

# Short Runs for a Long Slide: Principalization in Complex Facial Restoration after Acid Attack Burn Injury

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## Abstract

Burn injuries are responsible for a significant portion of surgically treatable morbidity throughout the world and particularly in underdeveloped and developing countries. Intentional flame, chemical, and contact burns are unfortunately a common mechanism of injury. It is estimated that intentional chemical burns are responsible for between 2 and 20% of burn injuries seen at burn centers in lower income countries. Women are commonly targeted and the perpetrators are often known to the victims. The combination of a high disease prevalence, limited surgical and anesthetic resources, a vulnerable patient population, and largely disfiguring, nonlethal injuries present unique challenges for the reconstructive surgeon who may not encounter such cases regularly. In this article, we present a case of a 16-year-old female who sustained severe, full-thickness burns to the face including eyelids, neck, abdomen, and upper extremities after an intentional acid attack. She began her treatment course with us approximately 1 year after the injury. The deformities of her oral and periorbital regions presented particularly difficult reconstructive problems, including impending visual loss. Using plastic surgical principalization, we provided our patient adequate restoration of facial form and function through numbers of interventions using fundamental and state-of-the-art techniques.

## Keywords

- ▶ chemical burns
- ▶ facial reconstruction
- ▶ corneal transplant
- ▶ violence prevention

Burn injury represents a substantial portion of surgically treatable morbidity and mortality throughout the world. Estimates suggest that roughly 300,000 people die yearly from burn-related injuries, and burns are among the leading cause of disability-adjusted life years in low- and middle-income countries (LMICs).<sup>1,2</sup> Regions with high population density, high levels of poverty, and low levels of education are particularly vulnerable to burn-related injury and death.

Intentional burns comprise a unique subset of these injuries in LMICs, and often represent a form of gender-based

violence. Flame, chemical, and contact burns are common mechanisms of injury and are estimated to represent between 2 and 20% of all burn injuries seen in burn centers in LMICs.<sup>3,4</sup> However, the true incidence numbers are incomplete and under-represented.<sup>3,4</sup> Women are more commonly targeted,<sup>3–9</sup> and the perpetrators are often known to the victim. Recently, gang violence in the developed world has also been attributed to a rise of intentional burn injury. Cultural factors, including fear of retaliation and disempowerment of female gender in society, and infrastructural

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factors, including limited access to treatment centers and poor regional capacity, preclude accurate assessments for the burden of disease in these settings.<sup>10</sup>

The combination of a high disease prevalence, settings with limited surgical and anesthetic resources, a vulnerable patient population, and largely disfiguring, nonlethal injuries present unique challenges for the reconstructive surgeon. In this article, we present a case of a 16-year-old female who sustained severe, full-thickness burns to the face, eyes, abdomen, and upper extremities after an intentional acid attack. We began treating her about a year postinjury, and her contractures and cicatricial deformities of the oral and periorbital regions presented difficult reconstructive problems. The Aristotelean ideal of a “sum greater than its composite parts” underlies many aspects of reconstructive surgery,<sup>11</sup> and through a return to basic foundational principles, we were able to provide our patient with adequate restoration of facial form and function.<sup>12</sup>

## Case Report

### History

Our patient (H.C.C.) is an otherwise healthy 16-year-old female from a small, underdeveloped town in Liberia. H.C.C. was uneducated, and she worked selling concessions at a local market. She was the victim of an intentional acid attack by a known male acquaintance, disgruntled by her refusal to accept his marriage proposal. H.C.C.’s injuries were multiple and severe, and we have little information regarding the initial date of her acute burn treatment. Her case was referred to our institution, and she was ultimately seen in April 2016.

### Initial Presentation and Physical Exam

H.C.C.’s initial complaints were mostly related to her vision and her excessive tearing. On presentation, she had obvious cicatricial ectropion of bilateral upper and lower eyelids,

with purulent exposure keratitis of her left eye and resultant visual loss (►Fig. 1). There was complete effacement of her supratarsal folds bilaterally, near-complete obliteration of her brow lines, and perioral contractures affecting her bilateral nasolabial folds and commissures. She had a flexion contracture of her neck that effaced her cervicomental angle and precluded adequate chin extension.

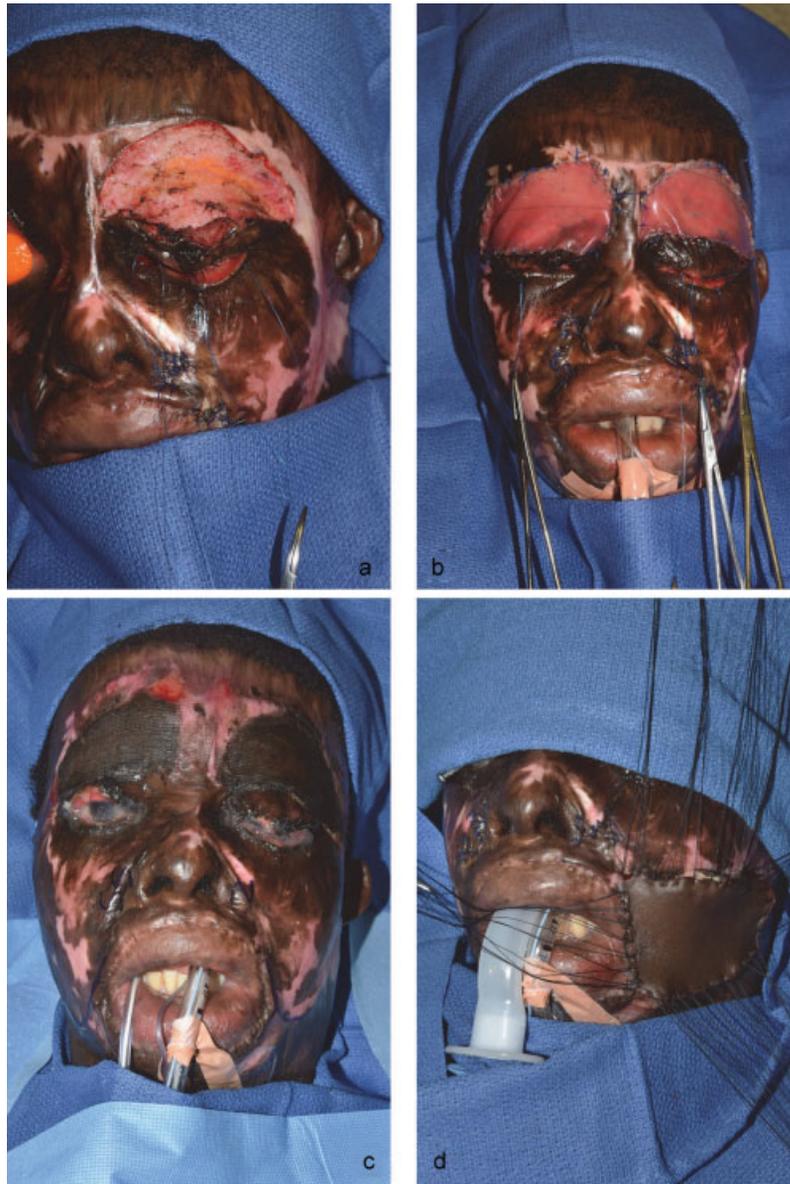
### Surgical Plan and Approach

- Phase 1: Eyesight preservation, brow remodeling, lid and mouth improvements (Principle 1: Correct the order of priorities; Principle 2: Return what is normal to normal position, and retain it there).

The most urgent treatment began with a focus on eyesight preservation. We requested immediate ophthalmologic consultation for eyesight preservation and possible corneal transplantation. In a multidisciplinary fashion, we then put forth a surgical plan in conjunction with our ophthalmology colleagues. Accordingly, we released her bilateral upper lid cicatricial ectropion first to provide an immediate improvement in globe coverage (►Fig. 2). Her eyelid skin was largely present, but it was scarred to her forehead. Our release, therefore, was initiated superior to her brow line in a supraorbicularis plane. We extended our initial dissection caudally to provide adequate lid coverage of her cornea but not enough to disrupt her levators. Because she was being seen commensurately with ophthalmology and would need repeated eye exams, we were unable to rely on traditional bolster dressings, as they would make repeated ophthalmologic exams difficult. We therefore placed Integra bilayer matrix wound dressing over her forehead releases to minimize bulky dressings and to optimize her chances of ultimate graft take (►Fig. 2). We performed Z-plasties to her nasolabial regions to relieve tension on her lower lids. Three weeks later, she underwent autografting of her bilateral forehead release sites, corneal gluing with protective lens placement,



**Fig. 1** Preoperative appearance of H.C.C. on initial clinical evaluation, ~1 year postinjury.



**Fig. 2** (a) Intraoperative view after release of left-sided cicatricial ectropion. (b) Integra placement on forehead defect following bilateral release of cicatricial ectropion. (c) Pre- and (d) intraoperative photographs of release and graft of the left cheek and local tissue rearrangements along bilateral nasolabial folds.

and additional tissue rearrangement in her neck for tension release.

- Phase 2: Corneal transplant and scar remodeling (Principle 3: Know the ideal beautiful normal; Principle 4: Extend your abilities to do the most good).

The following month, H.C.C. underwent an urgent corneal transplant, and we were able to coordinate additional steps in her facial reconstruction. Due to the limited time we would have her in our care, we began treating her mature burn scar contractures with fractional, ablative CO<sub>2</sub> laser (Ultrapulse, Lumenis, Yokneam, Israel).

- Phase 3: Sustain globe protection, oral competence, and overall facial appearance (Principle 5: Tissue losses should be replaced in kind; Principle 6: Reconstruction by units;

Principle 7: Consider the secondary donor area; Principle 8: Learn to control tension).

Over the next few months and five additional procedures, we undertook a series of staged reconstructive operations to restore form and function to H.C.C.'s face. Because she demonstrated areas of residual contractures, we released and grafted her left oral commissure and cheek and her right upper lid (►Fig. 2). Through a combination of release and grafting (to lower lid, cheek, and oral commissure), local tissue rearrangement (Z-plasties to neck, nasolabial folds), and laser treatments to her burn scars and skin grafts, we were able to provide her with improved globe protection, improved oral competence, and a more cosmetically appealing facial appearance (►Fig. 3).



**Fig. 3** Pre- and posttreatment course.

## Discussion

The nature of acid burn injuries and subsequent reconstructive needs mandate careful planning and, often, a multidisciplinary approach to care. Although injuries like those of H.C.C. can be complex, they can often be addressed in a stepwise fashion composed of smaller, fundamental reconstructive steps. In the present report, we detail the case of a young woman whose face and neck were disfigured following an acid attack in Liberia. She suffered from unprotected corneal exposure due to her bilateral upper lid cicatricial ectropion, as well as severe contractures of her neck and perioral region. An operative plan was formulated, in which we focused on the most urgent issues and prioritized functional improvement, while simultaneously thinking ahead to improvement of facial form. We utilized a combination of contracture release and skin grafting, local tissue rearrangement, and fractional, ablative CO<sub>2</sub> laser treatment to restore both facial form and function. While the operative techniques may not be revolutionary, adherence to the basic tenets of tension release and tissue recruitment can have dramatic effects in addressing even the most complex facial burns. When the reconstructive needs seem overwhelming, a return to foundational principles with a focus on the most critical needs will help guide the initiation of care. The principles we listed are by no means exhaustive but have clear relevance to our decision making in the aforementioned phases.

For example, our patient's corneal exposure and visual deficits mandated that we first address her cicatricial upper lid ectropion in our reconstructive plan. Various methods

exist to alleviate eyelid malposition from burn scar contracture, each with its own advantages and challenges. In 1959, Converse and Smith published a review on the treatment for eyelid burn contractures, and they highlighted three cardinal findings with cicatricial lid ectropion: (1) forward displacement of the medial canthus, (2) diminution of the transverse dimension of the palpebral fissure, and (3) loss of eyelid margin.<sup>13</sup> Our patient suffered from all three of these cardinal deformities on the left, and two on the right. Her left medial canthus was displaced forward, preventing her puncta from contacting the globe. This, combined with her loss of eyelid margin and cicatricial retraction, caused her to suffer from uncontrollable epiphora that worsened her already severe exposure keratitis.

Converse and Smith suggested release and grafting for canthal positioning, and they highlighted the use of a tarsoconjunctival flap for loss of lid margin. Others have suggested the use of local V-Y advancement flaps as a method to restore both upper and lower lid positioning.<sup>14</sup> We felt that the extent of our patient's soft-tissue injury, however, precluded the advancement of local tissue in the initial stages. Furthermore, and important to her treatment algorithm, most of her eyelid structure was intact, but was displaced by contractile forces in tissues adjacent to the lid itself. Some authors have elaborated on this concept of *extrinsic ectropion* and have suggested modifications of midfacial suspension to correct the deformity.<sup>15</sup> Although they report satisfactory results, we felt that we needed a much more drastic improvement in lid position to afford our patient acceptable corneal coverage. Additionally, the extrinsic ectropion was more pronounced on our patient's upper lids, which would not be addressed

with facial suspension. However, we did address some component of her extrinsic lower lid ectropion through Z-plasty tissue rearrangement of her nasolabial fold during her first operation.

Others have utilized the concepts of tissue expansion in burn injury to execute antegrade forehead plasties to reposition the upper face. Liao and colleagues published a series of patients in whom they performed tissue expansion and subsequent forehead advancement to restore upper face and brow position.<sup>16</sup> Our patient's impending blindness and corneal exposure precluded the use of similar techniques that would take weeks to months to complete. However, the principles of tissue expansion to release contractures and recruit local tissues are similar to those that underlie our approach. Through our releases and graftings, we were able to break the contractile forces that continued to threaten H.C.C.'s eyesight, and through our local rearrangements with Z-plasties, we were able to additionally recruit local tissues to help disseminate those forces. In addition, use of fractional ablative CO<sub>2</sub> laser as an adjunct to our traditional treatment paradigm was particularly important in this case.

Our patient's hypertrophic scars demonstrate the same types of contractile forces that are seen in many other types of burn injury. As previously mentioned, our basic underlying principles in addressing her deformities were tension release and tissue recruitment. Accordingly, we added adjunctive fractional, ablative CO<sub>2</sub> laser treatment to H.C.C.'s operative approach. In hypertrophic scars, ablative laser treatment results in thousands of microscopic thermal wounds within the scarred dermis that collectively help induce collagen remodeling, with resultant increases in tissue softness, flatness, and pliability.<sup>17</sup> With H.C.C., we were able to utilize our laser experience to treat her scars, making them softer, less pigmented, and more pliable. We used our fractional, ablative laser for her skin grafts as well, improving their overall contour. In combination, the interventions allowed for maximizing burn scar pliability, tension release, and less overall burn scar release and grafting that may have otherwise been necessary.

As burn and reconstructive surgeons, we are uniquely positioned to care for this under-recognized group of patients, and we ought to engage our national and international communities to advocate for them. The Acid Survivors Foundation (ASF)<sup>18</sup> is perhaps the largest and most far-reaching support network for victims of acid violence, and it provides both practitioners and nonpractitioners valuable information about the nature of this form of gender-based violence throughout the world. It also highlights the neglect and under-recognition of victims, and provides avenues for involvement and education. The ASF was founded in Bangladesh in 1999 with a vision to reduce and eliminate gender-based acid attacks around the world. The organization runs a 20-bed hospital, equipped to provide standard burn care services, including plastic and reconstructive surgery, physical therapy, and psychological care. They also provide legal assistance and financial support for economic rehabilitation to victims and their families. The foundation is financed through local and international support, and ASF relies

heavily on donated medical equipment and medicines. Due in large part to the organization's efforts in Bangladesh, the number of acid attack victims has decreased from more than 400 yearly in the early 2000s to fewer than 50 in 2017.<sup>18</sup> Though the ASF may be the largest and most well-known example, many similar organizations have been formed in countries across the globe. Yet, despite an increasing awareness, the magnitude of need remains high, and many poor victims in resource-limited settings lack access to even basic medical treatment and psychosocial support.

As we experienced with our patient, restoration and repair is possible in these difficult cases, and such cases should not be deemed "unsalvageable." Although ophthalmologic specialists may not be available in such under-resourced settings like H.C.C.'s home village, surgeons capable of release and grafting and local tissue rearrangement may be found in larger cities within the region. Simple reconstructive strategies can provide significant relief for patients with life-altering injuries typical of intentional acid attacks. Within the global health context, future efforts should be directed toward community education and training of local providers such that similar cases are not necessarily dependent on international relief alone. Additionally, we should use our experiences to generate evidence-based advocacy,<sup>19</sup> and to promote the continued development of advocacy-inspired evidence.

The Principialization of Plastic Surgery as put forth by Dr. DR Millard Jr. has and continues to stand the test of time.<sup>12</sup> We strongly advocate adherence to these principles particularly when encountered with complex burn injury sequelae as discussed in our patient example. We must continue to strive for excellence in our approaches to plastic surgical care and remember those fundamental principles that provide the framework in which to do so.

## Conclusion

Intentional acid burns represent an under-measured form of gender-based violence that is an under-addressed public health issue, especially in poor LMICs. Victims are typically vulnerable women who refuse advances from male acquaintances.<sup>10</sup> These burns are typically nonfatal, but are intended to disfigure the women for life. As such, the sequelae from acid burns are usually complex and require a coordinated group of specialists to provide adequate reconstructive care. However, as we have demonstrated in our case, these complex wounds can be treated with a series of smaller, fundamental operations. In each step of the approach, the surgeon can attempt to identify foundational principles in a stepwise fashion that will ultimately achieve the patient's long-term reconstructive and rehabilitative goals. Future work is needed to prevent such acts of violence as well as to improve local access to care and global awareness of this complex problem and its relatively simple solutions.

## Conflict of Interest

None.

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