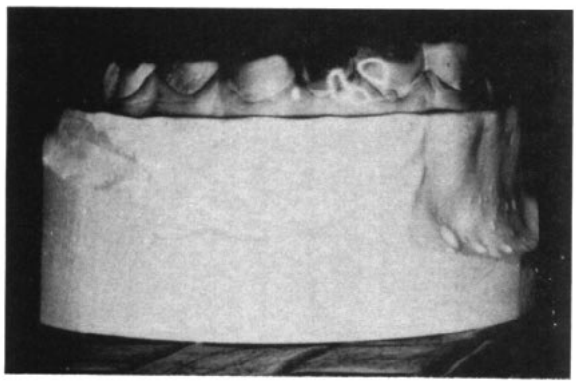
This sequence worked very well, and at the second appointment sufficient time was available to discuss the treatment and prognosis in depth, and to answer questions and initiate a foundation of confidence with the young patient. Taking photographs is useful at this stage. It seems to allay their fears, presumably because it is something that they understand from past experience, and they are most likely to relax at this point.

The following procedure was used to construct the appliance —

- Two plaster casts are made from the original impression, to provide a duplicate cast for any possible emergency replacement.
- The original cast is trimmed for use on a vacuum-forming machine, and coated with two applications of separating medium. It is important to coat the buccal and labial mucosa areas as well as teeth and palate. The deciduous teeth have relatively few undercuts, so the coating procedure is sufficient to allow easy removal from the cast.

Fig. 3 One day after an electrical burn in a 5yr-old girl, caused by an extension cord.

Fig. 4 Fifth day after the injury, showing changes in the wound.



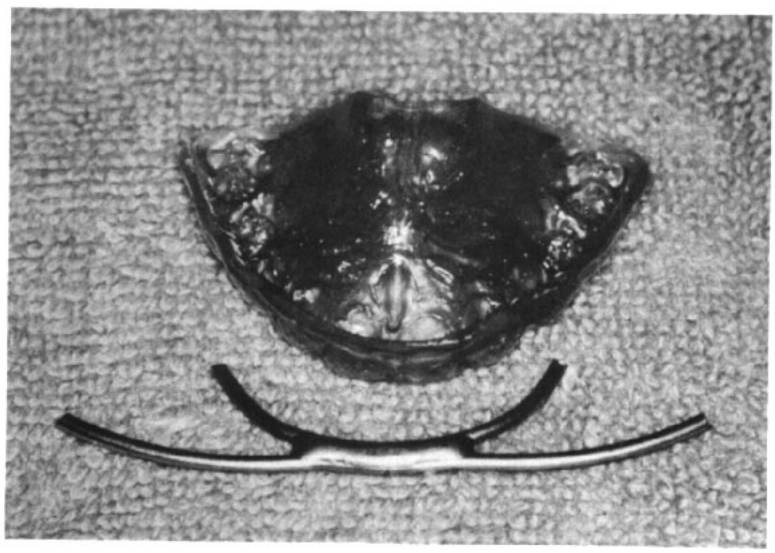


Fig. 5 *left* — Plastic overlay on the maxillary teeth extends 1-3mm beyond crown height.

Below — Metal framework cut from a headgear assembly is adapted to the denture overlay.

• A 2mm acrylic wafer is vacuum-formed on the cast. The powder-liquid method of fabrication may also be used.

• Excess plastic is removed, leaving a margin approximately 1-3mm apical to the gingival margins and including the distal surfaces of the last molars (Fig. 5, top).

• Prepare a metal extension to support the plastic flanges (Fig. 5, bottom). Any stainless wire between .035″ and .050″ diameter is suitable. A headgear assembly works very well, with the inner bow contoured to the outer surface of the overlay and the outer bow cut down to be used for the flange framework. Since the oral commissure is inferior to the occlusal plane, the wires must be adjusted accordingly (Fig. 6, top).

• A small amount of acrylic is then used to attach the inside wire to the overlay (Fig. 6, top).

• Plastic flanges are molded to conform to the affected burned area to supply

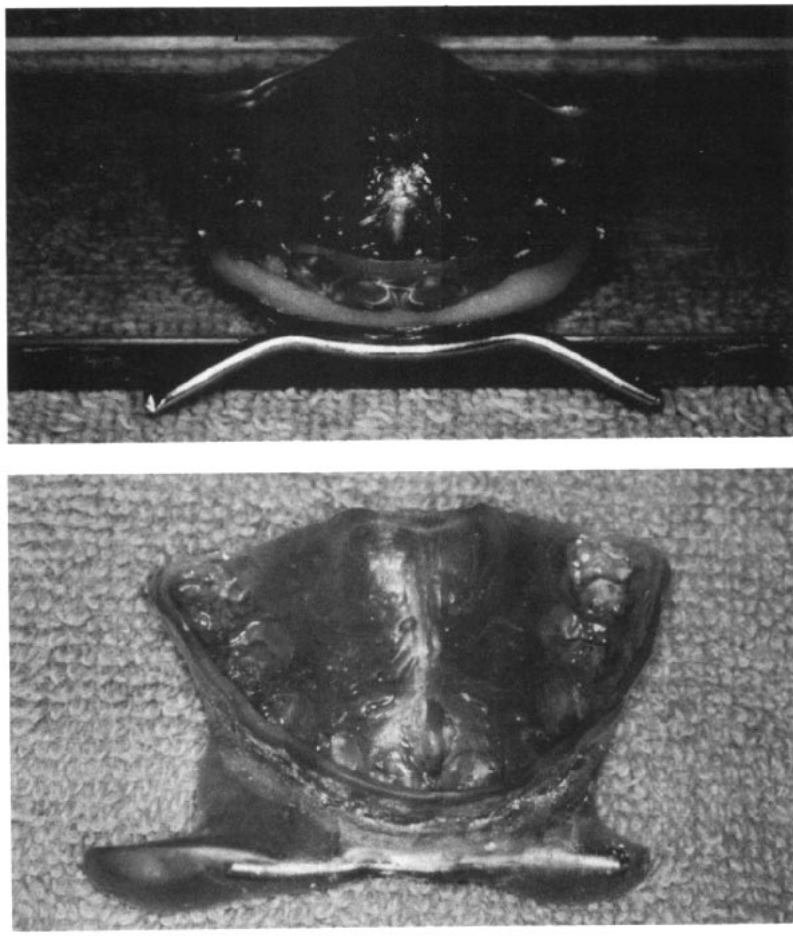


Fig. 6 *Top* — **The adjusted flange framework wires are joined to the denture overlay with acrylic. Note the downward angulation of the wires to relate the commissure level to the occlusal line.**

Bottom **— The completed pressure overlay appliance.**

the pressure needed for proper healing. They are formed around the metal framework, and customized to fit the buccal mucosal wall, the commissure, and any burned area of the lips. Plastic is alternately added and contoured with an acrylic bur, with final polishing at the the time of delivery (Fig. 6).

In this case, the appliance was delivered one week after the injury (Fig. 7). At that time, the flange of the appliance on the unaffected side matched the width from the midline to the commissure at rest, while at the commissure on the injured side it was several millimeters greater.

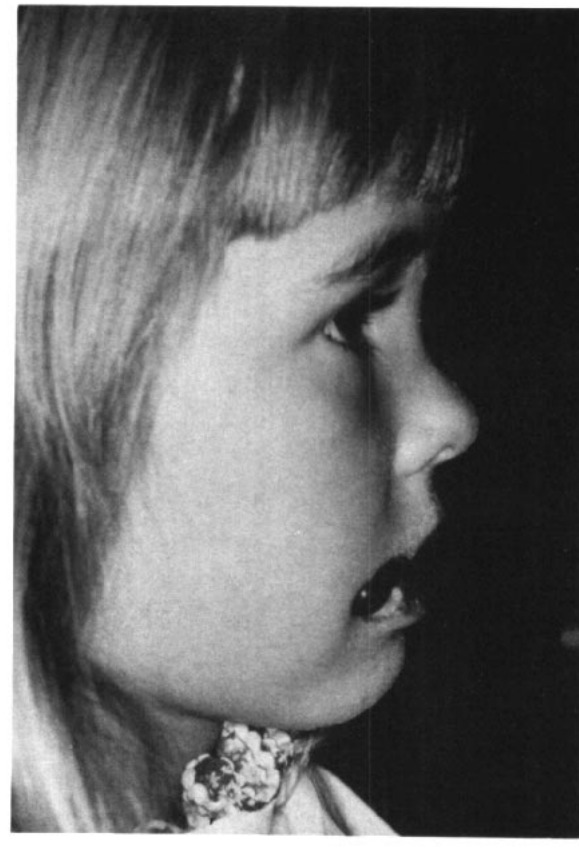


Fig. 7 *Above and right.* **The completed appliance in place.**

Some operators believe that a bilaterally tight flange is desirable because of the lateral mobility of the lips. Other clinicians have abandoned the bilateral flange method for a unilateral appliance following experiences in which a hypertrophic scar has formed on the uninjured commissure.

This Author's experience supports a combination approach with a flange on the unaffected side only equal to the measurement at rest, but with the flange on the injured side exceeding the estimated preburned dimension by several millimeters. This provides support and balance on the unaffected side without applying excessive pressure.

At the time of delivery, the parents are cautioned about the critical importance of the child wearing the appliance at all times except when eating. The expectation of losing the eschar, and the vigilance necessary to watch for arterial bleeding, are emphasized. In such event, gauze pads must be placed on the outside of the cheek and inside the vestibule and compressed for ten minutes. If bleeding still persists, it must to be treated as an emergency.

Progress is checked about a week later, and then after a three-week interval, which will be about five weeks after the injury (Fig. 8). This picture shows a much improved patient. The commissure measurements at this stage were essentially equal; however, the wide-open mouth shows some measure of asymmetry as seen at the philtrum. Because these patients are unable to close their mouths, the lips are usually dry and chapped.

Healing 16 months after the injury is seen in Figure 9.

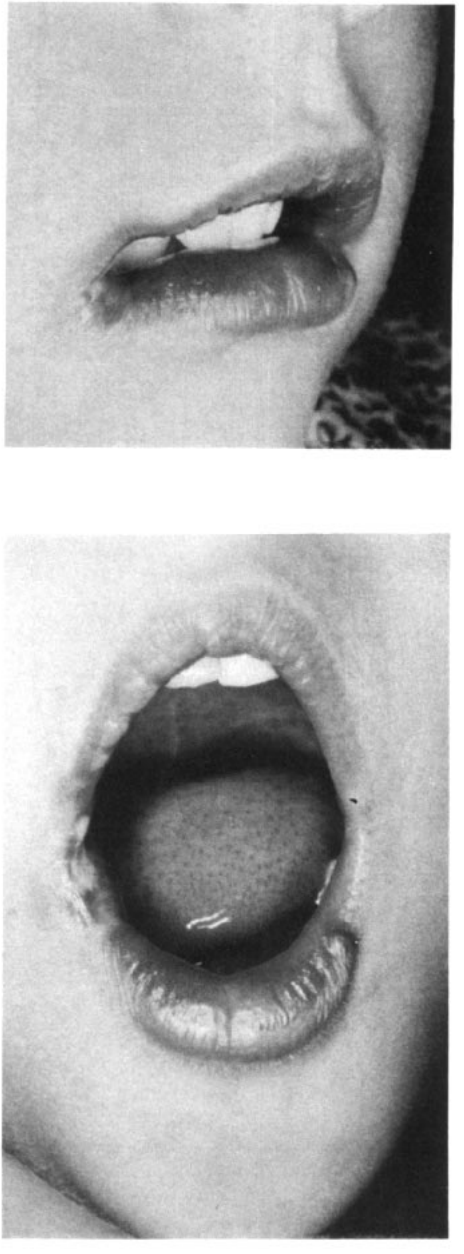


Fig. 8 Five weeks after the injury. Good superficial healing, with some asymmetry.

Revision Surgery

Surgical revision is illustrated by this case of an 18mo-old boy who received an extensive electrical burn from placing a

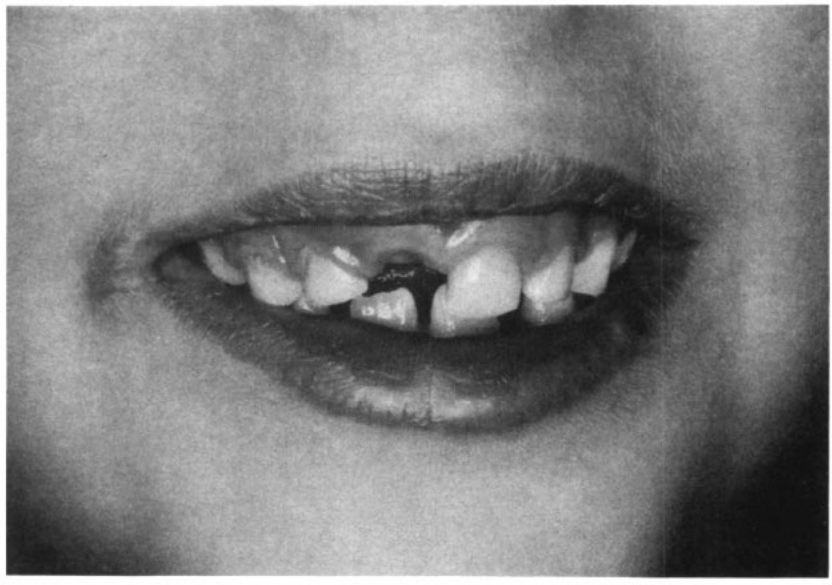


Fig. 9 Healing continues improvement 16 months after the injury.

plugged-together extension cord connection in his mouth (Fig. 1). He was examined and treated at the Riley Hospital for Children in Indianapolis as an outpatient, and an appliance was constructed for full-time wear.

He wore the appliance as instructed for about eight months, when the plastic surgeon recommended surgical revision. A difference in opinion at this point resulted in the surgery being done without the use of a follow-up appliance.

Two years later, at age 4, he was referred for construction of an appliance in anticipation of a commissurotomy. He was already scheduled for surgery, and the appliance was to be prepared, tried in, and approved by the surgeon beforehand.

It was obvious at the first examination that he was not too enthusiastic about the impression or the prospect of wearing an appliance again for an extended period, but he did realize its value and necessity and cooperated fully. The cruel torments and peer pressure of other children, and the less crude but equally thoughtless comments of adults, are often more distasteful to these young children than the mere inconvenience of wearing the appliance.

Examination revealed that the vermillion area of the left lateral third of the superior and inferior portion of the lips, extending to the healed commissure, was gone (Fig. 10). It was also evident that the left lateral third of the superior and inferior mass of the orbicularis oris, as well as other muscle slips or incisal band muscles, were partially missing or scarified. As a result, the left commissure was 5–7mm closer to the midline than the right.

The effects of the loss of muscle and limitations on mobility induced by the injury and subsequent repair on the func-

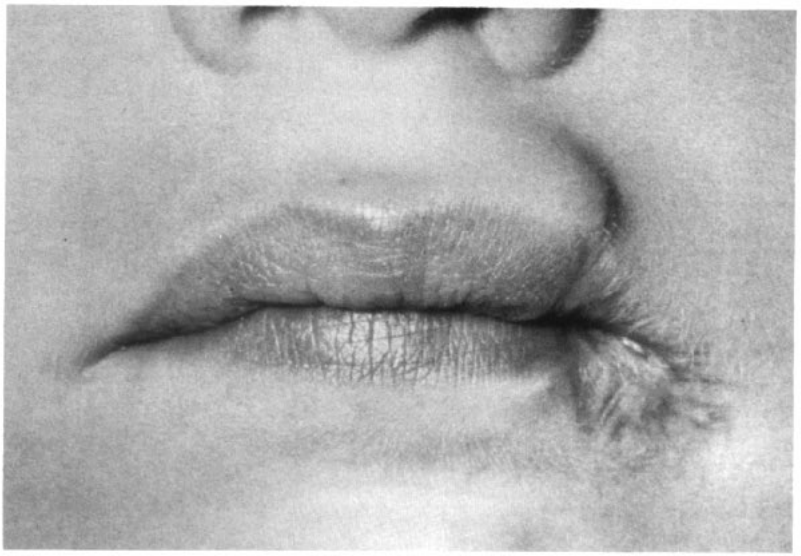


Fig. 10 The scarred lip of a 4yr-old boy before revision surgery.

tion of the remaining musculature became most apparent in the wide-open jaw position. The denture reflected no gross anomalies that could be attributed to the healing process. However, the midline raphe and vestibular attachments had been affected by the burn and the subsequent repair and contraction.

A moulage of plaster was prepared to aid in the design of an appliance. A form on which pertinent data are recorded is now used for this purpose. The appliance was tried in and finished prior to admission to the hospital for surgery (Fig. 11).

Figure 12 shows the surgical reference points of the midline and the bilateral points of the philtrum and the contemplated outline of the new left commissure as marked by the surgeon. The appliance was placed immediately after surgery.

Extensive occlusal contouring is not necessary because the appliance is not used for eating, and natural occlusal function will accomplish fine adjustments in the acrylic material.

Figure 13 shows the mouth four weeks after surgery. At this time, the right and left commissure are equidistant from the midline. The cheek thickness is about 5–6mm greater on the affected side. The wide-open view shows asymmetry due to a vertical contraction.

Further improvement is seen 5 months after surgery (Fig. 14). Exercise and massage as advised by the surgeon are important adjuncts in the treatment of such burns of the oral commissure.

— Conclusion —

Treatment of electrical burns of the oral commissure may appear to be very simple from a technique and management viewpoint. The appliance therapy and tissue management are such that

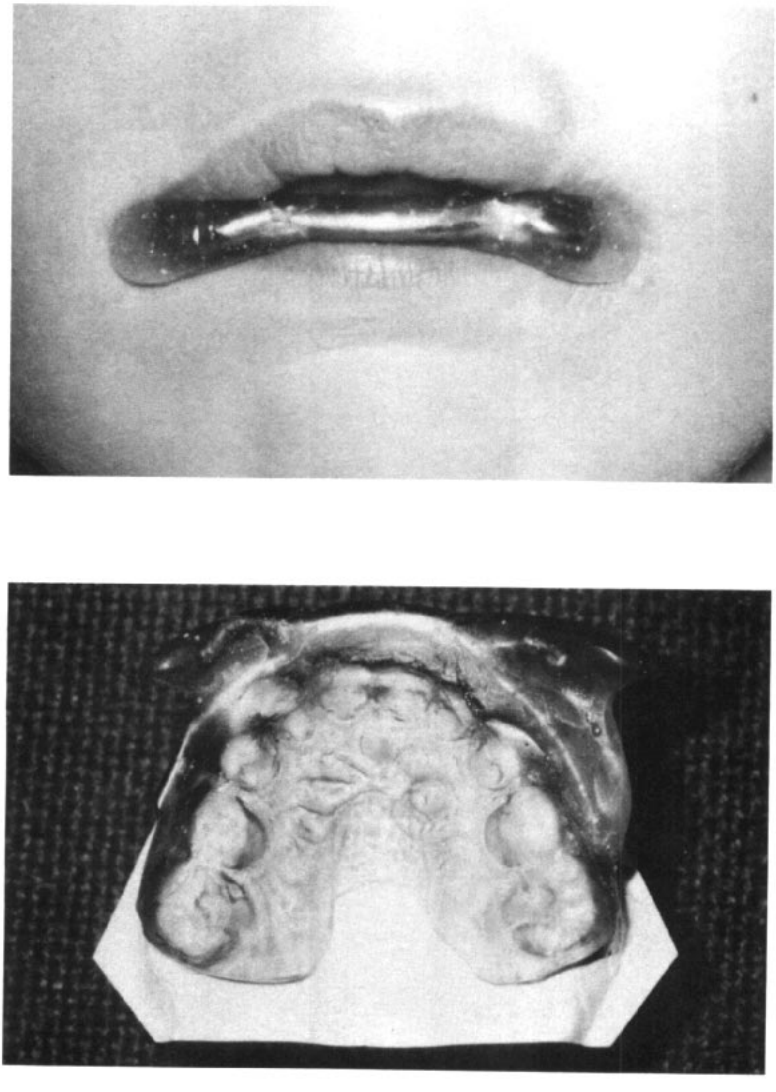


Fig. 11 Pressure appliance used as a post-surgical splint.

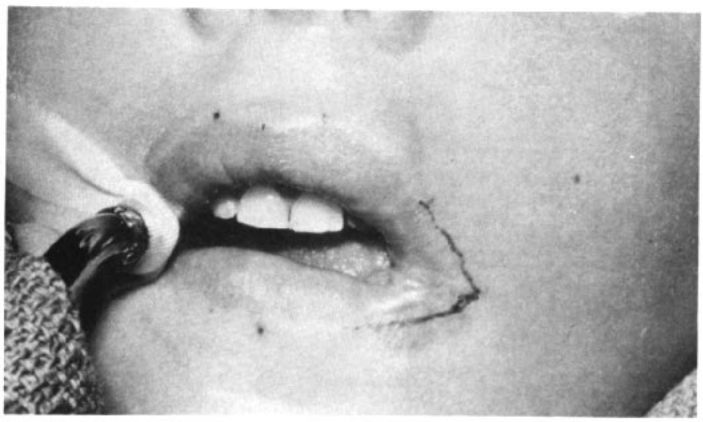


Fig. 12 At surgery, the plastic surgeon marks reference points and projected outline of the commissure.

Fig. 13 Asymmetry and thickened cheek four weeks after surgery.

the orthodontist is exceptionally well qualified to provide such care in cooperation with the plastic surgeon.

However, the nature and severity of these injuries varies widely, and their small number means that they are seldom seen by most practitioners. Timing can be critical in these cases, and it is hoped that the background information presented here may prove helpful if a reader should suddenly be confronted with such a problem, so that this needed service can be provided in a timely and effective manner.

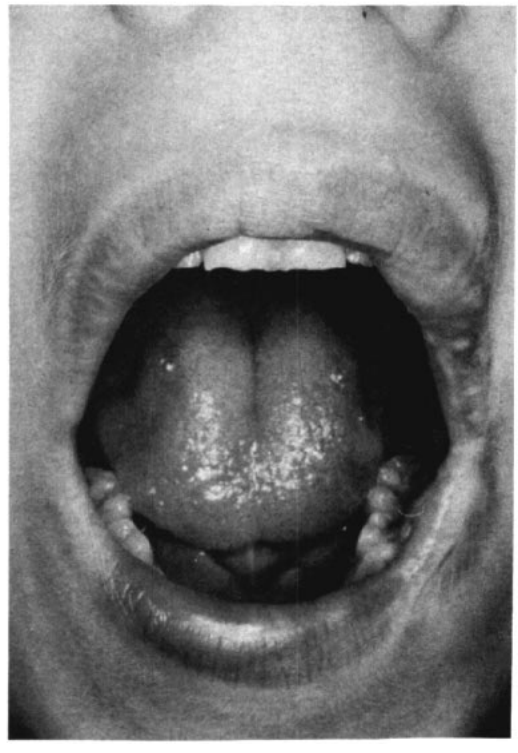


Fig. 14 The left commissure five months after surgical revision.

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