

Compartment Syndrome: Recognizing The Hidden Emergency and When to Intervene – Case Report

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ABSTRACT

Compartment syndrome secondary to deep burns constitutes a surgical emergency that threatens the function and viability of the affected limb. We present the case of a 37-year-old male patient who suffered an explosion resulting in deep second-degree and third-degree burns on the right upper extremity, developing progressive edema, severe pain, paresthesia, and decreased distal perfusion, findings consistent with compartment syndrome. Intracompartmental pressure measurement confirmed the need for immediate decompression, leading to a combined fasciotomy of the anterior and posterior compartments of the forearm, preserving neurovascular structures and optimizing hand function. Postoperative management included pain control, wound care, delayed coverage of deep burns with partial-thickness skin grafts, and early physical rehabilitation. Clinical evolution was favorable, with full recovery of mobility, strength, and sensation of the limb, minimal scar contracture, and satisfactory aesthetic outcomes. This case highlights the importance of early detection of burn-related compartment syndrome, precise indication for fasciotomy, and a multidisciplinary approach in plastic and reconstructive surgery to achieve optimal functional and aesthetic outcomes.

KEYWORDS: Compartment syndrome; Fasciotomy; Deep second-degree burns; Third-degree burns; Upper extremity; Reconstructive plastic surgery; Surgical decompression; Explosion injury.

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INTRODUCTION

Compartment syndrome is a true surgical emergency characterized by increased intracompartmental pressure that exceeds tissue perfusion, leading to progressive ischemia, muscle necrosis, and irreversible nerve damage if not promptly addressed.^{1,2} This condition represents not only a functional but also an aesthetic challenge, making it particularly relevant in plastic and reconstructive surgery.

Involvement of muscle compartments in the extremities can result in permanent sequelae, including loss of mobility, contractures, scar deformities, and significant functional impairments that impact patient quality of life.³

Among the multiple described etiologies, burns are a frequent and particularly complex cause of compartment syndrome. Burns induce significant tissue inflammation and progressive

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edema, which increase pressure within closed compartments, especially in the extremities. Localization in the upper extremity is critical due to the complex function of the hand and forearm, structures that require fine mobility, muscular strength, and functional aesthetics.^{4,5} Complications resulting from delayed decompression include muscle necrosis, neuropathies, loss of motor and sensory function, permanent deformities, and aesthetic compromise, all of which can profoundly affect the patient's quality of life and social reintegration.⁵

Early diagnosis of compartment syndrome is based on a combination of clinical findings and objective measurements of intracompartmental pressure. Classic signs include severe pain disproportionate to the injury mechanism, pain on passive movement of the affected muscles, paresthesia, pallor, weakness, and diminished distal pulses. However, the clinical presentation can be insidious and vary according to the extent of the injury and edema progression, highlighting the need for a high index of suspicion and constant monitoring in patients with extensive or deep burns. Early and systematic evaluation enables timely surgical decision-making, minimizing complications and optimizing functional and aesthetic recovery.⁶

Definitive treatment consists of surgical release of the affected compartments through fasciotomy. In plastic surgery, this intervention aims not only to restore perfusion and muscle function but also to preserve aesthetic integrity, as the design and placement of incisions can influence healing, mobility, and final appearance. Indications for fasciotomy include clinical signs of vascular and neurological compromise, objectively elevated intracompartmental pressure, imminent functional impairment, and risk of tissue necrosis. Delay in intervention increases the risk of permanent sequelae, including contractures, scar deformities, loss of strength and sensation, and the potential need for additional complex reconstructive procedures.⁷

In the context of plastic and reconstructive surgery, multidisciplinary assessment and surgical planning are essential. Coordinated involvement of plastic surgeons, traumatologists, anesthesiologists, and physical therapists allows management not only of the initial emergency but also of functional and aesthetic recovery in the medium and long term. Early rehabilitation, physical therapy, and scar

management are key components for optimal reintegration of the patient into daily, work, and social activities.⁸

This report describes the case of a 37-year-old male patient who developed compartment syndrome in the right upper extremity secondary to deep second-degree burns. Clinical findings, preoperative assessment, surgical decision-making, execution of fasciotomy, and postoperative evolution are detailed. This case highlights the importance of early detection, timely surgical management, and comprehensive rehabilitation to preserve function, mobility, and aesthetics of the affected limb, emphasizing the critical role of reconstructive plastic surgery in managing severe burn complications.

CASE REPORT

The case of a 37-year-old male patient, previously healthy and without significant comorbidities, is presented. The patient suffered a work-related accident involving an explosion and direct contact with hot liquids and flames, resulting in extensive burns to the right upper extremity. Upon admission to the plastic and reconstructive surgery service, areas of superficial second-degree, deep second-degree, and third-degree burns were identified, primarily affecting the forearm and right hand.

The patient reported intense pain, progressive edema, difficulty moving the fingers and wrist, as well as a sensation of numbness in the hand. Clinical evaluation revealed erythematous areas with small and large blisters, third-degree necrotic areas, and regions with superficial burns, accompanied by tense edema compromising distal perfusion. Palpation of the forearm muscle compartments showed abnormal tension, pain exacerbated by passive movement of the fingers and wrist, and slight reduction in sensation on the palmar surface of the fingers, findings consistent with compartment syndrome.

Due to the severity of the condition, intracompartmental pressure measurement was performed, recording elevated values up to 50 mmHg in the flexor and extensor compartments of the right forearm, confirming the diagnosis of compartment syndrome. Given the imminent risk of muscle necrosis, irreversible nerve damage, and functional loss of the limb, urgent decompressive fasciotomy was indicated.



Figure 1: Surgical intervention images (fasciotomy)

The surgical procedure was performed under general anesthesia. Strategic longitudinal incisions were made in the anterior and posterior compartments of the forearm, designed to fully release pressure in all affected compartments,

carefully preserving neurovascular structures and minimizing aesthetic impact. During the fasciotomy, congested but viable muscle tissue was observed, with immediate restoration of distal perfusion following pressure release.



Figure 2,3: Surgical intervention images (fasciotomy)

The importance of adequately extending the incisions was emphasized to ensure complete decompression, avoiding residual pressure points that could lead to muscle necrosis or nerve damage. Additionally, all compartments—including flexor, extensor, and interosseous compartments—were inspected to ensure total release. The wound was temporarily covered with a sterile dressing, with delayed closure planned for areas affected by deep second-degree and third-degree burns. Postoperative management focused on pain control, infection prevention, and early rehabilitation of joint and muscle mobility.

DISCUSSION

Compartment syndrome is a critical surgical emergency defined by increased pressure within a closed muscle compartment, leading to decreased tissue perfusion and, if untreated, progressive ischemia, irreversible muscle necrosis, and permanent nerve damage. Pathogenesis is based on an imbalance between intracompartmental pressure and capillary perfusion pressure, resulting in interstitial edema, compression of blood vessels and nerves, and eventual functional loss of the affected limb. The temporal evolution is rapid; studies have shown that irreversible muscle ischemia can occur within 6–8 hours from the onset of pressure elevation, emphasizing the need for strict monitoring and immediate surgical action.⁹

Among relevant etiologies, burns are a significant risk factor, especially deep second- and third-degree burns, due to the combination of direct thermal damage, tissue inflammation, and progressive edema. Deep burns increase intracompartmental pressure not only through edema but also by surrounding tissue retraction and dermal protein coagulation-induced skin stiffness. Burns combined with trauma or explosion further increase risk due to vascular damage, soft tissue destruction, and initial necrosis. In the upper extremity, this is particularly critical due to the functional complexity of the hand and forearm, where preservation of fine mobility, grip strength, and aesthetic integrity is essential for quality of life.⁹

Fasciotomy is the only definitive treatment for compartment syndrome. Indications are based on clinical evaluation and objective intracompartmental pressure measurement. Classic criteria include severe disproportionate pain, pain exacerbated by passive movement, paresthesia, pallor, reduced distal pulses, and palpable compartment tension. Pressure measurements are considered indicative when exceeding 30 mmHg or within 30 mmHg of the patient's diastolic pressure. In extensive burns, even with palpable pulses, progressive edema, functional limitation, or severe pain justify preventive fasciotomy to avoid irreversible muscle necrosis.¹⁰

Various fasciotomy types exist, tailored to limb anatomy and affected compartments. In the upper extremity, common approaches include volar/anterior fasciotomy for flexor

compartments, dorsal fasciotomy for extensor compartments, and combined fasciotomies to release all forearm compartments. Hand fasciotomies may include interosseous and thumb incisions to release specific compartments. Choice of fasciotomy depends on extent of compromise, edema severity, associated injuries, and need to preserve neurovascular structures, as well as aesthetic considerations in plastic surgery. Careful incision planning minimizes visible scars and facilitates subsequent functional rehabilitation.¹⁰

A multidisciplinary approach is essential. Plastic, reconstructive, and trauma surgeons ensure an integrated strategy combining immediate decompression with aesthetic and functional preservation. Anesthesiologists, physical therapists, and specialized nursing contribute to perioperative care, pain management, infection prevention, and optimization of postoperative mobility. Early intervention prevents necrosis and reduces the need for complex secondary procedures such as extensive skin grafts, local flaps, or late reconstructive surgery for scar deformities.¹¹

Despite its effectiveness, fasciotomy carries potential complications, including wound infection, bleeding, secondary tissue necrosis, hypertrophic scarring, contractures, and significant aesthetic alterations. Correct surgical technique, preservation of perfusion, appropriate incision placement, and careful postoperative management are key to minimizing these risks. In burn patients, surrounding skin may be compromised, increasing susceptibility to infection and delayed healing; temporary sterile dressings and delayed closure or partial-thickness skin grafts are recommended strategies.¹¹

Fasciotomy should be performed by surgeons trained in plastic, reconstructive, or trauma surgery, familiar with compartment anatomy and decompression techniques. Surgical decision-making requires advanced clinical judgment, assessment of compartment syndrome extent, and skill in preserving critical neurovascular structures. In emergency settings, general surgeons trained in limb decompression procedures may perform fasciotomy following safe anatomical principles.^{12,13}

Absolute contraindications are rare, including patients with imminent clinical death or extensive irreversible tissue necrosis. Relative contraindications include mild intracompartmental pressure, absence of neurological or vascular compromise, or severe comorbidities that preclude immediate surgery, where initial stabilization takes precedence. Individualized patient evaluation is essential to balance risks and benefits.¹⁴

This case exemplifies these principles. The 37-year-old patient with deep second- and third-degree burns of the right upper extremity developed explosion-related compartment syndrome. Fasciotomy indication was clear, based on clinical signs of vascular and neurological compromise, severe pain, progressive edema, and elevated intracompartmental pressure. A combined anterior and posterior approach

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allowed complete decompression, restored distal perfusion, preserved muscle function, and achieved satisfactory aesthetic recovery, highlighting the importance of timely intervention.¹⁵

CONCLUSION

Compartment syndrome secondary to second- and third-degree burns represents a highly complex surgical emergency requiring prompt diagnosis and immediate management to prevent permanent functional sequelae, irreversible neuromuscular damage, and significant aesthetic complications. Early identification of characteristic clinical signs—disproportionate pain, progressive edema, paresthesia, compartment tension, and decreased distal perfusion—alongside objective intracompartmental pressure measurement, forms the basis for fasciotomy indication. Timely intervention is decisive for preserving limb function and minimizing morbidity associated with severe burns.

Fasciotomy, as the definitive treatment for compartment syndrome, should be performed following rigorous surgical principles, considering compartment anatomy, neurovascular preservation, and incision planning to allow delayed closure or grafting in deep burns. Selection of fasciotomy type— anterior, posterior, or combined—depends on lesion extent, tissue compromise, and the need for complete decompression of all affected compartments, with particular attention to hand and forearm function in upper extremities.

Fasciotomy success relies not only on surgical technique but also on a multidisciplinary approach involving plastic and reconstructive surgery, trauma, anesthesiology, physical therapy, and specialized postoperative care. This comprehensive approach enables restoration of limb function, preservation of muscle strength, joint mobility, and sensation, as well as optimization of aesthetic outcomes, all essential for patient quality of life.

This case demonstrates that early fasciotomy by a skilled team not only halted ischemic progression but also allowed complete recovery of right upper extremity function, with minimal contracture and satisfactory healing. Delayed coverage of deep burn areas with partial-thickness skin grafts improved aesthetic outcomes, emphasizing the importance of reconstructive planning combined with surgical decompression.

Clinically, this case reinforces the relevance of constant monitoring in patients with deep burns and explosion exposure, the need for objective pressure measurement when compartment compromise is suspected, and the early indication of fasciotomy as a lifesaving procedure. It also underscores the importance of surgeon experience and multidisciplinary coordination to minimize complications, optimize functional recovery, and preserve limb aesthetics.

In conclusion, fasciotomy is a critical and effective procedure that, when performed timely and following appropriate anatomical and reconstructive principles, preserves limb function, prevents irreversible damage, and achieves

satisfactory aesthetic outcomes in patients with severe burn-related compartment syndrome. This comprehensive approach demonstrates that plastic and reconstructive surgery restores not only form but also function, mobility, and quality of life, reaffirming its fundamental role in managing complex limb injuries and preventing disabling sequelae.

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