

Histopathological study of adrenal glands in autopsy cases of flame burn cases: An original research study in North Western India at a tertiary health care centre.

Niraj Kumar^{1*}, Vivek Mangare¹, Deepali Pathak²

¹Department of Forensic Medicine and Toxicology, Govt. Doon Medical College Dehradun, Uttarakhand, India

²Department of Forensic Medicine and Toxicology, Sawai Man Singh Medical College Jaipur, Rajasthan, India

Abstract

Introduction: Burn injuries, akin to other forms of trauma, elicit a systemic inflammatory response mediated by a plethora of mediators including prostaglandins, interleukins, and other inflammatory agents. This response is not confined to a solitary organ system; rather, it incites a multi-organ systemic reaction. Notable observations within this scope are adrenal hemorrhage, necrosis, and congestion. The etiology of adrenal hemorrhage in burn victims is inherently complex and multifaceted. This study was designed to investigate the histopathological alterations in the adrenal glands subsequent to lethal flame burns.

Materials and methods: The research methodology employed was an observational, descriptive analysis conducted within the autopsy facilities of SMS Medical College. Decedents presenting with a burn body surface area exceeding 35%, as determined by Wallace's Rule of Nine, were incorporated into the study. A total of 80 cases was meticulously selected for this investigation.

Observations: Adrenal congestion was identified in 50 cases, succeeded by adrenal necrosis in 25 cases. The prevalence of adrenal hemorrhage, congestion, and necrosis was most notable in patients who endured for a duration of 4 to 7 days post-injury, with 10, 16, and 12 cases respectively. Necrosis was predominantly observed in individuals who succumbed to shock, accounting for 10 cases.

Conclusion: Adrenal hemorrhage has the potential to induce adrenal insufficiency, which may escalate to fatality in burn cases. The histopathological examination of adrenal tissues is instrumental in delineating the cause of death. It is imperative for clinicians to meticulously monitor and manage adrenocortical functions in burn victims, as such vigilance and intervention are pivotal in reducing mortality rates.

Keywords: Burn Injuries, Adrenal haemorrhage, Adrenal necrosis, Autopsy

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Introduction

Thermal traumas, encompassing flame burns, scalds, exposure to corrosive chemicals, radiation, frostbite, and trench foot, have been recognized by humanity since ancient times. Physicians have historically encountered numerous challenges in treating such afflictions and have continually sought innovative methods to enhance therapeutic approaches for these patients. Flame burn

injuries are particularly prevalent in the modern era of rapid industrial growth and other contributory factors. In our nation, these injuries are alarmingly frequent and pose a significant risk. The management and remediation of such lethal injuries present a formidable challenge, especially as the healthcare sector is still evolving and requires substantial enhancements.

Flame burns obliterate the protective barrier that separates

the microorganism-laden external environment from the body's sterile internal compartments. Similar to other forms of injury, burn wounds trigger an inflammatory cascade mediated by an array of prostaglandins, interleukins, and other inflammatory agents. This inflammatory response is not confined to a single organ system; instead, it provokes a systemic reaction affecting multiple organ systems, such as the vascular system, which leads to edema due to heightened vascular permeability [1], and the renal system, which can result in acute tubular necrosis and cloudy degeneration of the tubules [2].

It has been noted by some scholars that aggressive fluid resuscitation, a critical management step, may precipitate abdominal compartment syndrome [3]. The etiology of mortality in burn cases spans a broad spectrum, including hypovolemic shock, sepsis, asphyxia, and vasovagal episodes, among others.

A select group of researchers [4-9], have delved into the adrenal gland's response to flame burns. Documented findings encompass adrenal hemorrhage, necrosis, and congestion. The pathogenesis of adrenal hemorrhage in burn victims is inherently complex. Adrenal necrosis and hemorrhage can also arise from ischemia or as a consequence of adrenal stimulation due to vascular engorgement and stasis [4]. Given that the adrenal gland receives blood from three arteries and drains through a single vein, this anatomical feature predisposes it to hemorrhagic events [10]. The clinical manifestations of adrenal insufficiency are often indistinct and can be easily mistaken for sepsis, which, if undiagnosed, may lead to hemodynamic instability, multi-organ dysfunction, and ultimately, death. Therefore, adrenal hemorrhages are predominantly identified during post-mortem examinations and are frequently overlooked.

This study endeavored to examine the histopathological alterations in the adrenal glands following fatal flame burns. The histopathological observations gleaned from these autopsies could be invaluable for forensic pathologists in determining and ascribing the cause of death in burn victims. Furthermore, this research could assist clinicians in recognizing and managing a catastrophic condition such as adrenal insufficiency, thereby directly contributing to a reduction in mortality rates and an improved prognosis for patients enduring such grievous injuries. Consequently, this investigation was initiated to elucidate the pathological significance of adrenal changes in burn fatalities and to address the paucity of existing literature on the subject.

Materials and Methods

This investigation constituted a hospital-based, observational, descriptive analysis executed at the mortuary of SMS Medical College and its affiliated hospitals in Jaipur, Rajasthan, India. This was subsequent to the clearance of requisite approvals from the research and review board of SMS Medical College and Hospital,

in collaboration with the Department of Pathology, Sawai Man Singh Medical College, for the preparation and examination of samples from March 2020 to August 2021. Throughout this interval, an aggregate of 5720 medico-legal post-mortem examinations were performed, within which 117 instances were identified as fatalities attributable to flame burns.

Inclusion criteria

- Cases of mortality due to flame burns where the burn surface area exceeded 35% (rule of Wallace).
- Valid consent was given by the attendants of the deceased.

Exclusion criteria

- No valid consent was given by attendants.
- Burn surface area below 35% according to rule of Wallace.
- Thermal deaths due to electrocution, scalds, chemical burns.

From these, 80 cases were meticulously selected based on predetermined inclusion and exclusion criteria. A particular focus was directed towards the inspection of both adrenal glands for discernible gross pathological alterations during the post-mortem process.

Observation and Results

In this research, female subjects prevailed over male counterparts, comprising 55% of the study population. Adrenal hemorrhage was observed in 38 cases, accounting for 47.50%. Adrenal congestion was noted in 50 cases, while adrenal necrosis was identified in 25 cases (Table 1). Adrenal hemorrhage emerged as the most consistent pathological finding in individuals with a burn surface area surpassing 85%, affecting 11 cases. Congestion of the adrenal glands was the predominant finding in decedents with burn surface areas between 45 to 55% and those exceeding 85%, with 10 cases in each category. For individuals with burn surface areas above 75%, necrosis was the most common histopathological observation, with 14 cases (Figure 1).

Table 1. Distribution of cases according to histopathological changes in adrenal glands.

Histopathological changes in adrenal glands	Number (%)
Adrenal haemorrhage	38 (47.50%)
Congestion	50 (62.50%)
Necrosis	25 (31.25%)

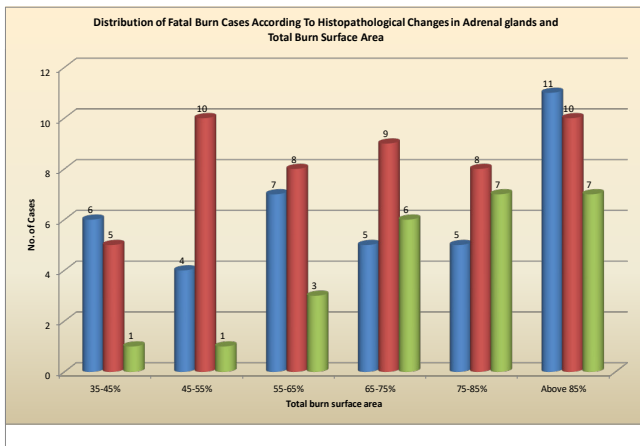


Figure 1. Distribution of fatal burn cases according to histopathological changes in adrenal glands and total burn surface area.

Note: (■): Adrenal haemorrhage; (■): Congestion; (■): Necrosis.

The study further indicated that adrenal hemorrhage, congestion, and necrosis were most frequently observed in patients who survived for 4 to 7 days following the incident, with 10, 16, and 12 cases respectively (Figure 2). The greatest incidence of adrenal hemorrhages occurred in cases resulting in death due to shock, with 16 cases. Congestion was the most consistent pathological feature in cases of septicaemia, with 19 instances, followed by shock with 18 cases. Necrosis was most seen in subjects who died due to shock, with 10 cases reported (Table 2).

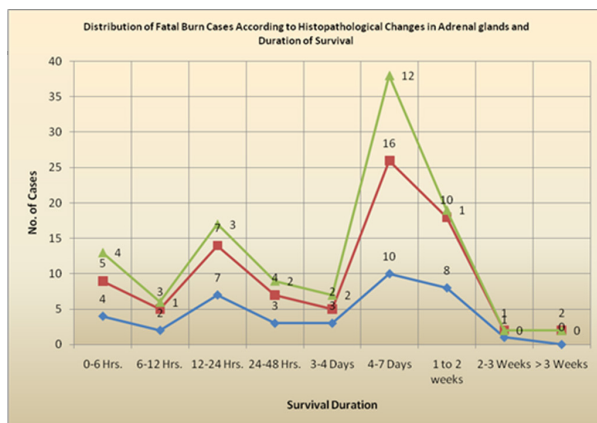


Figure 2. Distribution of fatal burn cases according to histopathological changes in adrenal glands and duration of survival.

Note: (—■—): Adrenal haemorrhage (Present); (—■—): Congestion (Present); (—■—): Necrosis (Present).

Table 2. Distribution of fatal cases of burn according to histopathological changes in adrenal glands and cause of death, (n=80).

Histopathological changes in adrenal glands	Septicemia	Shock	Toxemia	Total
Adrenal haemorrhage	13	16	09	38
Congestion	19	18	13	50
Necrosis	07	10	08	25

Discussion

Adrenal congestion emerged as the predominant pathology, affecting 62.5% of cases. Adrenal hemorrhage was observed in 47.5% of cases, while adrenal necrosis was present in 31.25%. The incidence of adrenal hemorrhage in this study was 60% in cases with 35-45% burns and 58% in those with 55-65% burns, reaching its zenith at 61% in cases with burns exceeding 85%. Congestion was most frequently observed in cases with 45-55% burns (90.9%), followed by 55-65% burns (66.67%), and 65-75% burns (60%). Hemorrhage was absent in 52.5% of cases. The adrenal gland was notably congested and enlarged in 62.5% of cases, with hemorrhagic areas evident upon microscopic confirmation in the cut sections. In 37.5% of cases, the adrenal gland appeared grossly normal. The findings of this research align with those reported by Ahmed *et al.*, [5], and diverge from Kumar *et al.*, [6], who noted adrenal hemorrhage in 27.5% of cases.

The majority of cases exhibiting congestion and adrenal hemorrhages had a survival span of 3-7 days post-burn injury. Histopathological changes in the adrenal glands reached their apex in cases with a survival duration of 4-7 days. A progressive increase in adrenal necrosis was correlated with the extent of burns. The present study's results slightly exceeded those reported by Kumar *et al.*, [6]. The study demonstrated that adrenal hemorrhages were commensurate with the total burn surface area, with the majority of cases exhibiting adrenal hemorrhages having more than 50% total burn surface area. These findings are consistent with those of Reiff *et al.*, [7] and Kumar *et al.*, [6]. Adrenal gland congestion was uniformly distributed across burn cases, regardless of the total burn surface area, whereas adrenal necrosis was more prevalent in cases with over 65% total burnt surface area. Thus, the total burnt surface area is a significant risk factor for acute adrenal insufficiency in severely burnt patients, corroborating the findings of Reiff *et al.*, [7].

Tedeschi, [11], also noted increased functional activity and enlargement of the adrenal glands in fatalities due to burns. Wieskotten [9], observed that the adrenal glands were swollen and deeply red, exhibiting pronounced congestion and hemorrhage in cases of uncomplicated superficial burns. Harris reported hemorrhage in both adrenal glands in instances of second- and third-degree burns.

Conclusion

Histopathological scrutiny of the adrenal glands disclosed the incidence of adrenal hemorrhages in approximately 50% of cases, a factor contributing significantly to the mortality associated with burn injuries. These pathological alterations were discernible in fatalities both with and without concurrent septicaemia. However, the clinical diagnosis of adrenal hemorrhage is infrequently established due to its generally non-specific presentation. Adrenal hemorrhage has the potential to precipitate adrenal insufficiency, which may, in turn, be a causative factor in

burn-related mortality. The histopathological examination of renal and adrenal tissues proves instrumental in ascertaining the cause of death. Therefore, it is imperative that histopathological analysis of the kidneys and adrenal glands be integrated into the post-mortem examination protocol for victims of burn injuries to elucidate the cause of death.

The authors wish to highlight to the treating clinicians that the magnitude of the burn injury has been observed to influence the duration of patient survival, corroborating findings from previous research. Such burn extent also independently contributes to the histopathological changes observed in the adrenal glands. It is crucial that adrenocortical functions be meticulously monitored and managed with alacrity in patients with burn injuries. Incorporating these measures into the diagnostic and therapeutic criteria for burn victims will undoubtedly facilitate a more favourable outcome in the treatment of these grievous injuries.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Declaration

This research was done under dissertation and the research review board and Institutional Ethics Committee Sawai Man Singh Medical College Jaipur provided the necessary clearance.

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***Correspondence to:**

Niraj Kumar
Department of Forensic Medicine and Toxicology
Govt. Doon Medical College Dehradun
Uttarakhand
India