



Fasciotomy in the upper limb after compartment syndrome due to snakebite with subsequent grafting and z-plasty: case report

Fasciotomia em membro superior após síndrome compartimental por acidente ofídico com posterior enxertia e plástica em Z: relato de caso

FELIPE ANDRADE LOPES¹
MARIANA FERNANDES
INÁCIO¹
LEONARDO FLUD IDEAL²
TONY TOBIAS JUNIOR¹
GIOVANNA CAVALCANTI
BANOV²
ALEXANDRE VENÂNCIO DE
SOUSA^{1*}
ROBERTA LOPES BARIANI²

■ ABSTRACT

This case study examines the clinical course of a Bothrops snakebite poisoning that occurred in Jarinu, São Paulo, Brazil, in 2021. The patient required a fasciotomy in the upper limb due to acute compartment syndrome, followed by a second surgical procedure involving dermo-epidermal grafting. In the late postoperative period, the patient experienced retraction, leading to a subsequent surgical intervention to correct the retraction in the left upper limb. The severity of the snakebite accident, the effects of venom on tissues, complications, acute compartment syndrome, as well as the indications and techniques for decompressive fasciotomy, are discussed based on the available literature.

Keywords: Snake bites; Fasciotomy; Skin transplantation; Surgical flaps; Upper extremity.

■ RESUMO

Este relato de caso aborda o curso clínico de um envenenamento botrópico ocorrido no município de Jarinu, SP, no ano de 2021. O paciente necessitou de fasciotomia em membro superior após síndrome compartimental aguda com enxertia dermoepidérmica em um segundo momento cirúrgico. No pós-operatório tardio, o paciente evoluiu com retração, necessitando de reabordagem cirúrgica com correção de retração de membro superior esquerdo. Discute-se a gravidade do acidente ofídico, efeitos do veneno nos tecidos, complicações, síndrome compartimental aguda, indicação e técnica da fasciotomia descompressiva com base na literatura.

Descritores: Mordeduras de serpentes; Fasciotomia; Transplante de pele; Retalhos cirúrgicos. Extremidade superior.

Institution: Hospital São Vicente de Paulo, Jundiá, SP, Brazil.

Article received: July 17, 2023.
Article accepted: December 5, 2023.

Conflicts of interest: none.

DOI: 10.5935/2177-1235.2024RBCP0850-EN

INTRODUCTION

Bothropic accidents account for the majority of snakebite incidents in Brazil, representing approximately 90.5% of cases. Snakes from the Viperidae family, specifically the *Bothrops* and *Bothrocophias* genera, are found throughout Brazil, particularly in agricultural, coastal, and peri-urban areas.

In 2021, 31,354 snakebite incidents were reported in the country, with 5,723 cases in the state of Pará, 3,118 cases in the state of Bahia, 3,030 cases in the state

of Minas Gerais, 2,238 cases in the state of Maranhão, 2,112 cases in the state of Amazonas, and 2,023 cases in the state of São Paulo, ranking it as the 6th state with the highest incidence during that period¹⁻³. The World Health Organization (WHO) recognizes snakebite envenomation as a neglected tropical disease that poses a significant public health concern with high morbidity and mortality rates⁴⁻⁶.

The disease has a low fatality rate, estimated at 0.3%. However, complications resulting from *Bothrops* snakebites are the major concern in these incidents,

¹ Hospital São Vicente de Paulo, Jundiá, Jundiá, SP, Brazil.

² Faculdade de Medicina de Jundiá, Jundiá, SP, Brazil.



as they can lead to bleeding, compartment syndrome, muscular necrosis, and acute kidney injury, resulting in significant anatomical or functional sequelae. In these cases, specific treatment is crucial, especially the early administration of antivenom to neutralize the injected toxins^{3,7}.

OBJECTIVE

In this context, the purpose of this report is to describe the case of a patient who underwent fasciotomy in the upper limb after acute compartment syndrome secondary to *Bothrops* envenomation at a time when the duration of hospitalization was constrained due to the SARS-CoV-2 pandemic. Furthermore, it explores the indication and technique of decompressive fasciotomy, as well as its approach to dermo-epidermal grafting in a subsequent surgical procedure.

CASE REPORT

A 52-year-old right-handed white male patient from a rural area (farm) was referred from a medical facility in Jarinú, SP, Brazil, to the Emergency Department of São Vicente de Paulo Charity Hospital (HCSP) on April 2, 2021, in Jundiaí, SP, Brazil. He arrived 4 hours after being bitten by a Jararaca snake (*Bothrops*) on the thenar region of his left hand, seeking specialized medical care.

Upon initial assessment, a small puncture wound was observed on the left hand without any bleeding. The patient's left upper limb was swollen and hardened up to the cubital region, with the neurovascular system intact. The patient was in a stable overall condition, showing no signs of cyanosis or jaundice, breathing comfortably, with mild acute mental confusion but preserved consciousness level. There were no neurological deficits or ptosis. His heart rate was 85 bpm, and his blood pressure was 90/60 mmHg. The neurological evaluation was challenging due to intoxication.

Initial management was conducted in the emergency room, which included intravenous hydration, pain relief, corticosteroid therapy, clinical support, as well as hemodynamic and neurological monitoring. Initial laboratory tests showed a progressive increase in creatine phosphokinase levels (2,782U/L), prolonged prothrombin time and activity (INR: 1.78), and severe thrombocytopenia (18,000/mm³).

However, blood transfusion was not required as the values improved after initial treatment. There was no evidence of metabolic acidosis (pH 7.37), acute kidney injury (Cr 0.88mg/dl), or electrolyte disturbances (Sodium 137mEq/L; Potassium 5.0mEq/L;

Calcium 1.18mmol/L). The Campinas Center for Toxicological Information and Assistance (CIATox) was consulted, and they recommended the administration of Antibotrophic Serum, a single dose of 120 mL, with infusion scheduled for 7 hours after the initial event.

During the follow-up assessment, after 2 hours, the patient experienced severe pain that did not respond to opioid analgesia. Blistering lesions and limited movements, such as elbow extension and flexion, were observed. Despite receiving antivenom, the edema continued to spread up to the axillary region.

Due to the worsening clinical condition, accompanied by paresthesia and paresis, acute compartment syndrome was diagnosed. Consequently, a fasciotomy of the left upper limb was indicated after 16 hours. The surgical procedure consisted of a single incision through the skin and subcutaneous tissue with a cold scalpel, starting at the palmar region of the hand, continuing on the anterior surface of the forearm and the mid-third of the arm, following the natural tension lines of the skin. Hemostasis was achieved, and the tense muscle fascia was released with Metzenbaum scissors. No evidence of muscle necrosis was observed during the surgery, eliminating the need for additional fasciotomy incisions (Figure 1).



Figure 1. Fasciotomy of the thenar region, forearm, and distal arm to release compartmental tension, with no areas of muscle necrosis.

During the immediate postoperative period in the intensive care unit, the patient showed clinical stability, and gradual improvement in pain, edema, and paresthesia, but continued to have limited extension of the arm and finger movements. After 12 days (April 14, 2021), dermo-epidermal grafting was performed in the raw area (Figure 2).



Figure 2. Dermo-epidermal graft after integration, without collections or signs of infection.

The patient progressed without signs of infection or collection, with adequate integration of the graft. During a late postoperative outpatient reevaluation (5 months after the surgical procedure), the patient complained of limited extension of the left elbow. It was decided to readdress the issue due to the diagnostic hypothesis of graft contraction.

On October 27, 2021, partial excision of the skin graft area of the arm and cubital region (fibrotic areas) was performed, with the creation of 2 Z-plasty flaps. The patient remained clinically and hemodynamically stable, without complaints, and was discharged from the hospital for outpatient follow-up. During the follow-up consultation, the return of the left upper limb functionality was observed, with no new surgical indications (Figures 3 and 4).

DISCUSSION

In Brazil, snakebite accidents remain a public health problem and are considered the second most frequent cause of human poisoning, second only to medication-related poisoning⁸. The venom is injected into the body through the fangs upon snakebite. The secreted toxin consists of complex mixtures of proteins (90 to 95% of the total), peptides, amino acids, lipids,



Figure 3. Late postoperative outcome following Z-plasty (extended arm).



Figure 4. Late postoperative outcome following Z-plasty (flexed arm).

carbohydrates, enzymes (such as acetylcholinesterase, proteases, collagenases, fibrogenases, among others), inorganic compounds, and cations, which determine a biochemical and toxicological profile with a wide range of clinical manifestations^{4,9}.

These compounds target cellular receptors, membrane proteins, and coagulation. The action of *Bothrops* venom primarily results in cytotoxicity, myotoxicity, and hemotoxicity in the human body.

This leads to hemolysis, destruction of muscle cells, myocytes, and lymphocytes, tissue necrosis, increased vascular permeability, and interference with the coagulation system. Possible consequences of this process include acute kidney injury, organ failure, local or systemic hemorrhage, hypotension, rhabdomyolysis, and acute compartment syndrome.

Research on this toxin has led not only to the development of treatments for envenomation but also to pharmaceutical advancements, such as the production of Captopril and other therapies^{4,9}.

The first aid measures after a snakebite involve removing the patient from the site and transferring them to an appropriate medical center, immobilizing and resting the affected limb. Identifying the snake is advised only if it can be done in a safe environment without delaying medical attention, and it is recommended to take a digital photo for identification. Furthermore, it is advisable to remove jewelry from the affected limb due to the increased risk of compartment syndrome¹⁰⁻¹².

In the intrahospital setting, the approach involves managing vital signs, and paying attention to the risk of bleeding and shock (hypovolemia due to hemorrhage secondary to coagulopathy, toxin action, or edema of the affected area). The initial infusion of crystalloid solution may be initiated or advanced to blood transfusion based on laboratory parameters (complete blood count).

Specific treatment consists of early and targeted administration of anti-bothropic serum when the agent is suspected. Tropical countries with a high incidence of accidents involving venomous animals, such as Australia, use combined venom detection kits for this purpose, to identify the most likely animal. However, this test is not available in Brazil, and clinical methods are used for distinction¹⁰⁻¹².

Among the potential outcomes, compartment syndrome stands out due to its rapid progression and significant morbidity, including myonecrosis, limb amputation, neuropathy, and even death, although the reported incidence is low (6.6%)¹³. The majority of cases occur in the upper limbs, accounting for 69.6%, as observed in this report¹⁴.

The pathophysiology of compartment syndrome involves increased pressure within the muscle compartments, which are surrounded by fascia. This pressure surpasses the tissue perfusion pressure and obstructs venous return in the affected limb, resulting in ischemia and cellular damage.

Initially, there is disproportionate pain compared to the extent of the injury, as well as altered nerve conduction, leading to paresthesia and muscle

weakness when the compartment pressure exceeds 30 mmHg or when the diastolic pressure gradient within the compartment drops below 30 mmHg. Subsequently, ischemia develops, leading to tissue necrosis.

Monitoring can be done by directly measuring intracompartmental pressure or by assessing clinical parameters.

It is crucial to highlight that any tense and painful muscle compartment following an injury could indicate a potential compartment syndrome. Regular reassessments, specialized surgical evaluation, and subsequent compartment release are necessary in such cases^{15,16}.

Early fasciotomy, ideally within the first 4 hours of the onset of clinical symptoms, is the definitive treatment and reduces the need for amputations. Indications for the procedure include a strong clinical suspicion or measurement of compartment pressure to confirm the presence of acute compartment syndrome.

The surgery should be performed in a surgical center, but in cases where unstable patients cannot be transported, it may be beneficial to perform the procedure in an intensive care unit with mild sedation and local anesthesia. The objective is to carefully dissect the affected limb along specific planes, releasing the tight muscle fascia under direct visualization and subsequently relieving the compartment pressure. After the procedure, it is important to assess the integrity and appearance of the muscles while being cautious of reperfusion syndrome.

After resolving the compartment syndrome, it is necessary to consider options for reconstructing the operative wound. These options encompass early primary closure, gradual wound approximation (the "Lace Technique"), negative pressure therapy (NPT), and partial-thickness skin grafting¹⁶⁻¹⁹. According to the literature, no consensus on the best closure method has so far been reached¹⁹. Consequently, the chosen technique varies based on the surgeon's preference and the context in which the patient is placed²⁰.

In our case, the patient was not considered suitable for early primary closure as he was in the postoperative period with significant muscle herniation and a high risk of compartment syndrome recurrence¹⁸. The use of NPT and the gradual wound approximation technique was constrained by the requirement for an extended hospital stay^{17,20}.

These procedures were not feasible due to the context of the SARS-CoV-2 pandemic when all human and material resources were directed toward COVID-19 patients. Furthermore, NPT showed the additional limitation of its considerably high cost, particularly in hospitals lacking resources, such as those integrated

into the public health system (Brazilian Unified Healthcare System-SUS).

CONCLUSION

Accidents involving venomous animals, although categorized as neglected tropical diseases, remain highly prevalent in Brazil, resulting in low fatality rates but significant morbidity. One notable complication is acute compartment syndrome, a rapidly advancing condition that should be taken into account in such accidents. Early identification and treatment of this complication, with emphasis on regular reassessments by specialized medical care, are crucial for favorable outcomes. Although the literature recommends a maximum ideal time frame of 4 hours, the procedure was effective in preventing further morbidity in our patient, even being performed beyond the recommended timeframe.

Given the lack of consensus on the best technique, the surgeon's experience and the patient's context determine the most suitable approach. Furthermore, postoperative follow-up is crucial for identifying and treating potential late complications, including suture dehiscence, tissue necrosis, and scar contractures.

COLLABORATIONS

FAL	Conceptualization, Methodology, Project Administration, Realization of operations and/or trials, Supervision, Writing - Original Draft Preparation, Writing - Review & Editing.
MFI	Realization of operations and/or trials.
LFI	Analysis and/or data interpretation, Methodology, Realization of operations and/or trials, Writing - Review & Editing.
TTJ	Analysis and/or data interpretation, Conception and design study, Conceptualization, Supervision, Writing - Review & Editing.
GCB	Analysis and/or data interpretation, Methodology, Writing - Original Draft Preparation, Writing - Review & Editing.
AVS	Conceptualization, Methodology, Project Administration, Supervision, Writing - Original Draft Preparation, Writing - Review & Editing.
RLB	Conception and design study, Final manuscript approval, Realization of operations and/or trials, Supervision, Writing - Review & Editing.

REFERENCES

1. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. Boletim Epidemiológico [Internet]. Volume 53. Brasília: Secretaria de Vigilância em Saúde; 2022. Disponível em: <https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/edicoes/2022>
2. Brasil. Ministério da Saúde [Internet]. Série histórica de acidentes ofídicos - 2000 – 2022. Disponível em: <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/a/animais-peconhentos/acidentes-ofidicos/publicacoes/serie-historica-de-acidentes-ofidicos-2000-2022/view>
3. Graciano AR, Carvalho KCN. Síndrome compartimental associada a acidente ofídico por serpente do gênero *Bothrops*: relato de caso. Rev Pesq Saúde. 2017;18(1):54-6.
4. Gutiérrez JM, Calvete JJ, Habib AG, Harrison RA, Williams DJ, Warrell DA. Snakebite envenoming. Nat Rev Dis Primers. 2017;3:17063. DOI: 10.1038/nrdp.2017.63
5. de Silva HJ, Kasturiratne A, Pathmeswaran A, Laloo DG. Snakebite: the true disease burden has yet to be determined. Ceylon Med J. 2013;58(3):93-5.
6. Kasturiratne A, Wickremasinghe AR, de Silva N, Gunawardena NK, Pathmeswaran A, Premaratna R, et al. The global burden of snakebite: a literature analysis and modelling based on regional estimates of envenoming and deaths. PLoS Med. 2008;5(11):e218.
7. Pinho FMO, Pereira ID. Ofidismo. Rev Assoc Med Bras. 2001;47(1):24-9. DOI: 10.1590/S0104-42302001000100026
8. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. [boletim na internet]. Boletim Epidemiológico [Internet]. Volume. 50 n° 11. Brasília: Secretaria de Vigilância em Saúde; 2019 [acesso: 2020 Maio 30]. Disponível em: <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/a/animais-peconhentos/acidentes-por-abelhas/arquivos/boletim-epidemiologico-11-vol-50-mar-2019-acidentes-de-trabalho-por-animais-peconhentos-entre-trabalhadores-do-campo-floresta-e-aguas-brasil-2007-a-2017.pdf/view>
9. Waheed H, Moin SF, Choudhary MI. Snake Venom: From Deadly Toxins to Life-saving Therapeutics. Curr Med Chem. 2017;24(17):1874-91.
10. Severyns M, Nevière R, Resiere D, Andriamananaivo T, Decaestecker L, Mehdaoui H, et al. Case report: Bothrops lanceolatus snakebite surgical management - Relevance of fasciotomy. Am J Trop Med Hyg. 2018;99(5):1350-3.
11. Russell JJ, Schoenbrunner A, Janis JE. Snake Bite Management: A Scoping Review of the Literature. Plast Reconstr Surg Glob Open. 2021;9(4):e3506.
12. White J. Snakebite worldwide: Management. In: Danzl DF, Wiley JF, eds. Waltham: UpToDate; 2021. [acesso 2021 Dez 29]. Disponível em: <https://www.uptodate.com/contents/snakebites-worldwide-management>
13. Valente-Aguiar MS, Gonçalves da Costa E Silva B, Magalhães T, Dinis-Oliveira RJ. Compartment Syndrome following *Bothrops* Snakebite Leads to Decompressive Fasciotomies. Case Rep Med. 2019;2019:6324569.
14. Kim YH, Choi JH, Kim J, Chung YK. Fasciotomy in compartment syndrome from snakebite. Arch Plast Surg. 2019;46(1):69-74.
15. Hamdi MF, Baccari S, Daghfous M, Tarhouni L. Upper limb compartment syndrome after an adder bite: a case report. Chin J Traumatol. 2010;13(2):117-9.
16. Chung KC, Yoneda H, Modrall G. Pathophysiology, classification, and causes of acute extremity compartment syndrome. In: Butler CE, ed. UpToDate. Waltham: UpToDate; 2023. [acesso 2022 Jan 10]. Disponível em: <https://www.uptodate.com/contents/pathophysiology-classification-and-causes-of-acute-extremity-compartment-syndrome>.

17. Galli R, Baptista RR, Barreiro GC, Reis JOG, Fortes FSG, Ferreira MC. Tratamento cirúrgico dos defeitos complexos causados por acidentes por animais peçonhentos. *Rev Bras Cir Plást.* 2011;26(3):9.
18. Igoumenou VG, Kokkalis ZT, Mavrogenis AF. Fasciotomy Wound Management. In: Mauffrey C, Hak DJ, Martin III MP, eds. *Compartment Syndrome: A Guide to Diagnosis and Management.* Cham: Springer; 2019. DOI: 10.1007/978-3-030-22331-1_9
19. Alkhalifah MK, Almutairi FSH. Optimising Wound Closure Following a Fasciotomy: A narrative review. *Sultan Qaboos Univ Med J.* 2019;19(3):e192-e200. DOI: 10.18295/squmj.2019.19.03.004
20. Jauregui JJ, Yarmis SJ, Tsai J, Onuoha KO, Illical E, Paulino CB. Fasciotomy closure techniques. *J Orthop Surg (Hong Kong).* 2017;25(1):2309499016684724. DOI: 10.1177/2309499016684724

***Corresponding author:** Alexandre Venâncio de Sousa
Rua São Vicente de Paulo, 223, Centro, Jundiaí, SP, Brazil
Zip Code: 13201-625
E-mail: alexandrevenancio@gmail.com