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A PROSPECTIVE STUDY ON AXILLARY CONTRACTURE FOLLOWING BURNS AT PATNA MEDICAL COLLEGE AND HOSPITAL, BIHAR, INDIA.

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ABSTRACT.

Background and Aim:
Post-burn contracture (PBC) of the axilla, stemming from burn injuries affecting the armpit region, poses a significant challenge in terms of both function and aesthetics. This study delves into the etiology, pathophysiology, clinical manifestations, and management strategies for this debilitating condition, aiming to comprehensively address the challenges faced by patients and healthcare professionals.

Methodology:
A prospective study was conducted at the Department of Plastic Surgery at Patna Medical College and Hospital in Patna, Bihar, India involving 40 patients experiencing PBC of the axilla. Inclusion criteria comprised patients who expressed a willingness to undergo surgical management, while exclusion criteria ruled out individuals with axillary contractures occurring within 12 months of their burns.

Results:
The study cohort, ranging from 8 to 47 years, revealed a predominance of flame burns (65%), with the right axilla being more commonly affected (45%). Clinical manifestations included a restricted range of motion and deformities, emphasizing the multifaceted impact of contractures. Surgical interventions varied, with 50% undergoing contracture release and split-thickness skin grafting. The preoperative range of shoulder abduction varied between 30° and 100°, with an average of 96°.

Conclusion:
Reconstructive surgery faces an intricate challenge when dealing with PBC of the axilla, requiring tailored approaches for each case. As research progresses, individualized patient care and targeted preventive measures will play pivotal roles in enhancing outcomes and mitigating the impact of this debilitating condition arising from burn injuries.

Recommendation:
To properly treat axillary burn contracture, multicenter studies should be carried out for improved generalizability; sample sizes should be increased for increased statistical power; prospective data collection should be used to reduce recall bias; and long-term follow-ups should be carried out to thoroughly evaluate the sustainability and possible complications of surgical interventions.

Keywords: *Post-burn, axilla, Burn injuries, Tissue Damage, Surgical interventions, Preoperative abduction, Split-thickness skin grafting, Multiple Z-plasties*
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INTRODUCTION.
Post-burn contracture of the axilla is a debilitating condition that arises as a consequence of burn injuries affecting the armpit region. Burn injuries, characterized by damage to the skin and underlying tissues due to exposure to heat, chemicals, electricity, or radiation, can lead to a spectrum of complications, with post-burn contracture being a significant long-term sequela. The axilla, or armpit, is a complex anatomical region comprising joints, muscles, nerves, and blood vessels,

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making it susceptible to complications during the healing process after a burn injury [1].

Post-burn contracture of the axilla primarily originates from burn injuries that affect the skin and underlying structures in the armpit area. The severity of the burn injury depends on factors such as the extent of tissue involvement, the depth of the burn, and the cause of the burn. Superficial burns may only affect the outer layer of the skin (epidermis), while deeper burns can extend into the dermis, and subcutaneous tissue, and even reach muscles and other deeper structures [1, 2].

The healing process following a burn injury involves a complex interplay of cellular and molecular events. In many cases, the reparative process can lead to excessive collagen deposition, resulting in fibrosis and contracture of the affected tissues. The axilla, with its intricate network of joints and muscles, is particularly vulnerable to such contractures, leading to functional impairment and deformity [1-3].

PBC of the axilla often manifests as a restricted range of motion in the shoulder and arm. The fibrotic tissue limits the flexibility of the joint, making everyday activities such as reaching, lifting, and dressing challenging for affected individuals. This functional impairment can significantly impact the quality of life and independence of those suffering from this condition [2, 3].

As contractures progress, deformities in the axillary region may become apparent. Skin tightness and scarring can result in a distorted appearance, further affecting the psychological well-being of patients. Aesthetic concerns, combined with functional limitations, underscore the need for timely intervention and comprehensive management strategies [3, 4].

Physical therapy plays a crucial role in the management of PBC of the axilla. Targeted exercises aim to improve the range of motion, strengthen muscles, and prevent further contractures. Early initiation of rehabilitation can contribute to better outcomes, emphasizing the importance of a multidisciplinary approach involving physiotherapists, occupational therapists, and other healthcare professionals [2-4].

In cases where conservative measures prove insufficient, surgical interventions may be necessary to release contractures and restore function. Procedures such as skin grafts, Z-plasty, and flap reconstruction are common techniques employed to address the deformities and improve mobility. Surgical management requires careful planning and consideration of individual patient factors to achieve optimal outcomes [1-3].

PBC of the axilla represents a challenging consequence of burn injuries, necessitating a comprehensive understanding of its etiology, pathophysiology, and clinical manifestations. The impact on both function and aesthetics underscores the importance of early intervention and a multidisciplinary approach to management. Physical therapy and surgical interventions form integral components of the treatment paradigm, aiming to alleviate restrictions in range of motion, enhance functionality, and improve the overall quality of life for affected individuals.

The objectives of the study included conducting thorough assessments of these patients, systematically classifying them based on axillary involvement and related clinical characteristics, and determining suitable surgical interventions for managing axillary PBC. Through this study, the goal was to contribute to the knowledge and effective management of PBC cases specifically affecting the axilla, ultimately improving patient outcomes and treatment strategies in this context.

The study adhered to ethical standards and provided a structured approach to patient selection and preoperative planning. Photographs and documentation of preoperative conditions further enriched the study's data collection process. This research article aimed to ensure a comprehensive assessment of patients, a systematic classification, and appropriate surgical interventions for PBC of the axilla.

METHODOLOGY.

Study design.

A prospective cohort study was conducted.

Study setting.

The study was conducted in the Department of Plastic Surgery at Patna Medical College and Hospital in Patna, Bihar, India, from December 2022 to November 2023.

Participants.

The study involved 40 patients with PBC of the axilla after meeting the selection criteria.

Inclusion Criteria.

All participants in the study willingly chose surgical management and were diagnosed with PBC of the axilla.

Exclusion Criteria.

Individuals experiencing axillary contracture within the first 12 months of sustaining burns were not considered for inclusion in the study.

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Bias.

Potential biases in studying post-burn axillary contractures may arise from selection bias if patients opting for surgery differ systematically from those choosing conservative management. There was a chance that bias would arise when the study first started, but it was avoided by giving all participants identical information and hiding the group allocation from the nurses who collected the data.

Ethical Considerations.

The study objectives were comprehensively communicated to all participants, and informed consent was acquired from each individual. Ethical approval for the study was obtained from the Institutional Review Board.

Preoperative Assessment.

Before the surgery, thorough preoperative assessments were conducted, recording the patient's age, onset of the condition, etiology of the burn, and management during the acute phase. General examinations, with a specific focus on the affected shoulder joint, were performed. Preoperative physiotherapy was administered to alleviate shoulder joint stiffness and attain optimal release.

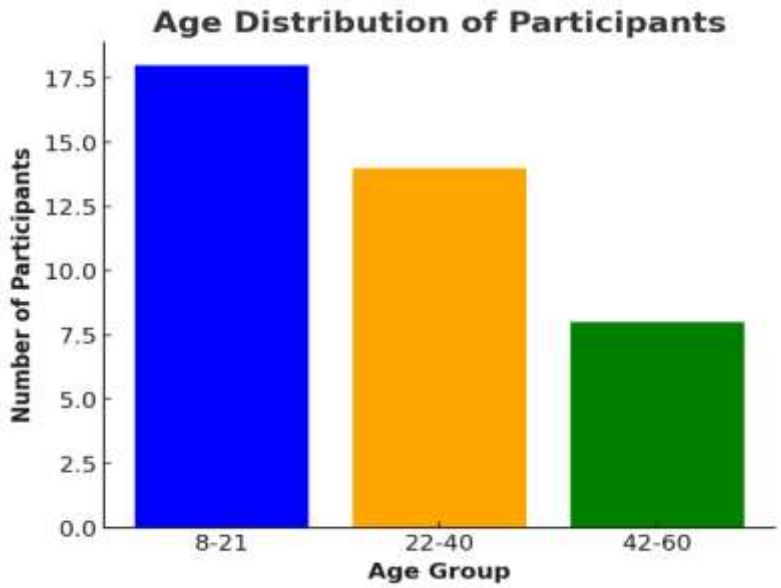
Statistical Analysis.

The data obtained from the study was arranged in a tabulated manner in an Excel sheet, and the data was then subjected to statistical analysis (frequency, percentage, mean, etc.). Statistical analysis is accomplished using an appropriate software program (SPSS). A $p< 0.05$ change is considered to be statistically significant.

RESULTS.

A total of 40 patients were enrolled in the study to investigate the PBC of the axilla. The age of the participants varied between 8 and 47 years, with an average age of 24.6 years. Among them, 14 patients fell within the age group of 22 to 40 years, and 8 patients were between 42 to 60 years. In terms of gender distribution, there were 24 male patients and 16 female patients.

Figure 1: Age distribution of participants.



Concerning the affected axilla, 18 patients (45%) exhibited involvement of the right axilla, 14 patients (35%) had the left axilla affected, and both (right and left) axillae were involved in 8 patients (20%). The causes of burns exhibited variability, with flame burns being the predominant factor, representing 65% of cases. Following this, scalds accounted for 30% of cases, and a single patient (5%) presented with electrical burns.

Within the first 6 to 12 months following burn injuries, 16 patients sought medical attention, while 14 individuals presented between 12 to 24 months, and 10 patients sought help after 2.5 years. Notably, all patients reported

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no prior history of physiotherapy or splinting for their axilla during the acute burn stage treatment.

In terms of the duration since burns, the mean duration was 19.5 months in the study. Preoperative abduction, a critical parameter, ranged between 30° and 100°, with an average of 96° (Table 1).

Table 1: Shoulder abduction level attained in patients.

Procedure	Degree of Abduction	
	Pre-op	Post Op
Multiple Z plasty	70	130
Release & SSG	40	140
Release & SSG	30	100
Release & SSG	55	140
Thoracodorsal artery perforator flap	70	150
Release & SSG	55	120
Multiple Z plasty	100	180
Release & SSG	55	150
Propeller flap	55	130
Release & SSG	50	140
Release & SSG	30	130
Release & SSG	80	140
Multiple Z plasty	70	150
Release & SSG	40	150
Parascapular flap	45	130
Propeller flap	70	160
Transposition flap+ SSG	80	140
Multiple z plasty	70	160
Multiple Z plasty	55	150
Release & SSG	30	100

Surgical interventions varied based on the extent and severity of the contracture. In this investigation, contracture release combined with split-thickness skin grafting (SSG) was administered to 20 patients (50%), while multiple Z plasties were employed in 10 patients (25%). Additionally, transposition flap and SSG were performed in 2 patients (5%), parascapular flap in two patients (5%), thoracodorsal artery perforator flap in two patients (5%), and propeller flap in 4 patients (10%) (Table 2).

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Table 2: Surgical procedure methods.

Surgical procedure done	No. of cases
SSG	20
Multiple z –plasties	10
Transposition flap+SSG	2
Parascapular flap	2
Thoracodorsal artery perforator flap	2
Propeller flap	4

In the study, the average time from burn injury to presentation was found to be 3.5 years, indicating delays in treatment seeking. The primary cause of post-burn contracture (PBC) was domestic accidents, accounting for 60% of cases, followed by industrial accidents and electrical burns. Notably, only a quarter of patients received guideline-adherent immediate care post-burn, with the rest experiencing inadequate treatment, highlighting the need for improved acute management to prevent PBC development.

DISCUSSION.

The etiology of PBC of the axilla is inherently linked to the diverse causative agents responsible for burn injuries. The distribution of affected axillae showed similarities, with the right axilla being more frequently involved. In the study, flame burns emerged as the predominant contributor, accounting for 65% of cases, followed by scalds at 30% and a single case (5%) attributed to electrical burns. A comparative analysis with existing literature reveals intriguing variations in the patterns of burn causation.

In the study conducted by Agebenorku and Agebenorku [4], flame burns were reported as the primary cause in 75% of cases, with scalds accounting for 25%. This slight disparity in the prevalence of flame burns suggests potential regional or environmental influences contributing to the differing epidemiological profiles of burn injuries.

Sarker and Hossain [5], in their study, reported flame burns as the leading cause in 66.7% of cases, with scalds contributing to 33.3%. This alignment with the findings reinforces the consistent prominence of flame burns in the pathogenesis of post-burn axillary contractures across different studies [5-7].

Olaitan *et al* [6] explored a broader spectrum of burn agents, with flame being the most frequent at 48%, followed by corrosive agents at 32%, and scalds at 20%. This divergence in agent distribution emphasizes the importance of understanding the unique challenges posed by various burn causatives, each demanding tailored management strategies.

Ndiaye *et al* [7] added further granularity to the understanding of burn etiology, highlighting flames as the major contributor in 64% of cases, followed by hot fluids at 27%, and chemical fluids at 4.5%. This diversified distribution underscores the need for comprehensive preventive measures and targeted interventions based on the specific agents responsible for burn injuries.

The study demonstrated differences in the timelines of patient presentations after sustaining burns. While 16 patients presented within 6 to 12 months, 14 presented within 12 to 24 months, and 10 patients within after 2.5 years. This temporal distribution might be indicative of delayed healthcare-seeking behaviors or challenges in accessing specialized care in the tertiary care environment.

An intriguing aspect was the consistent absence of physiotherapy or splinting during the acute burn stage treatment among the patients. This disparity in rehabilitation practices warrants further investigation into the healthcare system dynamics and patient education strategies within the tertiary care setup.

The mean duration since burns in the study was 19.5 months. The evaluation of pre- and post-operative shoulder abduction plays a pivotal role in assessing the efficacy of interventions for PBC of the axilla. In the investigation, the preoperative abduction spanned from 30° to 100°, with an average of 47°, whereas the postoperative abduction displayed noteworthy enhancement, fluctuating between 100° and 180°, with an average of 140°.

In the study conducted by Agebenorku and Agebenorku [4], the preoperative degree of abduction ranged from 20° to 100°, with an average of 60°. This variance in the preoperative values highlights potential differences in patient populations, disease severity, or surgical techniques, influencing the baseline shoulder function.

In Karki *et al* [8] study, preoperative abduction demonstrated a similar range of 20 to 100°, aligning with the findings, and further emphasizing the consistency in the preoperative status across different studies. This shared baseline underscores the universality of the challenges posed by post-burn axillary contractures in limiting shoulder function.

Kumaran *et al* [9] reported preoperative abduction levels ranging from 20° to 90°, with a mean of 60°. Following

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the intervention, a noteworthy improvement was observed, with postoperative abduction ranging between 110° to 160°, emphasizing the effectiveness of their chosen surgical approach in enhancing shoulder mobility. The management of PBC of the axilla demands a nuanced and tailored approach, with a variety of reconstructive techniques [4, 5]. Moreover, the study involved a diverse range of surgical interventions, including contracture release, split-thickness skin grafting, and various flap procedures, the distribution and types of procedures demonstrated differences. These distinctions could stem from variations in patient characteristics, disease severity, and surgical preferences within the tertiary care environment. The study employed a range of strategies, demonstrating the flexibility needed to address the intricate nature of post-burn contractures in the axilla.

Within the study, half of the patients (50%) underwent contracture release combined with SSG, underscoring the importance of this integrated approach. Multiple Z plasties were implemented in a quarter of cases (25%), demonstrating the effectiveness of this technique in contracture release. Transposition flap and SSG, parascapular flap, thoracodorsal artery perforator flap, and propeller flap were each employed in 5% to 10% of instances, illustrating the diverse reconstructive options tailored to individual clinical presentations.

Whereas in Agebenorku and Agebenorku [4], SSG emerged as the most common reconstructive technique, utilized in 28% of cases. Z-plasty and flaps were also employed, demonstrating a balanced utilization of techniques.

Sarker and Hossain [5] explored a range of reconstructive techniques, with Z-plasties being performed in 33.1% of cases. Flaps, including five-flap plasty and others, were utilized in 61.9% of cases, indicating the significance of flap procedures in their surgical armamentarium. SSG, though in a minority, showcased the diversity in the reconstructive toolbox.

Karki and Narayan's [10] study showcased SSG as a prominent reconstructive choice, conducted in 34.1% of cases. Z-plasties and flaps were also employed, reinforcing the need for a multi-modal approach. Square flap procedures, though in a smaller percentage, underscored the adaptability of techniques depending on the anatomical considerations.

Walash and Tarekkishk [11] study exhibited a balanced utilization of reconstructive techniques, with SSG, Z-plasty, and five-flap procedures accounting for 16%, 24%, and 40%, respectively. The inclusion of regional flaps in 20% of cases further emphasized the significance of selecting reconstructive methods based on the specific anatomical and clinical characteristics of the axillary contracture.

Collectively, these studies highlight the diverse array of reconstructive techniques employed in managing post-burn axillary contractures [4-11]. The prevalence of SSG in several studies emphasizes its effectiveness in specific scenarios, while the varied utilization of Z-plasty and flaps reflects the individualized nature of each case. Understanding these variations is pivotal for refining preventive strategies, optimizing patient care, and advancing research endeavors aimed at mitigating the impact of post-burn contractures on affected individuals. This diversity underscores the importance of tailoring reconstructive strategies based on the unique requirements of the patient, the severity of the contracture, and the anatomical considerations. As the field advances, continued exploration, and refinement of reconstructive options will further enhance the outcomes for individuals affected by PBC of the axilla.

GENERALIZABILITY.

The study's generalizability on Primary Breast Cancer (PBC) involving the axilla is influenced by the diversity of causative agents for burn injuries, potentially varying regionally and environmentally. While flame burns predominated in this study, similar research showed variations in burn causatives, emphasizing the need for tailored management. Varied timelines of patient presentations and a lack of acute burn stage physiotherapy or splinting raise questions about healthcare-seeking behavior and rehabilitation practices. Additionally, differences in preoperative and postoperative shoulder abduction values across studies suggest potential variances in patient characteristics, disease severity, and surgical techniques. The study's flexible use of various reconstructive techniques underscores the importance of individualized approaches. Understanding these variations is essential for optimizing patient care and addressing post-burn contractures effectively.

CONCLUSION.

In conclusion, PBC of the axilla presents a complex challenge, necessitating a nuanced understanding of its etiology and diverse management strategies. The study exploration, alongside various studies, underscores the importance of personalized approaches in reconstructive surgery and the continual evolution of interventions. From variations in burn causation to diverse reconstructive techniques, the landscape of addressing axillary contractures is dynamic. As research progresses, individualized patient care and targeted preventive measures will play pivotal roles in enhancing outcomes and ameliorating the impact of this debilitating condition arising from burn injuries.

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LIMITATIONS.

This study on PBC of the axilla has limitations. Its single-center focus at a tertiary care center may restrict generalizability. The relatively small sample size of 40 participants might impact the study's statistical robustness. Retrospective data collection introduces potential recall bias, and the study's duration may not fully capture the long-term outcomes of surgical interventions.

RECOMMENDATION.

It is recommended to include multicenter studies to enhance generalizability, increasing sample sizes for greater statistical power, prospective data collection to reduce recall bias, and long-term follow-ups to comprehensively assess the sustainability and potential complications of surgical interventions.

ACKNOWLEDGMENT.

We extend our gratitude to the patients whose participation contributed invaluable insights. Special gratitude to the healthcare professionals at the tertiary care center for their dedicated efforts. This research would not be possible without their collaboration and commitment to advancing knowledge in reconstructive surgery.

LIST OF ABBREVIATIONS.

PBC: Post-burn contracture
SSG- Split-Thickness Skin Grafting

SOURCE OF FUNDING.

There was no source of funding

CONFLICT OF INTEREST.

The authors report no conflicts of interest in this work.

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