Case Report

Daily General Anesthesia for Treatment of Severe Wound Contractures in a Severely Burned Child

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Abstract

A 2-year-old child was treated at our institution for 60% Total Body Surface Area (TBSA) scald burns to her lower body and trunk secondary to Non-Accidental Trauma (NAT), or intentionally afflicted abuse. She required several surgeries and multiple autologous split-thickness skin grafts. This girl developed contractures over both knees and ankles because of hypertrophic scarring from these grafts. Aggressive passive range-of-motion (ROM) therapy was given during her initial burn dressing changes under general anesthesia (GA,) resulting in improvement in the contractures. Typically, once the patient no longer requires mechanical ventilation the ROM therapy would only be continued awake with mild pain medicine, often resulting in limited progress. However, in this patient, after the grafts had healed, we continued to administer GA for the therapy until she was able to ambulate and could tolerate the passive ROM with only slight discomfort. Extensive and aggressive physical therapy can be administered to contracted patients facilitated by the relaxation and hypnosis of GA administered by an anesthesiologist.

Introduction

Each year about 21,000 people suffer serious burns requiring hospitalization in the United States [1]. Approximately 30% of these cases involve children, with the greatest incidence of burns occurring in individuals younger than 5 years of age. Small children have thinner skin, immature motor skills, knowledge deficits, and a larger proportion of their total body surface area made up by the head and neck as compared to adults. These factors all contribute to the large percentage of younger burn patients. Thinner skin is more likely to incur a heat-related injury, immature motor skills can cause falls into fire pits or hot liquid spills, knowledge deficits can lead to the touching of hot surfaces, and a larger cephalic area means that a more of the body might be uncovered and exposed during splash injuries or flash burns.

Treatment of significant burns requires aggressive wound care; partial thickness burns usually heal with this regimen, but full-thickness burns require split-thickness skin grafting [2]. After management of severe burn injuries, hypertrophic scars and contractures can result. Early treatment of contractures leads to improved functionality for patients in the long-term, but the optimum way to administer this therapy remains unclear. We present the case of a 2-year-old female who developed contractures over her ankles and knees following a 60% TBSA burn injury, which were successfully treated with manipulation under anesthesia.

**Case Presentation**

A 2-year-old, otherwise healthy girl presented with a scald injury to 60% of her body following NAT. The burns covered her bilateral lower extremities (Figure 1) and both her anterior and posterior trunk; she had been dunked in a hot water bath. The child was initially managed with fluid resuscitation, early burn care (Figure 2), and endotracheal intubation. The girl had a standard ICU stay given her large burn, with extensive volume replacement, aggressive burn care and prevention of secondary infections.

However, due to the large body surface area affected, she remained intubated for five weeks after her injury. During these weeks, aggressive wound care with appropriate pain control was relatively simple, since her airway and breathing were being managed and heavy sedation could be applied at any time. Once she was extubated, an anesthesiologist provided either sedation or GA (depending on the extent of the daily treatments) in the burn unit to continue management of her burn injury, such as dressing changes and minor burn debridements.

During the early part of her care, cadaveric allograft was placed over her lower extremities and trunk. Definitive autografting (Figure 3) then followed over the course of several surgeries. Following autograft placement, hypertrophic scars formed on her bilateral knees and ankles (Figure 4), and ultimately contractures of nearly 90 degrees developed over all of these joints. Due to the tight nature of the grafts, passive range-of-motion (ROM) by the physical therapy team was initiated while the patient was under anesthesia for dressing changes. Although this passive ROM was attempted on the patient without GA, she was unable to tolerate sufficient manipulation to allow for full release of the contractures.

In order to provide adequate treatment, we continued physical therapy under GA throughout the remainder of her hospital course (we also gradually introduced this therapy while she was awake.) A propofol-based general anesthetic with supplemental pain management with morphine, ketamine and/or ketorolac was used to maintain spontaneous respirations without an instrumented airway.
On discharge from the hospital the patient was able to ambulate independently (Figure 5) and she had nearly full range of motion in the affected joints. The patient continued to maintain this same mobility for the first 6 months following discharge; she was then lost to follow-up after the family moved out of state.

**Discussion**

Burn injuries are a major source of morbidity and mortality in the United States and around the world. Over 300,000 deaths occur annually from fire related burns, with over 95% of these occurring in low to middle-income countries [3]. Other types of burns, including scald, chemical and electrical burns, also contribute to make burns a significant public health issue. In better resourced countries, such as the United States, the mortality associated with burns has decreased, shifting the focus of burn treatments away from just survival to include improvement in long term outcomes. Functionality remains an important long-term end-point for burn survivors, necessitating attention on prevention and treatment of contractures.

The body’s natural response to burn injuries is scar formation. Hypertrophic scarring occurs due to a surfeit of inflammatory response, which over-stimulates fibroblasts and results in excess amounts of collagen and extracellular matrix [4,5]. This response tends to occur most commonly in deep dermal burns in highly elastic areas such as the lower face, submental triangle, anterior chest and neck, as well as around joints where tension is present. Contractures can occur when hypertrophic scars cross over a joint, and they can form more commonly when patients assume flexed positions to alleviate pain from the burn injury. Depending on the site of the contracture, functional deficits and physical limitations can result. To reduce disability, early and aggressive treatment of contractures is imperative.

The best treatment of contractures relies on prevention of their formation. A common strategy involves serial casting and dynamic splints. These modalities can be used to exert constant stretch on a joint and prevent the contracture. In a survey of burn centers in the United States, Canada, Australia, and New Zealand, 66% of deep partial-thickness burns are sometimes or often splinted even before signs of contractures have developed in order to prevent them from forming [6]. Static splints are also commonly used in prevention of burn contractures [7] however the data is more controversial as to if static splints actually prevent burn contracture [8].

Once a contracture has formed, the treatment is passive and active ROM, which increase flexibility and movement of the joint, or surgical intervention (usually as a last option.) Physical therapists and occupational therapists typically guide these ROM exercises, and they can be painful. Treatment guidelines for physical therapy tends to be center specific, with 97% of centers formulating their own treatment plans [6]. The ideal treatment for pediatric patients, who often have more challenges than adults regarding cooperation and anxiety, is not clear. Our patient could not tolerate her ROM exercises, but contractures in the knees and feet would significantly limit her future functional status, so her PT was considered critical. Our goal was for her to be ambulatory. The only means to accomplish this was to perform the physical therapy under GA, allowing for more extensive and therefore more effective physical therapy, until the same treatments could be introduced and tolerated while awake.

Use of GA for treatment of immobile joints is not new. Manipulation under anesthesia (MUA) has been used and is effective in improving mobility in orthopedic patients [9-11]. Patients that have not been able to tolerate or achieve effective treatment of adhesive capsulitis joints are treated with MUA. Similarly following total knee arthroplasty MUA results in improved motion of the joint. With the experience of orthopedic MUA, we moved forward with providing ROM exercises under anesthesia.

The use of GA in young children is currently controversial and should not be performed without careful consideration [12-14]. Animal studies across multiple different animal species demonstrate anesthesia-induced neuronal damage following anesthetic exposure [15-18]. Human studies are less clear with multiple or repeated anesthetic exposure possibly resulting in impaired neurodevelopment, while single exposure studies do not demonstrate cognitive impairment [19]. More high quality human studies need to be performed before definitive conclusions can be reached. However, currently SmartTots, a collaborative between the Food and Drug Administration (FDA) and the International Anesthesia Research Society (IARS), recommends that prior to anesthetic delivery “Each child must be evaluated individually based on age, the type of procedure, level of urgency, and other health factors” in the 2015 consensus statement [12]. We felt that given this patient’s young age, with significant years of life to follow and severe loss of functionality, the benefit of additional exposure to anesthesia outweighed the risks.

Burn contractures significantly affect the functionality of burn patients. Efforts should be focused on prevention of these contractures. In children who are unable to tolerate ROM exercises to aid in treatment of these contractures, GA, especially when combined with other procedures such as dressing changes, should be considered.

**References**


12. Consensus statement on the use of anesthetic and sedative drugs in infants and toddlers.


