GHANA COLLEGE OF PHYSICIANS AND SURGEONS

FACULTY OF SURGERY

FUNCTIONAL OUTCOME BETWEEN THE USE OF Z-PLASTY AND FULL THICKNESS SKIN GRAFTING IN THE RELEASE OF AXILLARY CONTRACTURES AT KOMFO ANOKYE TEACHING HOSPITAL (KATH) -KUMASI, GHANA.

Submitted to the Faculty of Surgery, in partial fulfilment of the requirements for the conferment of a Fellow of the Ghana College of Surgeons (FGCS)

By

KWADWO ADAE-ABOAGYE

(GS/12/18/011/F)

SEPTEMBER, 2023

DECLARATION

I, Kwadwo Adae-Aboagye, do hereby declare that, with the exception of the references used, which has been duly acknowledged, the work done in this research has been of my own composition and that no part of this work has been used in any other publication, or academic work other than for the purpose of the fellowship examination. I hereby state clearly that I am solely responsible for the content of this dissertation.

…… ……

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CERTIFICATION BY SUPERVISORS

We, the undersigned, attest that this dissertation, titled **"FUNCTIONAL OUTCOME BETWEEN THE USE OF Z-PLASTY AND FULL THICKNESS SKIN GRAFTING THE RELEASE OF AXILLARY CONTRACTURES AT KOMFO ANOKYE TEACHING HOSPITAL, KUMASI"** was carried out by Kwadwo Adae-Aboagye under our supervision in fulfilment of the requirements for the fellowship of the Ghana College of Surgeons**.**

……. **……..**

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ABSTRACT

Axillary post-burn scar contracture is a challenging problem to the reconstructive surgeon owing to the wide range of movement with respect to the shoulder joint. Axillary post-burn contracture is disturbingly common and severe in developing countries and a significant problem in developed nations as well. Age related injuries abound as well as possible gender disparities. Most injuries have been found to be domestic related and when diagnosed, intervention need to be instituted at the earliest opportunity.

The aim of this study was to compare the functional outcome between the use of z- plasty and the use of skin grafting in the release of axillary contractures in patients presenting to the Komfo Anokye Teaching Hospital (KATH), Kumasi, Ghana.

Methods: The study was longitudinal, prospective and comparative to assess the functional outcome of axillary contractures release of patients presenting to Komfo Anokye Teaching Hospital, Kumasi. Study subjects included patients with axillary contractures presenting at KATH over a period of one (1) year.

Data management and analysis: Data was collected from the patients, using a case reporting form, after informed consent was sort, coded and analysed with SPSS software. Outcome of the study was presented in tables and charts and Chi-square and these were used to establish the relationship between dependent and independent variables to test the hypothesis.

Results: The median age for the sampled data was 13.5 years with 58% females and 42% males. The commonest aetiology was flame burns (50%), scald injury (31.6%), chemical burns (10.5%)and electrical burns (7.9%). The median angle changed from a mean of 92.9 degrees pre-operatively to 175 degrees immediate post-operatively, 170 degrees at two (2) weeks and 168

degrees at four (4) weeks post-operatively. With a p-value of 0.72 at the end of the study, the difference in change in abduction when the two modalities were compared was found not to be statistically significant.

Conclusion: The functional outcomes achieved in using z-plasty or full thickness skin grafting in the release of post-burns anterior and posterior axillary contractures are comparable and can be employed interchangeably.

Keywords: Axillary contracture, release, z-plasty, skin grafting, functional outcome.

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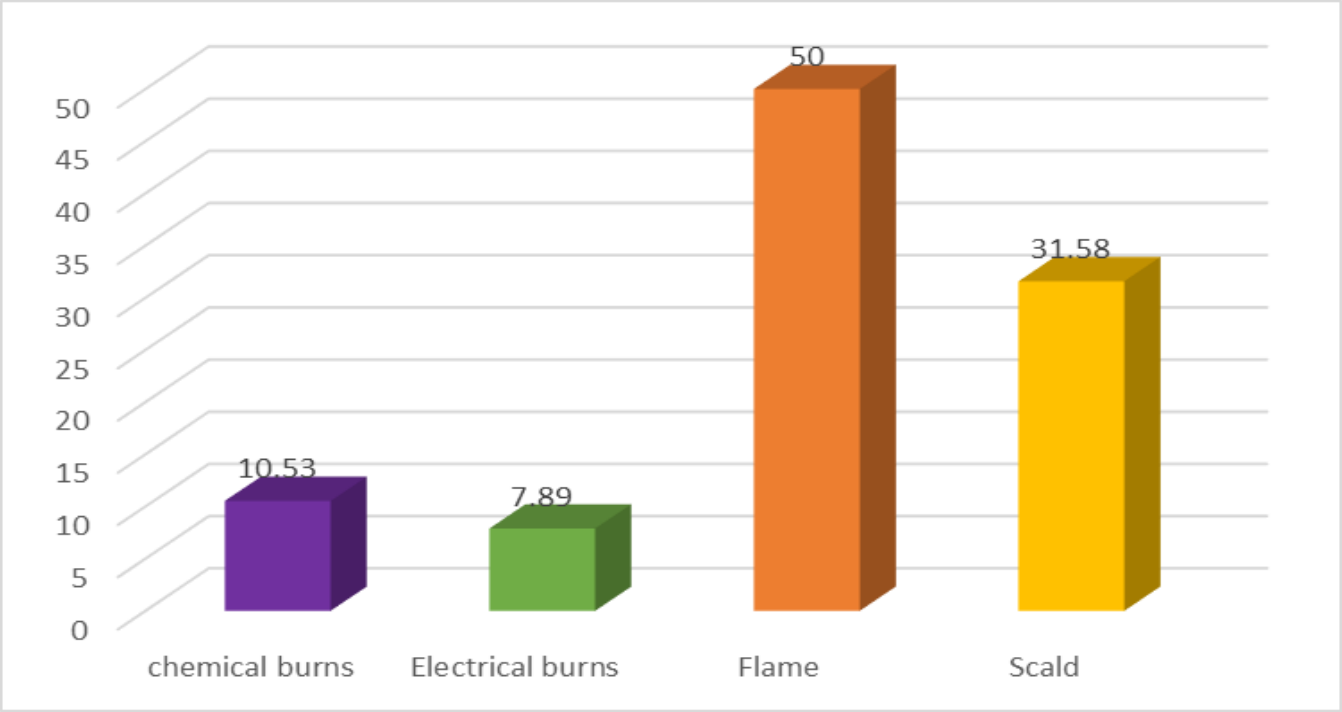

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CHAPTER ONE

INTRODUCTION

1.1 Background

Burn injuries are one of the most devastating trauma that one might have the unfortunate chance of experiencing. They can result in high mortality rates even before care can be instituted. Although studies have reported a decrease in the rate over time the numbers are still high with the extremities of age being the most affected and women affected more than men[1]. This burden is typically high in the low to middle income countries with very high mortality rates ranging between 1.0 to 4.5 per 100000 per year from first world to third world countries respectively[2].

One of the most common unintended injuries worldwide is burns. A burn, according to the International Society of Burn Injuries, is an organic tissue injury to the skin or other organs that is primarily brought on by thermal or other acute trauma. Burns happen when scalds, contact burns, or flame burns decimate some or all of the skin's cells or those of other soft tissues. Burns also refer to wounds caused by radiation, radioactivity, electricity, friction, or chemical contact to the skin or other organic tissues. An estimated 6 million people worldwide seek medical attention each year for burns, the majority of them in outpatient clinics. Typically, the level of burn severity determines whether a patient is treated in a specialized burn unit[3].

The aetiology of burns ranges from thermal, electrical, chemical, radiation and in mostly the temperate countries, cold related burns. Thermal burns as a universal set has the basic subset of either dry heat (flame burns, contact burns) or liquid (scald) burns.

Whatever the cause of the burn injury, wound infection with resultant sepsis, respiratory tract complications from inhalational injuries, limb amputations, psychosocial morbidity, mortalities and contractures are some of the complications resulting from them. The face (head), the trunk (especially in females), the groin, the extremities and joint areas affected by burns can result in severe impairment of mobility.

Thermal burns occur in both the domestic and industrial settings and the initial management starts from the site of injury, through to the primary care facility to the secondary or tertiary site where

management is most often completed. The effectiveness of management at any of these sites can often determine the sequelae of any complications that eventually occur. Thermal burns to joints can be especially debilitating since if not well managed, could lead to functional impairment, a costly complication. Most often than not in the primary care setting, the burn wound is allowed to heal by secondary intention with little or no formal physiotherapy instituted. In the tertiary care site, even with skin coverage of the wound, the pain associated with early mobilization leads to low compliance to early physiotherapy and eventual restrictive scarring and consequently impaired mobility.

A contracture is defined as a scar across a joint which causes limitation of movement about that joint. They form during the proliferation and remodelling phase of wound healing when there is joint immobilization for lengthy periods of time, or when physiotherapy is not instituted early.

Scarring at these joints can involve the skin and subcutaneous tissue alone, or in combination with muscle and tendons

Contractures are classified based on the tissues involved and also the location with mentosternal contractures(neck), metacarpo-phalangeal contractures(hand), and axillary contractures.

Contractures pose problems with burns to the upper limbs and when not effectively managed in the early stages of the injury leads to remarkable limitation in the function of the limb and in some cases, socially unsightly scarring. Due to the exceptional configuration of the axilla, burns with resultant scarring pose a challenge when surgical management is to be instituted. In most instances the conventional management is the regimen of choice to achieve wound cover for burn injury to the shoulder region in our locality. Scarring to the shoulder joint following burns leads to limitation in joint mobility and thence restriction in daily activities of living (bathing, eating, etc.)[4].

Burns to the axillary fossa, no matter the extent can result in marked functional restriction. Inadequate immobilization of the joint, or post injury physiotherapy consequently results in very grave and limiting contractures of the affected limb[5]. Axillary scarring is a constant challenge due to abduction of the arm against resistance from a matured contracture. This can however be

circumvented if during the early phase of management, the shoulder is immobilized, and active rehabilitation is instituted when wound healing occurs.

Classification of post burns contractures varies depending of the location, anatomy and morphology of the contracture and varying modalities exist for the management of such ranging from non-operative management to surgical interventions. Surgical interventions take into cognisance the options on the Reconstructive ladder and elevator in administering the appropriate treatment protocol. It may be possible to have different options for one type of contracture and as such operator preference could play a role.

Most joints involved in contractures do not have the unique configuration of the shoulder joint in that, it is the only joint system that has two folds, anterior and posterior, traversing the joint. Any treatment modalities must therefore aim to maintain or restore these folds.

The Morphological African Scar Contracture Classification Algorithm classifies contractures generally into four (4) types bases on three (3) categorization: narrow or wide; long or short and high or low (Figure 1.1). Modalities available are ascribed to these classification types.

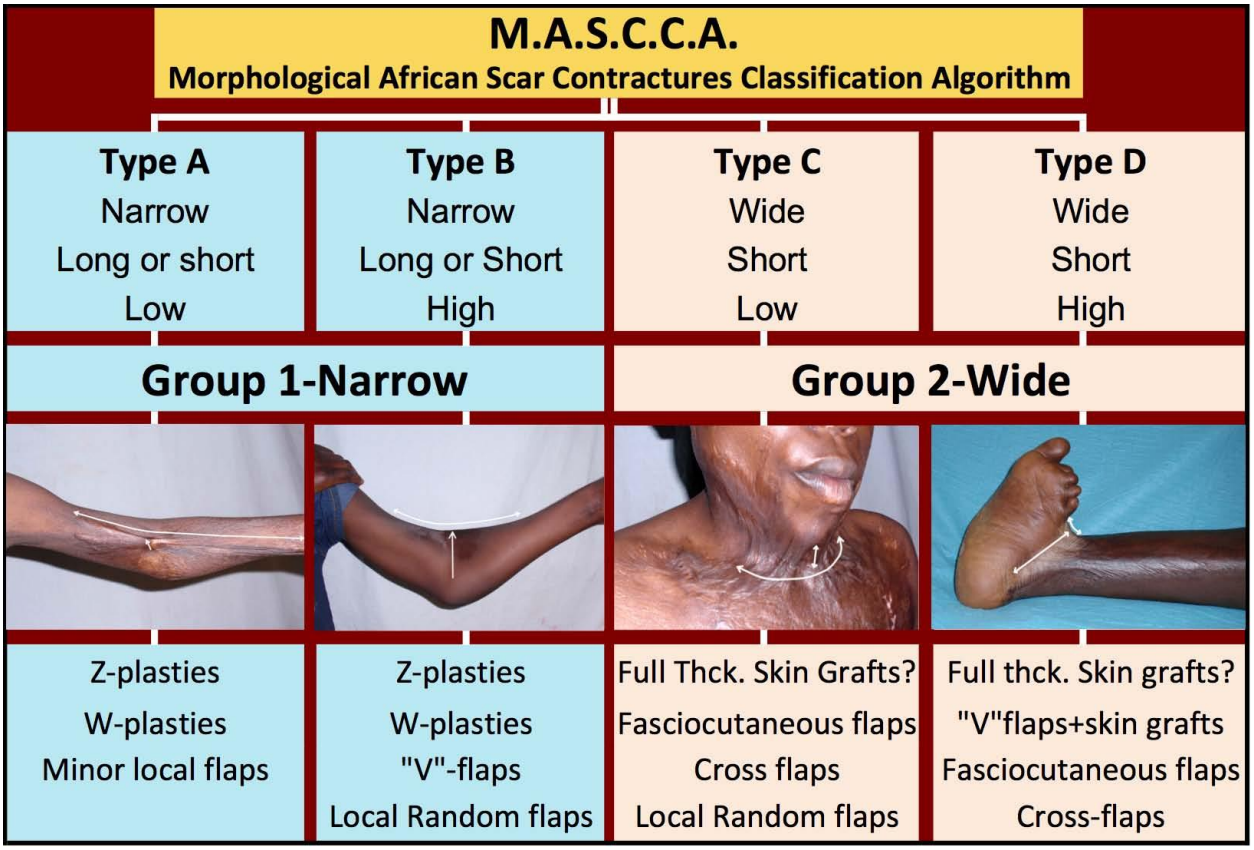

Figure 1.1: MASCCA classificationFigure 1.1: MASCCA classificationFigure 1.1: MASCCA classificationFigure 1.1: MASCCA classificationFigure 1.1: MASCCA classificationFigure 1.1: MASCCA classificationFigure 1.1: MASCCA classificationFigure 1.1: MASCCA classification

Source: 2nd-chance.org

The classification system for axillary contractures varies from anatomical or morphological, to functional and these have an effect on the modality used in their management.

Studies done worldwide do not stress enough the need for urgent operative intervention of axillary scarring on presentation to the health facility and this could prevent complications to the muscles and bone and even surrounding healthy tissues. It is based on anatomy and the integrity of surrounding tissue that a classification was made and possible surgical modality prescribed.

For simple scarring, with little or no surrounding tissue involvement , z-plasty or advancement techniques were prescribed whereas with involvement of both folds and the axillary dome with surrounding tissue involvement, single and double incisional releases were made[6].

The skin coverings of the neck and axillary regions of the human body are incredibly flexible and distributed in various surface planes, making them extremely mobile body parts. Damage to these

locations due to trauma runs the risk of causing severe tissue contractures, which will significantly restrict joint movement. Although the shoulder divides the two regions, their distance is not large, and a burn injury to one region is frequently accompanied by a similar injury to the other. In the worst cases, the contracture extends in a slightly curved line from the chin through the shoulder to the anterior fold of the axilla. Therefore, in an attempt to address these two regions together the

These contractures were either formed as the results of untreated or poorly treated burns, or either untreated or improperly treated burns caused these contractures, or the patients tended to produce hypertrophic scars. The majority of scars were recent (within three months of the day that full epithelialization following an acute burn), although 1.5% of patients had contractures that had persisted for l–10 years[7].

Thermal or chemical injuries are not distinctive in their characteristics or results, albeit the degree of scarring occasionally influences the degree of limits. There is frequently crossover between many categories.

Depending on the degree of scarring, Toet and Bosse divided post-burn axillary contractures following that done by Yang et al. into three kinds as follows:

Type I: The normal skin is present in the centre area with hair, but both the anterior and posterior axillary folds are affected. Throughout the abduction process, a web develops.

Type II: One axillary fold, the inner section of the upper arm, and the nearby trunk are all affected.

Type III: A single mass of U-shaped hypertrophic scar that entirely covers the upper arm and lateral portion of the trunk[8].

Kurtzman and Stern's classification is based purely on the site of the scar with respect to the anatomy of the axilla[6]. Hence:

Type I –Scarring of either of the axillary folds

IA – Anterior fold (Figure 1.2, Figure 1.3)

IB – Posterior fold (Figure 1.4)

Type II – Scarring of both anterior and posterior folds

Type III – Involvement of the axillary dome

Figure 1. 2: Type IA axillary contracture

Source: Plastic surgery theatre, KATH. 2023

Figure 1. 3: Type IA axillary contracture (posterior view)

Source: Plastic surgery theatre, KATH. 2023

Figure 1. 4: Type IB axillary contracture

Source: Plastic surgery theatre. KATH, 2023

When skin grafting for full thickness burns is done quite early, the tendency for contractures to develop becomes minimal. The goal therefore of surgical intervention of already formed scars of the armpit and surrounding soft tissues is to give the maximum functional benefit whilst at the same time reducing the effect on the local anatomy [5, 9]. When the decision to intervene is finalized, the procedure of choice must always be customised. A variety of traditional treatment options employed in the management of axillary contractures includes multiple Z-plasties, skin grafting, and local flaps[4, 10, 11, 12].

The conventional protocol has always been to wait for scar maturity before effecting release but a research done at the Burns institute in Cincinnati over a two (2) years period from 1988 to 1989

studied early scar release and their post-operative functional improvement in terms of flexion-extension and concluded there was final outcome were no different when compared to procedures done although functional deficit was worse in the less mature contractures. The final report controversially maintained immature scars could be released early[13].

The main discrepancy of axillary contractures is the rigid nature of the anterior and posterior folds which antagonizes effective movement of the arm with respect to the shoulder joint. In addition to the inflexible folds created by the scar, two distinct features that need to be taken into consideration when deciding on the surgical intervention is the integrity of the surrounding skin and the fossa of the armpit which is hair-bearing[10, 14]. While a retrospective study of axillary contractures managed in three separate health facilities in Ghana, one of which was a tertiary hospital was done, it was noted that contracture release with skin graft had the highest re-contracture rate[10].

In a study conducted on the different techniques used to release contractures of the axilla caused by burns, the preferred procedure was chosen on the basis of the integrity of the adjacent skin and the pattern of the scar Z-plasty was the technique concluded upon on account of its simplicity [5].

The purpose of this study was to describe the surgical management and results for post-burn contractures in various areas of the upper extremities in children, and to provide a final decision algorithm that can serve as a useful manual for the resident regarding surgical approach to contracture management. The study, performed in Pristina, Kosovo was retrospective, between 2014 and 2016. 2019 saw checkups for every instance. In order to determine the viability and healing of the repaired area, follow-ups were done for at least six months. The study included patients with upper extremities post-burn contracture of both sexes, aged 0 months to 18 years[15].

This study intends, therefore to compare the functional outcome between the use of z-plasty and skin grafting in the release of axillary contractures of patients presenting to Komfo Anokye Teaching Hospital, Kumasi-Ghana for a period of one year to ascertain the best procedure in respect to patient compliance, availability of logistics, cost, feasibility, re-contracture and functional outcome.

1.2 Rationale for study

Currently, surgeons use different modalities in the release of Kurtzman types I and II axillary contractures, the commonest being either skin grafting or z-plasty. The criteria for choosing a particular modality are subjective at best. Surgeon's preference, ease of procedure, and timing are some of the factors guiding the choice of procedure. There is as such, no scientific basis to guide such choices. To this end it would be useful to build a protocol governing the choice of procedure in this regard based on sound scientific footing. The purpose of this study was therefore to ascertain the best procedure available when planning for release of contractures of the axilla. Types I and II post burns axillary contractures were appropriate for this study due to the relative simplicity of the scar formed and the fact that any of the modalities can be applied to release them

1.3 Aims of study including definition of research problem

1.3.1 Research Problem

There are different procedures available for contracture release. As yet it is not certain, with respect to the axilla, the appropriate one to opt for depending on the extent of injury and with respect to anatomy, modality to be used is not site specific.

1.3.2. Aim of Study/Main Objective

To compare the functional outcomes between use of full thickness skin grafting and use of Z-plasty in the release of Kurtzman types IA and IB post burns axillary contractures of patients presenting at the Komfo Anokye Teaching Hospital (KATH), Kumasi-Ghana.

1.3.3. Specific Objectives

1.To evaluate the socio-demographic features, and aetiology of burn injury of patients with post burn axillary contracture.

2. To measure the angle of arm abduction pre- and post- operatively.

3. To demonstrate, if any, the advantage of one modality over the other with respect to post-operative arm abduction.

4. To assess the complications associated with each modality within the study period.

1.3.4. HYPOTHESIS

Null Hypothesis (H_0): There is no difference in outcomes between the use of z-plasty or full thickness skin grafting in the release if types IA or IB post burns axillary contracture.

Alternative Hypothesis ($H_{a)}$: There is a difference in outcomes in using either z-plasty or full thickness skin grafting to release types IA or IB post burns axillary contracture

Outcome measure: The angle in arm abduction of the upper limb before and after the procedure to be measured using a goniometer

CHAPTER TWO

LITERATURE REVIEW

2.1 Relevant anatomy

The axilla is a pyramid-shaped gap between the arm and the upper portion of the thoracic wall. Depending on where the arm is, it takes on a variety of shapes and sizes. As a result, when the arm is entirely abducted, it almost vanishes. The arteries and nerves from the neck travel through the axilla to the upper limb. According to accepted anatomy, the axilla has an apex, a base, and four walls, three of which are made up of muscles.

Apex: This refers to the transition area between the highest point on the axilla and the lower region of the neck. Its components, which are all bones, are the first rib on the medial side, the top edge of the scapula and the medial face of the coracoid process on the posterior side, and the clavicle on the anterior side. From the neck to the upper limb, the arteries and nerves pass via the apex, and the veins and lymphatic vessels travel in the opposite direction.

Base: This imagined downward-turned surface corresponds to the skin and thick fascia axillaris layer between the inferior edges of the pectoralis major muscle (anterior axillary fold) anteriorly and the latissimus dorsi posteriorly. It is wide at the thorax and thin at the arm (posterior axillary fold).

The muscles of the pectoralis major and minor comprise the anterior wall. Only the middle section of the pectoralis minor is included in the wall, but the entire pectoralis major is. The clavipectoral fascia fills the space between the pectoralis minor muscle's upper boundary and the clavicle, and the suspensory ligament of the axilla fills the space between the pectoralis minor muscle's lower margin and the dermis at its base (suspensorium axillae ligament). The costocoracoid ligament or Halsted's ligament (terms not recognized by the anatomical language) thickens the more cranial part of the clavipectoral fascia and runs from the first costosternal articulation to the coracoid process of the scapula.

The teres major and latissimus dorsi muscles make up the posterior wall, which is composed of its lower portion and the subscapularis muscle in its higher portion.

The first four ribs and associated intercostales muscles, as well as the top half of the serratus anterior muscle, make up the medial wall.

The tendon of the long head (caput longum) of the biceps brachii muscle and, more medially, the coracobrachialis muscle constitutes the lateral wall, which is where the anterior and posterior walls converge laterally towards the humerus.

In a study published in 2001 to assess the development of the human shoulder joint, fetal joints at various stages of development were compared to corresponding structures in the adult joint. It was discovered that the shoulder joint underwent significant developmental changes during the 12th week of the foetus' life, and it is presumed that genetic influences acting at this time were more significant than mechanical ones. The intracapsular glenohumeral ligaments had continued to mature by the 16th week. The three glenohumeral ligaments, the biceps tendon, and the glenoid labrum together made up a full ring around the glenoid fossa have a role in the function[16].

The acromion's form and slope both showed very little change. Compared to the shoulder of an adult, the coracoid was significantly bigger. At this stage of growth, the distinct anterolateral and posteromedial bands of the coracoacromial ligament were clearly visible. The inferior glenohumeral ligament was observed to be a conspicuous thickening of the capsule, but the intermediate and superior glenohumeral ligaments were thinner and more challenging to distinguish as separate structures. Histological analysis revealed that the inferior glenohumeral ligament is made up of numerous layers of well-organized collagen fibres. The labrum and glenoid border received insertions from the inferior glenohumeral ligament. In the area above the inferior glenohumeral ligament, the capsule was significantly thinner[17].

The skin creases on the trunk have distinct, thick bundles of collagen fibres that resemble beehives with a broad attachment to the dermis and denser at deeper locations connected to the fascia of the underlying muscle. In the papillary dermis and the reticular dermis, the elastic fibres radiate in a parallel pattern that matches the collagen pattern. Such structure is absent in the skin around the wrinkles[18].

2.2 Contractures

Contractures are an abnormal condition that develops after a significant amount of skin is injured and removed, leaving a scar[19]. The skin's edges are pulled together by the scar formation, resulting in a constricted area[20]. The muscles, joints, and tendons may then become less mobile as a result of the skin's shrinkage[21]. Contractures can be treated surgically in a variety of ways(Figure2.1). Deep burn injuries frequently result in contracture, particularly in low- and middle-income nations[22]. Axillary contracture can be particularly difficult and have a negative effect on the patient's quality of life[21]. The ideal time to treat burn contracture is at least a year after the accident, when the scar has had time to mature[23]. However, contractures that result in a serious functional limitation should be treated right away[24]. Both rich and developing nations still deal with the devastating condition of burns, and the severity and size of the burn have a significant role in the morbidity and mortality of burn injuries[25]. These scars can either be thin and linear (Figure 2.3) or large and broad (Figure 2.4). Scarring is the most persistent issue for those who survive, thus there is always hope to lessen the issues associated with scar development[26].In India, burns occur often, and many patients go on to acquire sequelae such burn contractures as a result of numerous socioeconomic conditions[27]. Burn contracture of the axilla is a particularly crippling issue because mobility of the shoulder impairs the capacity to locate the hand in space to carry out daily activities[28]. The victim typically notices a defensive stance with the arms strongly adducted and flexed at the time of damage[29]. The axillary fossa is frequently spared as a result, only typically affecting the anterior and posterior axillary folds[30]. The best form of treatment is prevention, which includes regular exercise, splinting, and appropriate primary care. Nevertheless, early surgical release should be performed once a contracture has formed[31]. The surgical approach differs depending on the type of axillary contracture and the location of the contracture, the involvement of the axillary fossa, and any nearby scarring[32].

Figure 2.1: Contracture release by opposing z-plasty

Source: link.springer.com

Axillary contracture was divided into four categories: Type I: Linear web at anterior or posterior fold with minimal adjacent scarring and no involvement of the hair bearing area; Type II: Scar contracture involving either anterior or posterior axillary folds with adjacent skin scarring (Figure

2.2), but sparing the hair bearing area; Type III: Linear webs at both anterior and posterior axillary folds with or without adjacent scarring, but sparing the hair bearing area; and Type IV: Contracture of one axillary[33]. All types of axillary contractures can be treated with release and skin grafting, although there is a risk of graft take failure, re-contracture, long-term splinting, lack of acceptable donor sites in cases of severe burns, and uncomfortable donor sites[34]. Because normal skin and subcutaneous tissue are included, using flaps over joints reduces the likelihood of recurrence, and splinting is not necessary for longer than two weeks[22]. Local flaps work well for contractures that have usable healthy tissue close by[35]. These include techniques for lengthening the skin, such as transposition flaps and propeller flaps, Z plasty, and its variations[36]. In individuals with significant burns, reconstruction of the axilla and elbow is challenging due to the scarcity of skin[37]. Any amount of unburned skin can be used centrally or nearby using a variety of local flap or central axis flap designs[19]. In addition to providing better aesthetics with superior and stable skin, these flaps can be used to manage many broad-based or numerous linear contractures[38]. The skin of the axilla that bears hair is not likewise dislocated by the central axis flaps. Many of these flaps, however, are only useful in mild contractures due to inherent restrictions because, when utilized in moderate contractures, they result in incomplete release in the initial stage[34].

Figure 2.2: Combined mento-sternal and axillary contracture

Source: Semantic Scholar

Classification of contractures

Contractures are structural alterations in non-bony tissue, such as muscles, ligaments, and tendons, which result in a prolonged loss of joint mobility[36]. They emerge as inelastic tissues take their place in these typically elastic tissues[39]. This causes these tissues to shrink and stiffen, which leads to rigidity, arthritic deformities, and a complete lack of motion around the joint[34].

The most common cause of contracture is immobility, but they can also be brought on by muscle imbalances, arthritic conditions, heterotopic ossification, prolonged hypertonic spasticity, ulcers, burns, total knee arthroplasty (TKA), local trauma, diabetes, or, in rare cases, a deficiency in the hormones that control the hypothalamus-pituitary-adrenal axis (HPA)[21]. Dupuytren's contracture has also been linked to exposure to vibration and manual labor[23].

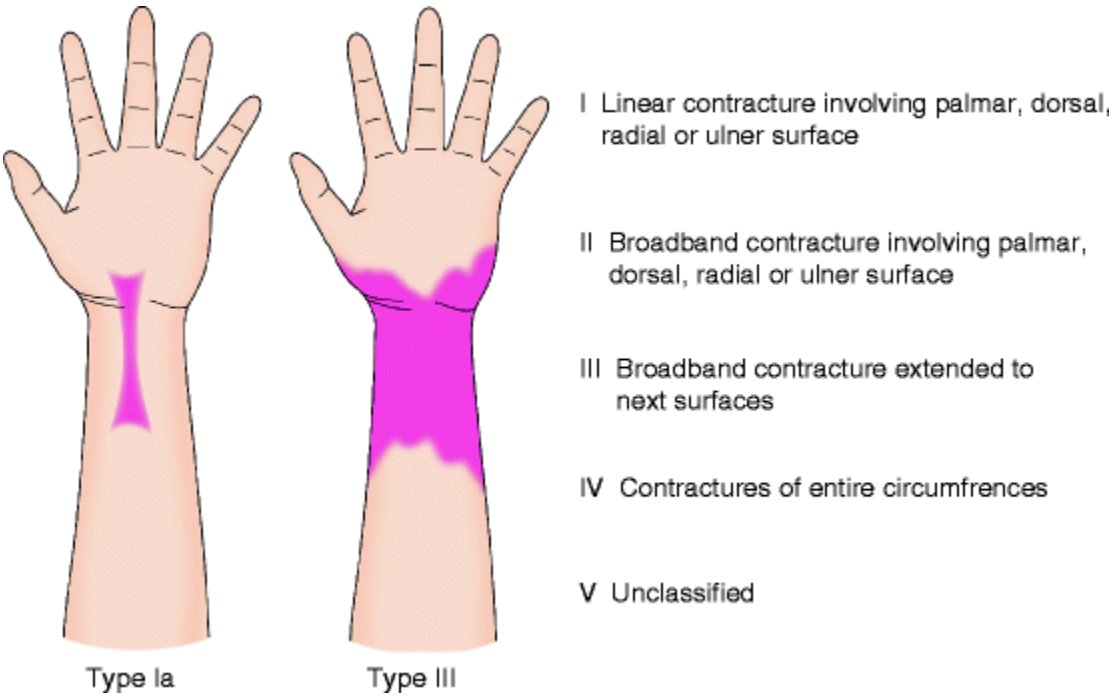

Figure 2.3: Morphology of a linear scar band and a broad scar

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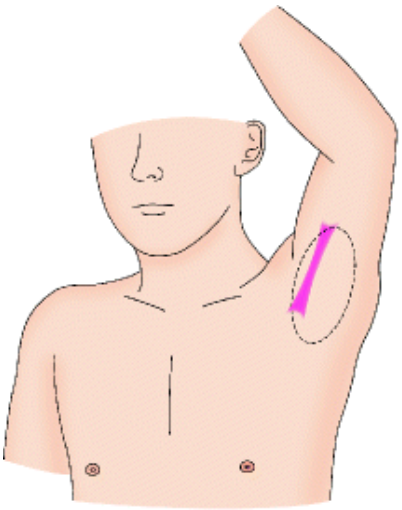
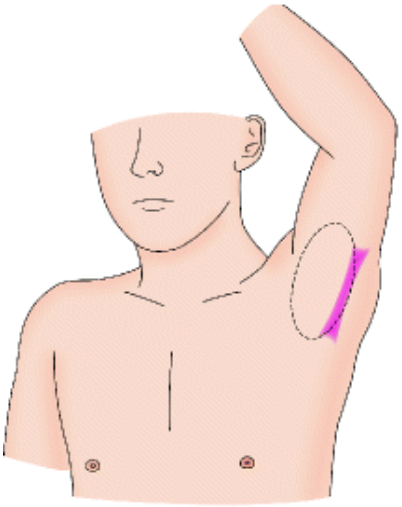
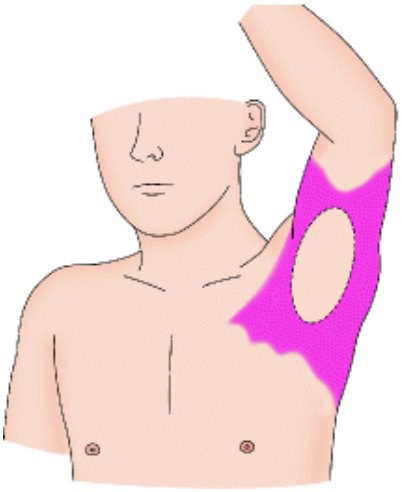


Type IIa



Type IIb



Type IIIa

I Minor area of contracture within the axillary area

II Single linear contractures

IIa anterior axillary line

IIb posterior axillary line

III Double linear contractures

IIIa Both anterior and posterior line with normal tissues between the lines

IIIb Both anterior and posterior line with contractures between the lines

IV Broadband contracture over the axillary area

IVa The contractures extended to the chest

IVb The contractures extended to the back

IVc The contractures extended to the upper arm

V Broadband contractures surrounded with scars

VI Others

Figure 2.4: Classification of axillary contractures with respect to axillary anatomy

Source: link.springer.com

The epidemiology of joint contractures as a whole is currently limited because the majority of epidemiologic data focuses on a particular joint contracture[34]. The differences in terminology across the research used as diagnostic criteria also produce a wide range of numbers. However, it is evident that major joint contractures are very common[27].

Very soon after the commencement of immobility, soft tissue changes that contribute to contractures start to occur[40]. Within six hours of immobilizing a joint, protein production in muscle fibres is diminished. Within 24 hours, muscle fibre lengthening happens[41]. Increased collagen infiltration of the perimysium appears after 48 hours[34]. Chronic inactivity also results in plastic reorganizations in the higher centres, which further lessen the capacity to actively recruit motor units, aggravating baseline paresis[40]. Patients with brain injury who have muscles and joints immobilized for extended periods of time see a reduction in longitudinal tension in their muscles[42]. Only 24 hours of unloading in animal models resulted in a 60% reduction in muscle fibre length[33].

Burn injury-specific contractures develop as a result of heat damage from vascular insufficiency, compressive oedema, or eschar, which may lead to myofascial and joint abnormalities later on[32]. Another point to take into account is the fact that researchers from Denmark released a thorough explanation regarding how contracture arises in the presence of central motor disorders in 2016[21]. They contend that the key to preventing and treating muscle contractures is the adaptation of the neuromuscular-tendon-connective tissue complex to the central motor lesion, along with a number of other factors (neural activation, bone/muscle growth mismatch, mechanotransduction, tensional homeostasis, micro vascularization, genetics, and epigenetics)[37].

It's crucial to do a differential diagnosis of ankylosis or contracture. Ankylosis is a joint stiffness that can range in severity from mild to severe[25]. The deeper tissues, such as bone, cartilage, and the joint capsule, may be affected by ankylosis, necessitating orthopaedic surgery to release it. Myogenic and neurogenic contractures in soft tissue should not be used for surgical repair[43]. Prior to making surgical plans, a differential diagnosis based on anatomical features should be made for connective tissue contracture[30]. According to the tissues they impact, connective tissue contractures can be divided into four categories: cutaneous, subcutaneous, or fascial contractures, tendon contractures, ligament contractures, and muscle contractures[31]. Numerous burn scar contractures are under the cutaneous/subcutaneous contracture category (Figure 2.5). These

replacement or repair techniques had to be taken into consideration if tendon, ligament, and muscle contracture were found[29].

Neurological harm A muscle imbalance brought on by either increased muscle tone or weakness leads to a tonic contraction. In this manner, spasticity frequently precedes joint contractures. If left untreated, a contracture forms and the spastic joint becomes immobile[33]. Hands and limbs get deformed as a result of direct heat injury in burns. Immobility and contracture may also arise from a subsequent scar that contracts the skin that crosses a joint. Without a specific injury, contractures can simply arise from inactivity[34]. For instance, prolonged sitting can cause hip flexion contractures due to age-related muscle loss (sarcopenia)[21].

2.3 Burn contractures

Contractures are a frequent and important burn damage consequence. They cause functional and cosmetic joint deformities as well as a reduction in joint range of motion. The shoulder, elbow, and knee are where contractures most frequently occur (Figure 2.6)[38]. Increased incidence and severity of contracture are related to length of stay, inhalation injury, and degree of burn(Figure 2.7)[36]. Although the metacarpophalangeal (MCP), proximal interphalangeal, and distal interphalangeal joints of all digits may be affected, wrist contractures of the hand are most frequently seen[34]. Burns on the hands and feet's dorsal surface may constrict, leading to joint hyperextension. Long-term hyperextension increases the chance of subluxation in the joint[30]. The metatarsophalangeal joint and MCP are the most frequently affected areas[19]. Concurrent medical conditions, TBSA grafting, the existence of hand burns, and hand grafting are all indicators of the development of hand contractures[37]. Dislocations of the shoulder and hip joints can also happen. Last but not least, contractures over the spine may cause postural modifications such scoliosis or kyphosis[36]. Severe burns that involve the upper arm and trunk commonly involve the axilla[44]. Deep axillary burns are notoriously difficult to treat acutely because of their unfavourable shape, which causes considerable skin graft loss[28].

Figure 2.5: Contracture with restricted movement about the joint

Source: Semantic Scholar

Axillary contracture is more frequent in young patients due to the extra difficulty of immobilization and physical rehabilitation[40]. The goal of management is the restoration of form and function as a requirement to the successful reintegration of burn survivors into society as the survival of patients with significant surface area burns becomes routine[45]. Release of upper extremity contractures whenever they develop has a substantial impact on the burn patient's total rehabilitation[24]. The functional restoration of arm movements at the shoulder joint is the goal of axillary contracture surgery. As the expense of medicine has continued to climb globally, there is an increasing need for an objective method of evaluating such functional outcomes[34].

Figure 2.6: Contracture of the popliteal region with restricted movement

Source: musculoskeletal key

In contrast to keloid scars, the growth of hypertrophic scars is restricted to the area of the original skin defect. These scars are often thick and rose, though they can also seem red[41]. Within weeks of the skin damage, hypertrophic scars typically begin to form. Although it can take a year or longer, hypertrophic scars may gradually improve[31]. Although there isn't a single straightforward treatment for hypertrophic scars, steroids may be the first line of therapy. Steroids can be used topically or administered intravenously[30]. Surgery is another option for removing these scars.

Steroid injections are frequently used in conjunction with surgery and may be continued for up to two years following the procedure to aid[36]. After the scar tissue is removed, skin grafts or skin flaps are applied. In skin grafts, the lost skin is replaced or joined to the skin-less area of the body[46].

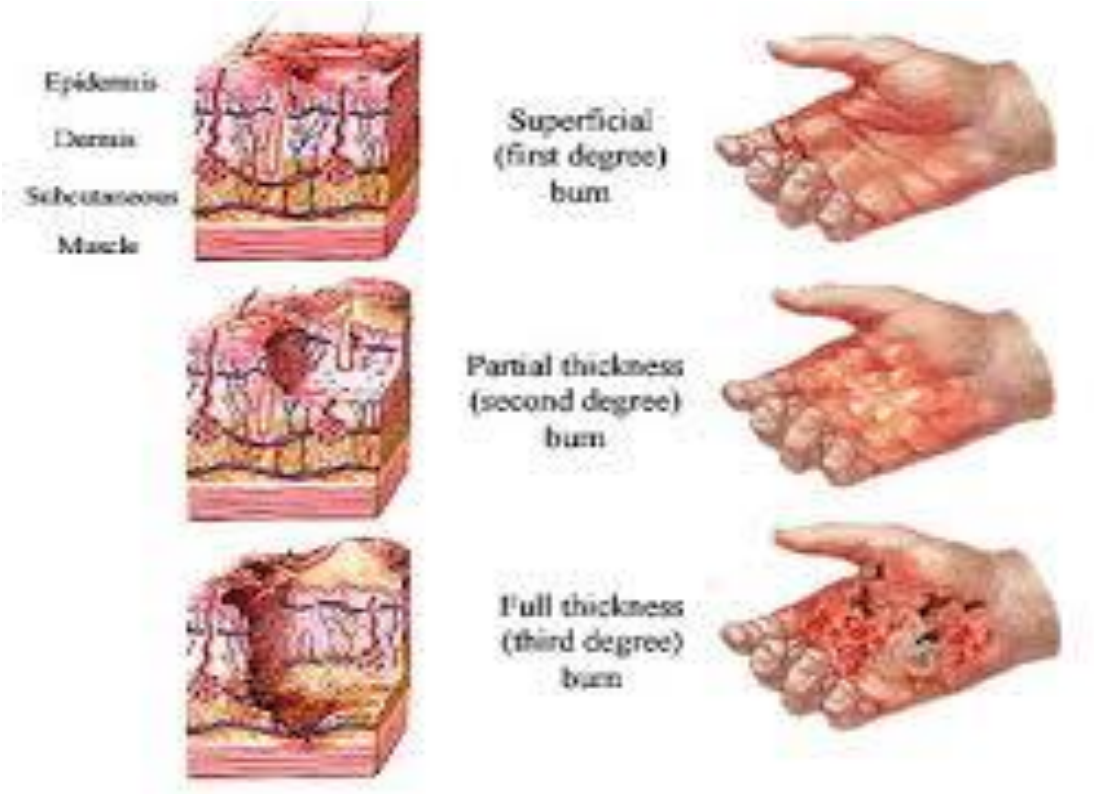


Figure 2.7: Classification of Burns

Source: Latina Health project

In order to accomplish a skin transplant, a piece of healthy skin from another part of the body, known as the donor site, is removed and attached to the desired area. In skin flaps, the skin that is recovered has its own blood supply, unlike in skin grafts where a portion of the skin is removed from another place[47]. The underlying blood arteries, fat, and muscles are present in the skin flap that is used. When the location where the skin is absent from the body has a poor blood supply, flaps may be employed[48]. The shoulder is the major joint most often constricted (38%), and most contractures are mild (60%) or moderate (32%)[23]. A surgical reconstruction should be done as soon as a shoulder adduction contracture was created because it prevents youngsters from

developing their upper limbs and curves the shoulder bone and spine[24]. Scars covering the joint's anterior flexion lateral (FL) surface from the fossa edge to the joint rotation axis ("+") and forming the fold along the axillary fossa's anterior edge are what produce edge shoulder contracture[37]. According to numerical classifications, Edge shoulder adduction contracture is classified as Type 1 and as Edge type, which accounts for 70% of all cases. Children's chest wall scars are prone to rapid expansion, which worries parents[47]. The majority of edge (Type 1) axillary contractures are treated with triangle flap-based procedures (Z-plasty and its variations and combination), although there are few papers devoted to the results of follow-up. Triangular-flap approaches offer a number of well-known drawbacks[30]. A recurrence of shoulder contracture, according to data from Balumuka et al., was 67%; incomplete contracture release led to contracture recurrence[36]. Outcomes results demonstrated that skin grafts and triangular flaps yield functional improvement. Our studies enabled the creation of a novel procedure called trapeze-flap plasty, which is based on trapezoid flaps. In children, mild to severe edge contractures are successfully treated by elevating the entire trapezoid layer without making any skin incisions[19].

2.4 Types of axillary contractures

Different axillary contractures categories have been presented by numerous researchers. Grishkevich divided the contractures into two groups: strip contractures and edge contractures, the latter of which was brought on by a large scar[30]. Axillary contractures can be divided into four categories by Hallock: a single anterior or posterior web, scar bands next to the axilla, anterior and posterior webs with the cupola spared, and entire axillary obliteration[31]. Huang et al. defined axillary contracture as mild with a loss of ROM of less than 25%, moderate with a loss of ROM of between 25% and 50%, and severe with a loss of ROM of more than 50%.

2.5 Different designs for central axis flaps in axillary contractures

The addition of propeller flaps to the toolbox for treating soft tissue abnormalities is crucial. Over the past few decades, the idea of a propeller flap has changed as our understanding of the location and vascular region perfused by perforators has increased[44]. As axillary and elbow contractures are frequently treated with central axis propeller flaps.

Classification of flaps

Type of flap	Pedicle	Definition
Subcutaneous pedicled propeller flap	Random subcutaneous	Based on a chance subcutaneous pedicle, the flap is created. The pedicle's perforators are not separated or visible. The flap turns 90 degrees.
Perforator pedicled propeller flap	Skeletonized perforating vessel included	Flap is built around a perforator that decides where the skin island will be located and is positioned directly above it. The fascial adhesions are then removed from the perforator, leaving it skeletonized. The flap rotates from 90 to 180 degrees. The most typical application of this flap type is in reconstructive surgery.
Supercharged propeller flap	Skeletonized perforating vessel with additional vein or artery, or both	An additional pedicle can be anastomosed if a lengthy pedicled flap is necessary and the isolated perforator vascular is unable to provide enough arterial inflow or venous outflow. The flap rotates from 90 to 180 degrees.

2.5.1 The “original” propeller flap

Hyakusoku first presented the original propeller flap technique in 1991. Depending on the estimated size of the defect and the amount of accessible normal skin, a diamond-shaped flap is created along the axis of the cubital or axillary fossa[24]. The flap is built on a subcutaneous pedicle solely. No attempt is made at Doppler localization of the perforators, preoperatively as the flap is

capable of surviving on a broad-based, random, subcutaneous pedicle[40]. The flap is turned 90° following elevation (Figure 2.8). The flap crosses the horizontal defect caused by contracture release, regardless of whether the rotation is clockwise or counter clockwise. Skin is grafted onto the flap donor area.

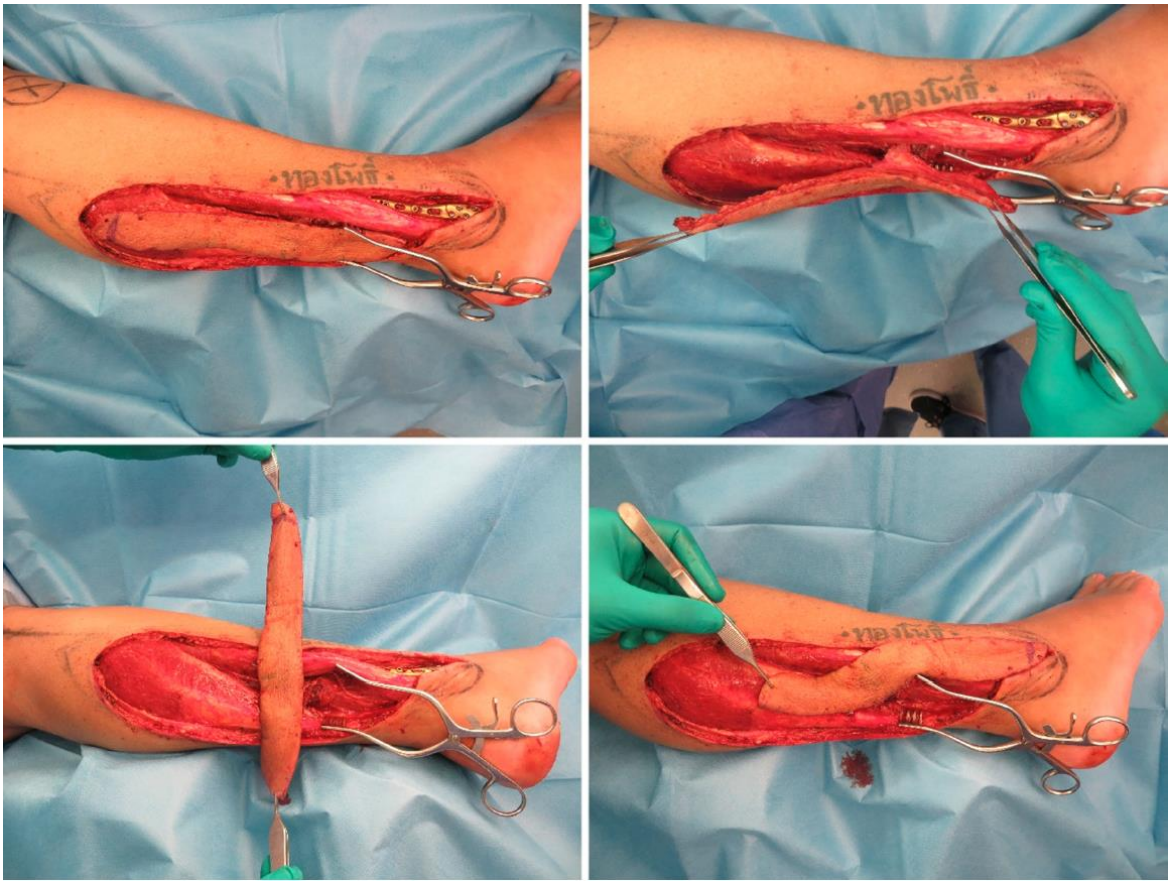


Figure 2.8: The use flaps for reconstruction

Source: Link.springer.com

Figure 2.9: Release of contracture with Skin graft

Source: Open source

2.5.2 Multilobed propeller flap

To avoid or reduce the need for a skin graft, the flap is created in the shape of bilobes, trilobes or quadrilobes (Figure 2.10)[46]. Similar to other flaps, this one is 90° rotated and based on a thick subcutaneous pedicle. The lobes were originally intended to border normal skin, however they may also be incorporated into scars[45]. Only a slight contracture can be released with this flap because a moderate contracture won't be able to return after being released. After contracture release, the donor area must be grafted for moderate to severe contractures[49]. In 10 patients, Karki et al. reported using the multilobed propeller flap technique with positive outcomes and no flap necrosis or recurrence of contracture.

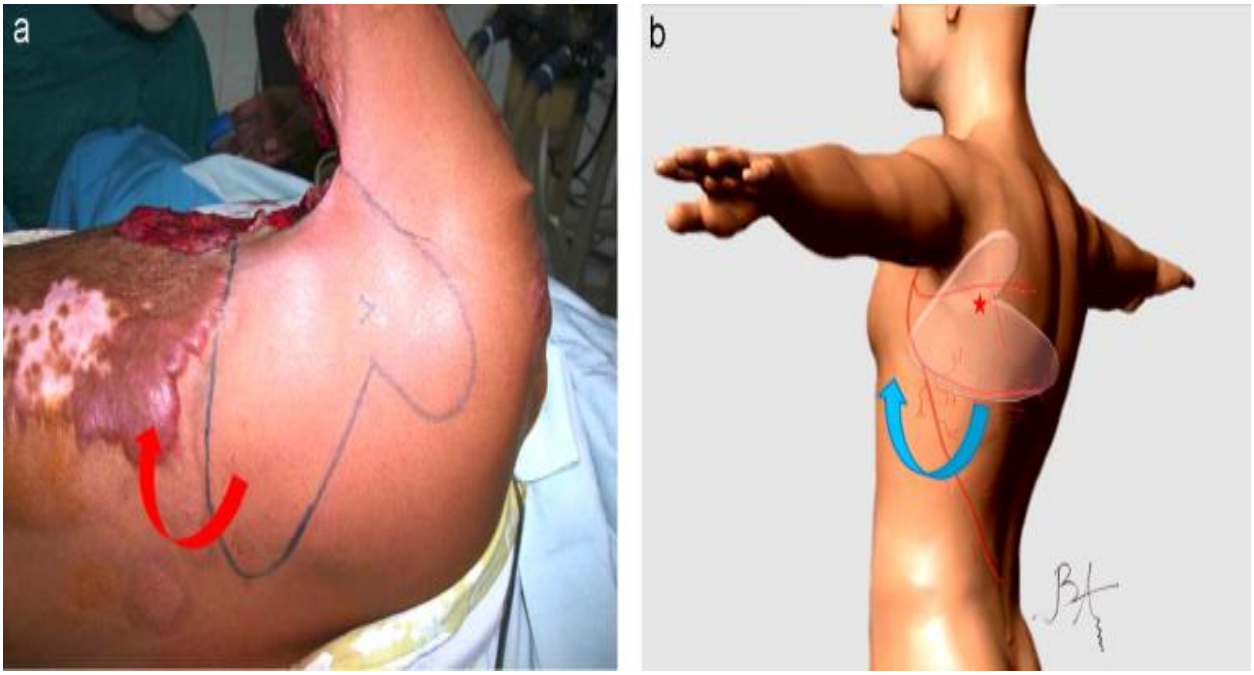


Figure 2.10: The use of flaps (bilobed) in axillary contracture release

Source: Open source

Figure 2.11: Pinwheel flap in axillary contracture release

Source: Research Gate

In the axillary or cubital fossa, Hyakusoku et al. in 2006 devised a pinwheel flap method for effectively deploying a circular patch of unburned skin (Figure 2.11). Innovative cuts can be made in the circular piece of skin to create flaps with different numbers of lobes that will unfold like a pinwheel upon mobilization[22]. Only the central axis serves as the basis for the flaps[31]. Typically, it is easy to primarily shut down the donor site. This flap design appears to be beneficial for only minor degrees of contractures and does not entirely remove the contracture[26].

2.5.3 Scarred propeller flap

A central axis flap of the contracting band itself may be elevated in mild contractures[50]. The contracting band's broad-based flap can be lifted on its axis and turned 90 degrees. Generally, it is possible to seal the donor sites. Since the flap is made from damaged skin, the biggest drawback of these flaps is their subpar cosmetic appearance[46]. We avoid raising a flap in cases of deep burns with juvenile scars because they may result in poor skin perfusion[46]. Scarred flaps can occasionally be bulky and may restrict elbow motion, necessitating routine follow-up with pressure garments and physiotherapy[28].

2.5.4 Eight-limb propeller flap

Eight triangular lobes and a central subcutaneous pedicle make up the flap's design[47]. To account for the shortening caused by rotation, the height of each triangle should be equal to the distance between its mid-base and the apex of the neighbouring triangle. The triangular lobes are random flaps, so their base shouldn't be higher than their height. Just a 45° rotation is made to each triangle flap. The triangular flaps don't all have to spin in the same direction. In rare circumstances, it may also be able to partially close the donor with a V shape[25].

Figure 2.12: Use of flaps (Namaste) in contracture release

Source: Semantic Scholar

The central axis flap is created along the long axis of the extremity over any remaining healthy skin after the contracture has been released[38]. Each limb's length is one centimetre longer than the defect's long axis, and the flap's breadth is equal to the defect's width in half(Figure2.12). The flaps are elevated by making a zigzag incision, and the propeller flaps two limbs are rotated 90 degrees in the same direction[33]. The majority of donor locations are closed. With a full recovery of range of motion, the contracture can be released instantly and completely. The primary benefit of this treatment is that the flaps totally conceal the deformity that results from the relaxation of contracture[27].

2.5.5 Multiple rhomboid flaps

Reconstruction of post-burn contractures has also been described using multiple rhomboid flaps based on subcutaneous pedicles[32]. With 1200 flap angles situated on the tension lines, rhomboid flaps are created along the contracture band's long axis[37]. The length of the flaps as a whole shouldn't be less than half the length of the contracture, but it also shouldn't be longer than the overall length[42]. Without much undermining, rhombicoid flaps are raised on a broad subcutaneous pedicle. Primarily, donor flaws are closed. Treatment of long, linear, and wide contractures with two or more contracture lines can be accomplished with multiple rhomboid flaps[31].

For the reconstruction of post-burn contracture of the axilla and cubital fossa, there are numerous techniques accessible today[25]. In the past, surgeons have used skin grafting to resurface mild to severe linear contractures but Z-plasty or another local flap modification to extend linear contractures[34]. Innovative local/regional flaps have been developed by surgeons as a result of the need for prolonged splinting with skin grafting, the breadth of scarring in a linear contracture, the availability of unburned skin in the axillary/cubital fossa, and the goal for superior aesthetics. Numerous methods can produce good outcomes[24]. Individual decisions have been influenced by factors such as tolerance for splinting, issues associated to graft or flap failure, and the skin transplant donor-site morbidity[31]. Skin grafting has been the most straightforward, tried-and-true reconstructive method, but the lengthy splinting requirement and recurrence risk have led to some dissatisfaction with the surgery[34]. Additionally, children who are less obedient with postoperative splintage and physical therapy have worse success with skin grafting. However, it appears to be the best option for resurfacing a severe elbow contracture or a type III axillary contracture according to Kurtzman and Stern[20].

In addition to the central axis flaps, there are various alternative choices for reconstruction, such as a square flap, a trapeze-flap plasty, or a free flap[25]. A trapeze-flap plasty may be used to treat both axillary and elbow contractures, while a free flap is obviously used when there is no local tissue and the necessity to remove splinting. A square flap has been developed for treating type I axillary contractures[39].

2.6 Timing of reconstruction

Before focusing on enhancing the aesthetic, burn repair addresses abnormalities that impose functional limitations[44]. Therefore, the restriction of shoulder function is given more importance than the reduction of trunk scarring. Even though there isn't a precise scientific justification, it has been suggested that a "moratorium" on burn reconstruction be in place for two years[48]. Operation on a "immature" scar, which is marked by redness, induration, inelasticity, and a lack of tensile strength, is thought to be technically challenging and difficult to control the bleeding from the wound[28]. When a partial-thickness skin graft is utilized to release a wound with active inflammatory processes, a significant incidence of re-contracture is observed. This finding may suggest delaying burn repair until scar maturation[24].

In cases of severe body contractures, release is always performed proximally to distally. Before moving on to the more distal joints, the proximal joint contracture is totally and individually relieved[22]. In order to treat concurrent elbow and hand contractures, it is necessary to first relieve the axillary contracture. Similar to this, the neck contracture needs to be released and resurfaced in the first stage if axillary and neck contractures coexist[45]. The postoperative splinting used after axilla release impairs the postoperative neck position; hence it is not desirable to release the neck and axilla at the same time[42].

Local flaps have been used for axillary and elbow contractures for a very long time. Most regional flaps, such as the parascapular flap, scapular flap, latissimus dorsi flap, and thoracodorsal artery perforator (TDAP)-based flap, are used in type III contractures to resurface the dome of the axilla[30]. Local flap options for type I contractures include random pattern flaps, Z-plasty, Y-V plasty, and a square flap. In patients with axilla contracture who lacked access to unscarred donor sites, Hyakusoku had already described the use of local fasciocutaneous and musculocutaneous flaps from the surrounding scarred tissue in 1986[44]. The use of the local flaps stated above or a local flap rearrangement developed by Z-plasty or its equivalents, however, might either detract from the aesthetics of the axilla by sacrificing healthy hairy skin or eliminates the possibility of using the unburnt skin in reconstruction when the axillary dome is spared[40]. The conditions with unburned skin in the cubital fossa in elbow contractures are very similar. In individuals with significant burns, reconstruction of the axilla and elbow is challenging due to the scarcity of skin[45]. Any amount of unburned skin can be used centrally or nearby using a variety of local flap or central

axis flap designs[25]. In addition to providing better aesthetics with superior and stable skin, these flaps can be used to manage many broad-based or numerous linear contractures[46]. The skin of the axilla that bears hair is not likewise dislocated by the central axis flaps. Many of these flaps, however, are only useful in mild contractures due to inherent restrictions because, when utilized in moderate contractures, they result in incomplete release in the initial stage[36].

2.7 Approach to the Release of Axillary Contractures

For minor contractures, numerous local tissue rearrangements have been tried. The use of local flaps made from the surrounding skin is desirable since it prevents the need for protracted postoperative splinting and does not contract with time[48]. Although doing Z-plasties or Y-V plasties on axillary bands may be appealing, the contractile bands are frequently already scarred, and skin grafts are the only way to successfully release and resurface such linear contractures. However, on rare occasions, it might be safe to raise substantial flaps of hardly damaged tissues for interposition[35]. It's important to support novel local skin flap application, but it's also advisable to apply skin grafts of an acceptable thickness on a small scale[42].

It takes a lot of skin to resurface such severe contractures, whether it's provided as skin transplants or flaps for severe contractures. The ideal method for axillary resurfacing is in dispute[25]. In severe contractures, it may only be viable to utilize a skin flap in the axillary dome region with skin grafts to the remaining raw areas. Both techniques have respective advantages and disadvantages[24]. The discussion about the best approach to burn restoration is reopened by the availability of dermal regeneration templates[37].

Achieving appropriate release by incising the scar at its point of peak tension is a common feature of all resurfacing techniques[28]. The pectoralis or latissimus fascia must also be released in order to release severe axillary contracture[40]. To stretch the neurovascular bundle, the shoulder joint is gently moved. If a forceful stretch is tried, the vessels in long-lasting, severe contractures may spasm[50]. In these situations, a less than ideal release is accepted on the operating table, and afterwards serial, gradual splinting is used to achieve complete axillary release by gently stretching the neurovascular systems. Such severe cases require split skin grafts to be applied to the partially released axilla, and a splint is used to preserve the release angle. Splinting is started in serial increments[22].

2.8 Burns distribution by age

One very crucial point to note in the management of the burn patient is to preclude possible scar formation. Scarce data is available generally when discussing the incidence of scar formation after burns and even more so about the risk factors in the development of these contractures. A study conducted in the early eighties in which contractures were release found that scarring was higher in children than in adults (7.8%: 2.0%). However, the extent of the post burns ulcers was almost the same in the two categories. The sizes of the post-burns ulcers formed had a direct relationship to the extent of the contractures the eventually resulted. In this study, patient demographics and the surgical modality employed, as well as the intervention time did not have any effect on the eventual outcome[52].

The effects of burn injury and the associated mortality on the African continent is very distressing, averaging about twenty (20) percent. More than half of those involved in the burn injury have been found to be children who eventually go on to experience post-burns contractures some of which could result in neoplastic formation, especially in the unstable scars.[53].

Anna Tyson reiterated the common findings that most burn injuries with subsequent complications occur in the younger age group, but generally with extremes of age in her findings after examining over four hundred patients and coming out with an average age of four (4) years with majority being females, another common finding. Children seems to have the worst survival outcomes as with the elderly[54].

The best study comparison done with respect to procedure for release has been with the use of different types of flaps in both paediatric and adults axillary contractures[55]. Generally, children seem to be more susceptible to burn injuries resulting from domestic accidents and are the age group mostly picked up in studies to assess the pre- and post-surgical intervention outcomes and presentation to the hospital for treatment post incident seems to vary across the continent[56].

Studies have revealed that young adults form the majority of persons involved in burns, with a female predominance and majority fell in the class of moderate contractures. This fits in the general conception that women are more likely to be associated with domestic burn injuries[4].

2.9 Gender Disparity

It is generally accepted that the low socio-economic population, people with mental ailments and significantly, biased towards the female gender. Due to the fact that in the typical African settlement, females are the ones involved in cooking and general house chores, they are more exposed to possible domestics burns accidents. The use of relatively primordial less secure modes of cooking such as ground level cooking practices and ignorant use of these liquefied petroleum gas cylinder stoves in enclosed areas. The apparels also worn during domestic work seem to catch fire easily as was found during a study done in Ghana which sort to assess the fuel source used in cooking.

Additionally, women and children, especially females seem to be susceptible to burns associated domestic or general violence in contrast to accidentally induced burn injuries[58].

Although some studies conflict with that general assertion of female preponderance, with respect to flame burns, in most if not all cases however, axillary burns were unilateral with very few being involved in bilateral injury. Most of burns were typically direct flame burn and in the minority, scald injury[5].

The aims and objective of another study conducted in India was to assess the different possibilities for post-burn axillary contracture management, the functional outcome of different treatment approaches, and late sequelae of treatment, a total of 18 patients were operated on during the study period. The predominant sex was male and the side involved was the left with axillary contractures the most frequent. Type I contractures topped the list followed by type II[55]. In another study, a total of 10 patients were enrolled, with a wide span with respect to age. There was a higher male preponderance. Patients' mean age was 19.2 years. The mean duration of contracture was 1.8 years. All patients involved in the study had thermal burns[56].

All patients with serious burns in a database at eight institutions were included in a 5-year retrospective review. Gender, age, month distribution, aetiology, location, presence of inhalation damage, total burn surface area, depth of burn, length of hospital stay, and mortality were among the information gathered.

There were 323 (28.7%) female patients and 803 (71.3%) male patients out of a total of 1126 individuals. Scalds (476, 42.27%) and fire were the most frequent causes of burns (457, 40.59 %). The trunk and extremities were the two locations that were most frequently impacted. The average stay in the hospital was 30 (15–52) days. The mortality rate as a whole was 14.21%[59].

2.10 Aetiology of Burns

In the Japanese capital, a public funded research by a number of burn centres banded together analysed data from these units to make sense out of the outcomes form the study.

Over six thousand (6000) patients on admission were included in the study with assessment of demographic data, aetiology, extent of injury, and eventual outcomes and this analysis was done by age groups.

The highest aetiological cause was found to be open fire associated injury with hot fluid burns taking up second place. Males dominated this study with respect to the gender most associated with burns with a mean age of around forty (40) years[60].

Badawi et al in a research in Egypt, over almost a two (2) year period assessed children presenting to the burns unit with burns. Most lived in very poor communities where overcrowding was an issue and less secure cooking modalities were used. Scald and flame burns took about ninety-five (95%) percent of the aetiological causes with electrical and chemical associated injuries in the very minor minority. Surprisingly and small proportion of these children were involved in industrial injuries, a leans towards possible child labour[61].

Another research in Tanzania, evaluated about 500 patients involved in burn injuries presenting to the hospital and also found flame and scald associated burns forming about ninety-eight percent (98%) of the aetiology surrounding the injury. Females formed the majority (54%) and not so surprisingly, the average age in this group was six (6) years[62].

In an interview done in Ghanaian households to evaluate the incidence of burn injuries in children and the associated risks involved, the open fire method was found to be the commonest modality for cooking and these systems were low-height meaning children could access them easily.

The commonest aetiological factor found was flame associated burns with a mean age of four (4) years[63].

To ascertain the cause and prognosis of juvenile burns, a 6-year retrospective assessment of burn patients treated at a significant burn centre was carried out. The identification of 439 patients under the age of 16 was done using the following criteria: age, sex, burn size, presence or absence of inhalation injury, cause of burn, and county of residence. Male: female ratio was 1.9:1, with a mean patient age of 4.3 years. There were 21 deaths overall (4.7%), the majority of which (18) were among children under the age of four. Children under the age of 4 had a death rate of 46.9 percent compared to 12.5 percent for big burns, which are defined as those that cover 30 percent or more of the total body surface area (TBSA), which is much higher[64].

In a study in China by Fan X. et el from 2005 which span 9 years, more than 180,000 participants from 76 trials were examined in total. The annual incidence of serious burns ranged from 0.22 to 2.09 per 10,000 people, with a downward trend over time. Nearly 50% of patients were under the age of 16, and 60% of patients were men. Among the general population, flames, scalds, and contact burns were the most common causes, while in children, scalds definitely predominated. Mortality typically ranged between 1.4 percent and 18 percent, and it is getting less common with time. Older age, a higher overall percentage of burned surface area, chronic diseases, and other risk factors for death were significant. The two most often reported causes of death were (multi) organ failure and infection. Burn shock and inhalation were the leading causes of sudden death (48 hours)[65].

2.11 Functional limitation associated with Axillary Contractures

Due to the exceptional anatomy of the axilla and in totality, the shoulder joint, there is significant restriction in the functional incapacitation in cases of post-burns contracture and this was confirmed in an anthropometric study done by Palminieri in children being scheduled for axillary

contracture release. In comparison to a normal population, it was determined that the total circum-rotation function of the joint was significantly restricted, especially the process of abduction.

In their use of what is known as motion analysis done in three-dimension, they confirmed the functional limitation associated with axillary contractures and recommended aggressive post burn physiotherapy to forestall scarring[66].

The best paediatric burn follow-up strikes a balance between spotting complications and preventing needless hospital stays. We evaluated the complication trends in young patients with burns who needed surgery in a long-term review. The Welsh Burns Centre database was used to conduct a retrospective note assessment of paediatric burns during a three-year period beginning in 1995, identifying every kid who underwent burn surgery. A median follow-up since injury of 13.6 years was found among the 94 individuals that were identified. It was 5.27 years on average (standard deviation: 4.9). TBSA varied between 1 and 70%. Split-skin grafting was done in 94%. Contractures and hypertrophic scarring both occurred in 18% (n = 17) and 33% (n = 31), respectively. In comparison to individuals who developed hypertrophic scarring or those who did not experience issues, those who developed contractures were younger and sustained considerably more TBSA burns (p 0.05). Each and every contracture emerged within[67].

2.12 Management of Axillary contractures

Successful management of post burn scarring of the armpit with its folds requires consideration of individual patient requirements, detailed understanding of the anatomy of the axilla and experience in a range of reconstructive techniques. Ideally the optimal treatment for the complications associated with burns is to prevent the initial injury. Effective pre-hospital management with adequate basic intervention is a vital facet of the complete burn care. Primary and secondary assessments must be tailored to each patient and treatment procedure must carefully thought through[68]. The effect of burns, with its attendant complications such as joint contractures and hypertrophic scars can decrease patients' quality of life, both physically and psychologically. To select the appropriate operative method for release of contractures to this specialized area, it is

essential to consider the orientation, pattern, and site of the scar, as well as the extent of involvement of tissues deep to the skin.[69].

Numerous epidemiological research has shown that elbow contractures are the second most common type of burn injury sequelae, behind axillary contractures. Adduction contracture of the axilla is a prevalent issue for burn surgeons, despite the fact that it may be prevented with early splinting and range-of-motion exercises that counterbalance the comfortable position. Axillary contractures may affect one or both axillary folds as well as the axilla's hair-bearing dome, with severity increasing. We advise waiting at least six months after wound healing to allow scars to mature in order to get better results, unless there is a serious functional handicap present. Z-plasties, Y-V plasties, or a variety of other local flaps may be performed on isolated axillary lesions in milder presentations[11].

2.12.1 Use of skin grafting in axillary contracture release

At the burns unit in a hospital in England where patients who had had skin grafting as the option for scar release done, the conclusion was that the procedure was easy to effect, safe, and dependable[70]. In another study, axillary contractures were noted to be a common complication of chest burns. They concluded that skin graft was a good alternative in the management of axillary scar contractures[12]. In a study to accomplish the choice of appropriate procedure in the release of axillary contractures, skin grafts was noted to give similarly optimal functional benefits while keeping morbidity to a minimum[71]. The high recurrence rate and patients not adhering to immobilization regimen was the observed trend in the use of skin grafting as the technique for contracture release in another study. The procedure was however found not to be difficult and could be applied to any form of axillary post burn scarring[4].

Studies have sought to compare different modalities in the release of axillary contractures with the aim of offering the most optimal release but with minimal change to the surrounding tissue anatomy and types Ia and Ib contractures that had surrounding tissues involved but spared the dome was better managed using split thickness skin grafts[72]. Most studies conducted on the use of skin grafting in the release of axillary scar contractures, found it to be a simple procedure and recommended when combined with early splinting and physiotherapy[70, 73].

In the release of post burn contractures, the modalities employed might differ but in each case, healthy surrounding tissues plays a very important role in the eventual outcome

Over a ten (10) years period, a study in England assessed the release of contractures using the two common skin grafting modalities (split thickness against full thickness grafts). Other data teased out evaluated the etiology, timing of release, site involved in the injury and possible post-operative complications.

Flame and scalds together took up the highest percentage in terms of etiology. The upper limb was the region involved in the highest frequency of burns with the armpit taking the major stake. The use of split thickness skin grafting as a modality resulted in more recurrence over the period of evaluation, compared to full thickness skin grafting

Over the ten (10) year period, children required multiple procedures compared to adults. Surprisingly, donor site morbidity was comparable[70].

After burn injuries, contractures are a frequent consequence. Axillary burns frequently cause a limited arm abduction and provide a significant obstacle to recovery. We use a unique grafting approach to prevent axillary contractures following burn injuries. In this study, we used this method to treat 17 patients who had 23 axillary burns. Patients were splinted early, and five days after splinting, a rigorous physiotherapy regimen was begun. The mean abduction of the successfully treated axillary burns at twelve months was 152 degrees. Of the 23 axillary burns that were treated, only 5 required a secondary reconstruction. We advise using the outlined grafting procedure for axillary burns together with early splinting and vigorous physical rehabilitation[73].

After a deep thermal injury, the axilla is frequently the site of adduction contracture, especially in underdeveloped nations where a lack of adequate facilities prevents prompt burn treatment and contracture prevention. As vast sections of wounds must be covered with skin grafts or flaps, chronic contractures are challenging to cure. The most challenging part of adduction contracture, however, is maintaining release after treatment; this is frequently accomplished with long-term abduction splints, the majority of which are quite unpleasant. Here, we're looking to analyze our findings using a straightforward figure-of-8 sling. 40 examples of chronic widespread axillary

contracture were included in a descriptive research that covered a period of ten years. Every case received treatment[74].

Often times, axillary contractures that can limit movement appear in kids who have had burns to their upper extremities. Function is recovered with surgical axillary contracture release. This study uses three-dimensional motion analysis to ascertain the effects of surgical axillary contracture release on upper extremity motion during simulated activities of daily living over the long term (up to 7 years). Motion analysis was performed on 10 participants (nine males and one female; 16 axillary contractures; mean age 10 +/- 3 years at baseline; mean TBSA burn (15%) before, 1 year after, and 2 to 7 years (mean 3.2 years) after axillary contracture release with split-thickness skin graft surgery. Three functional tasks, including high reach (reaching overhead for an object), hand to head (combing hair), and other movements, were examined[75].

2.12.2 Use of z-plasty in axillary contractures release

In a study conducted in India, fifteen patients underwent five flap-plasty and two undertook running Y-V-plasty. In the subsequent review s which span a period of one and a half years, there were no reported recurrence and the release was termed satisfactory. The aim during the procedures were to attain improved function and the patients' overall confidence. Aesthetic appeal was also considered. The integrity of the tissues surrounding the scars, the type or classification of the contracture and the surgeon's ability were some of the factors considered in the choice of technique. Considering the numerous options in terms of modality for contracture release. The use of flaps gave the optimal results with overall significant improvement in range of motion, less re-contracture and insignificant or no flap loss[5].

Durga Karki and colleagues described in their study that "operative procedure was nominated according to the pattern of scar and condition of surrounding skin". The study involved the use of different patterns of the classic z-plasty, skin grafting, and fasciocutaneous flaps and in the end postulated that the z-plasty had an advantage over skin graft because of the better outcomes seen during analysis of data[76]. In another study on the pattern of burns associated scarring of the upper limbs undertaken in Nigeria, contracture release using local tissue rearrangement was the modality chosen with acceptable functional outcomes [77].

As soon as the diagnosis is confirmed, post burn axillary contractures should be surgically treated to prevent deeper tissue involvement. Based on regional anatomical conditions, we have categorized axillary contractures, and we have provided the most effective methods for correcting each type.

A linear web at either axillary fold and minimal neighboring scarring are features of type I contractures. The preferred surgery is a double Z-plasty with Y-V advancement. Either axillary fold is involved in type II contractures, and the surrounding skin is scarred. The preferred method is a double incisional release on both sides of the hair-bearing region. Linear webs at both axillary folds without involvement of the surrounding skin define Type III contractures. The method of choosing in certain situations[78].

In analytic studies where the release of burns associated contractures was effected using flaps, the predominant mode for release was by the use of the five- flap plasty, with the Y-V plasty the second commonest followed by the para scapular flap. Excellent release with no recurrence in post- operative reviews spanning more than a year was achieved [4]. In another observation, the mean score for patient satisfaction was significantly higher for patients for whom Z-plasty was the modality employed for scar release compared to the skin grafting group who also had reported longer hospital stay. It was therefore concluded that contracture release with flap was the preferred procedure with respect to patient satisfaction, recurrence, duration of admission, and time to get back to normal activities[9].

The different modalities used in contracture release may depend on the area involved, the integrity of the surrounding skin and the advantages or otherwise of the treatment involved. Skin grafting, with its primary and secondary contraction properties can be a disadvantage in the outcome of released scared when compared to tissue rearrangement.

The possible deficit associated with burn injuries in joint areas most times produce bands that are best served by using local tissue rearrangement to release them as opposed to taking tissue from distant regions which comes with possible donor site morbidity[31].

Sadly, any soft tissue shortage in the area around the axilla can readily result in a functional restriction of the upper extremity that requires an immediate and straightforward treatment. Burn injuries typically result in significant skin damage, which requires healing. Whatever the underlying reason of substantial abnormalities, resurfacing with vascularized tissues derived from sources near to the defect is the best option to preserve the axillary structures and shoulder range of motion. If so, efficient placement of these local muscle or fascial flaps will require a realization that there are only so many possibilities accessible. A suitable flap has been designed using the relative severity and anatomical position of the flap[79].

CHAPTER THREE

METHODOLOGY

3.1 Study design

This was a longitudinal, prospective and comparative study among patients presenting with axillary contractures to Komfo Anokye Teaching Hospital, Kumasi

.

3.2 Study site

The study was conducted at Komfo Anokye Teaching Hospital (KATH), Kumasi, the capital of the Ashanti Region with a total population of about 4,780,380 (National population census, 2010).

The geographical location of the hospital, the road network, and the unique commercial setting of Kumasi makes the hospital accessible to about 15 of the regions, especially those sharing boundaries with the region. Clients who assess the services rendered by KATH are mostly from Upper East, Upper West, Savannah, North East, Northern, Bono, Bono East, Ahafo, Central, Western North and Eastern regions with a few occasionally from the Greater Accra and Volta regions.

The hospital is a 1200-bed facility which currently has 13 clinical directorates and 2 non-clinical support service directorates namely Obstetrics and Gynaecology, Child Health, Family Medicine, Anaesthesia and ICU, EENT, Medicine, Surgery, Oral Health and Laboratory Services with Technical and domestic Services as the 2 non-clinical BMCs.

The Directorate of Surgery is divided into 6 (six) major units namely General Surgery, Paediatric Surgery, Neurosurgery, Cardiovascular and Thoracic Surgery, urology, and the Plastics, Reconstructive and Burns Unit.

The Plastic, Burns and Reconstructive Surgery unit oversees the management of burn injuries referred from the northern part of the country and is involved in the correction, whenever possible, of post burn complications

The enrolment of the patients was done at the out- patient clinic of the plastic, reconstructive and burns unit.

Figure 3. 1: Administrative map of Ghana showing KATH

Source: Wikipedia

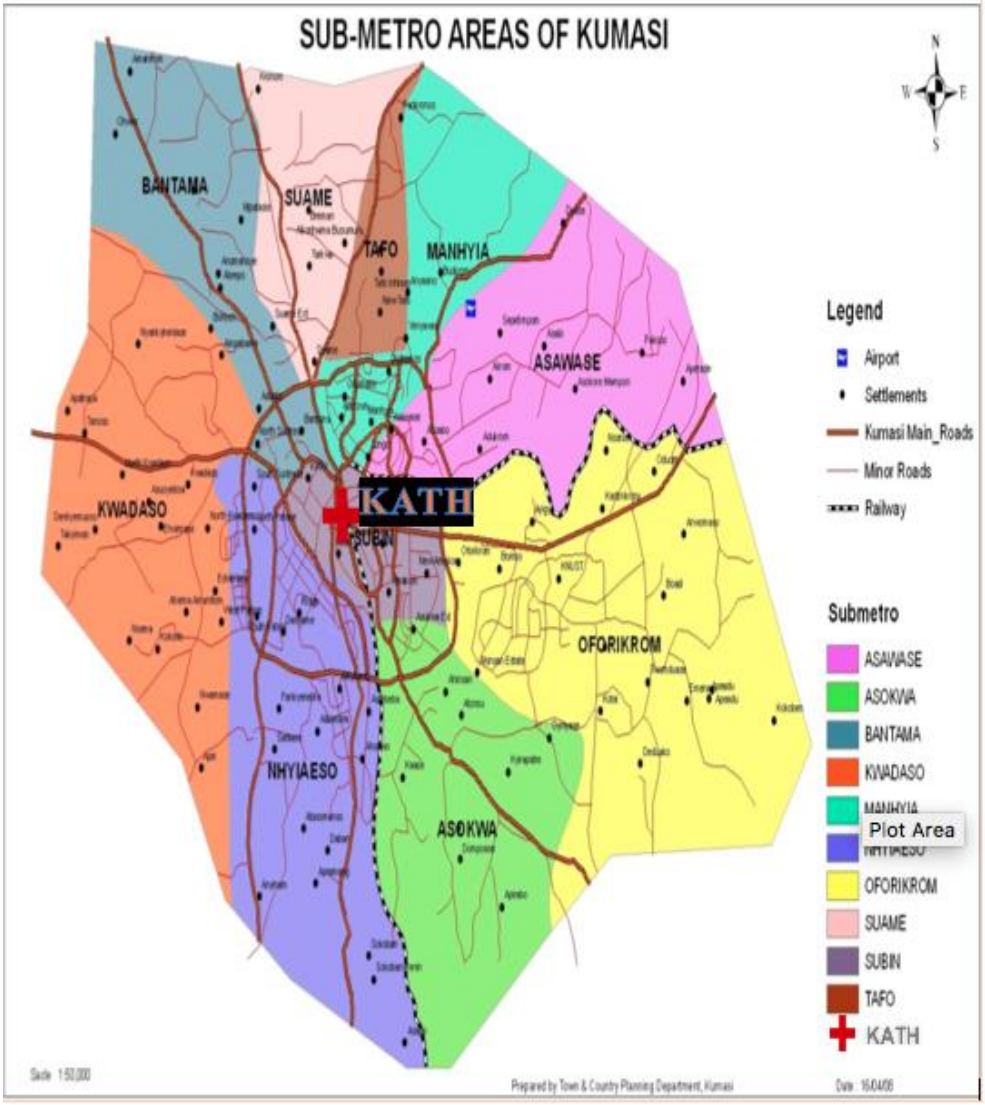


Figure 3. 2: Sub-metropolitan areas of Kumasi

Source: Wikipedia

3.3 Population analysis

3.3.1 Study Population

This study consisted of patients presenting to KATH with Kurtzman types IA and IB post burns axillary contractures during the study period

3.3.2 Sample Size

Several studies conducted around the world don't have a prevalence of axillary contractures. For this study, the prevalence of axillary contractures was adopted from a research done on the complications associated with burn injuries with gave the proportion attributed to axillary scarring as 36.7%[80]. The sample size estimation was based on Cochran's Bland formula for calculating sample for a single proportion as shown below:

$n = \frac{Z^2 P(1-P)}{d^2}$ where:

n=sample size

Z= 95% confidence interval

P= proportion

d=margin of error

The sample size for this study was calculated as;

$$\mathrm{n} = \frac{\mathrm{Z}^2\mathrm{P}(1-\mathrm{P})}{\mathrm{d}^2} = \frac{(1.96)^2 * (0.02)(0.98)}{(0.05)^2} = 0.07530/0.0025 = 30$$

Where

n=the desired sample size

P=0.02 assumed proportion of patients presenting with axillary contractures

d= 0.05 desired precision

A sample size of 30 was estimated for this study with a non-response rate of 10% added.

3.3.3 Study Flow

Patients (adults and children from1 year and above) who presented with post burns axillary contractures at KATH within the study period were screened by the principal investigator/ researcher at the Plastic Reconstructive and Burns Unit Out patients' clinic to determine their eligibility to participate in the study.

Initial data including the socio-demographics of the patient, aetiology, clinical examination findings to ascertain the type of axillary contracture were recorded. Patients presenting with post-burn scar contractures in the axilla were randomized into two groups (1:1), group 1 for use of full thickness skin grafting and group 2 for use of Z-plasty. All patients had the same chance to be selected for treatment using either of the methods employed in this study at the Plastic, Reconstructive and Burns Unit, out-patient department of Komfo Anokye Teaching Hospital. The parameters extracted included age, gender, cause of burns and the area of the axilla involved.

The preoperative investigations used in the evaluation of the patients included FBC, BUE, Creatinine, grouping and cross matching and where necessary, ECG and chest x-ray for patients above forty (40) years of age done as per the normal routine. Plain x-ray of the joints and bones of the affected limbs were performed. Pre and postoperative clinical photographs were taken.

Initial ranges of motion were measured using a double arm goniometer and limitations quantified.

Patient randomization was confirmed before the procedure, by the scrub nurse. This was done by the patients picking from a transparent bot containing papers marked S (skin grafting) and Z(z-plasty) that had been folded after which preoperative markings were done. After the procedure, the affected arm was placed in an aeroplane splint for a maximum of 10 (ten) days, during which time they would be on admission. Surgical site inspection was however done on post-operative day three (3) for patients randomized to Z-plasty and they were discharged two (2) days after.

Upon discharge, patients were reviewed two, four and six weeks post operatively with regular scheduled wound dressing done before the scheduled time at the Plastic surgery unit's dressing room

Post-operative complications were managed at the plastic surgery out-patient clinic.

3.3.4 Measuring tools

Axillary contractures that were surgically managed with z-plasty and skin grafting were operated on by the principal investigator during the course of the study. Normal full arm abduction is 180 degrees. Pre-operative arm incursion, and for the purpose of this study, the limit of arm abduction, was measured and same done immediate post operatively. The measured indices were compared to the normal (180 degrees) and expressed as percentages. This was done immediate post operatively, at two (2), and four (4) weeks post operatively.

The double arm goniometer was the tool used for the measurement (Figure 3.3).

Figure 3. 3: Double-arm goniometer

Source: Plastic surgery theatre. KATH. 2023

3.3.5 Patient selection Criteria

Inclusion Criteria

1. Patients with Kurtzman and Sterns types IA and IB post-burns axillary contractures more than 6 months old presenting to KATH.

Exclusion Criteria

1. Patients with co-existing co-morbidities that would interfere with the administration of anaesthesia

2. Patients who decided to opt out after the surgery.
3. Patients who, intra-operatively, were found to require other modalities other than the one employed for the study, for a successful release of the contracture.
4. Patients with keloids
5. Patients who had undergone previous surgery to release the contracture

3.4 Data management and analysis

Data collection was done using Ona (Nairobi, Kenya) electronic data collecting tool and exported to STATA v14 (College Station, Texas) for data cleaning and analysis. The analysed data was presented using frequencies, percentages and charts. Statistical significance for all testing was set as 0.05. Conclusions or recommendations were based on the data presented

3.5 Ethical considerations

Approval for the study was granted by the Committee of Human Research and Publication Ethics (CHRPE) of the Kwame Nkrumah University of Science and Technology, Kumasi.

A formal consent was sought from patients or in the case of minors, from their legal guardians. Information obtained from the patients were used solely for the purpose of this study.

3.6 Logistics and time schedule

This study was conducted over a six (6) months' period after approval by the dissertation committee and Ethical clearance granted by the ethical review committee of the Komfo Anokye Teaching Hospital. The first four (4) months was used for data collection and the last two (2) for data imputing, analysis and write up of the thesis. Throughout the study, the records were kept solely by the principal investigator after the collection of data. They would be retained for at least three to five years. Hard copies would be under lock and key. Soft copies are password protected.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results of comparing the functional outcomes of skin grafting and Z-plasty in the treatment of axillary contractures at KATH. The narrative is followed by tables and figures that show the results. The study enrolled 40 patients with axillary contractures in total, two (2) patients were lost to follow up with thirty-eight (38) as the final sample available for data analysis.

Data was obtained from patients' age, sex, duration of injury, and aetiology of injury. Information on the axilla involved and the type of contracture (Ia or Ib) was also tabulated.

Finally, anthropometric assessments we done, in this case measurement of the angle of abduction pre- and post-operatively over a period of four (4) weeks.

These were then computed and analysed to come to a definitive conclusion regarding the null hypothesis.

Pre- and post-operative photographs were taken to assess functional change as a result of the modality employed (Figure.4.1).

Figure 4. 1: Pre- and post-operative release with z-plasty

Source: Plastic surgery theatre. KATH 2023

Full thickness skin graft employed in the release of axillary contracture were perforated to prevent seroma formation. (Figure.4.2)

Figure 4. 2: Post-operative release with fill-thickness skin graft

Source: Plastic surgery theatre, KATH. 2023

Post-operative aeroplane splints were applied immediately post-operatively to immobilize the joints after release. (Figure. 4.3)

Figure 4. 3: Application of an aeroplane splint post-operatively

Source: Plastic surgery theatre, KATH. 2023

4.2 Demographic Status of Patients

The demographics of the patients cover age, gender, level of educational status, religious status, and aetiology of injury. Out of the 38 patients, 13 (34.21%) were males and 25 (65.79%) were females. The age distribution ranged from 2 years to 45 years with a median age of 13.5. The majority, 22 (57.89%) fell within the age category below 15 years with the rest, 16 (42.11%), being adults fifteen (15) years and above. More than half, 21 (55.26%) were Primary graduates. Almost three quarters of the patients, 28 (73.68%) were Christians while a few 10 (26.32%) were Muslims. Regarding aetiology of injury, exactly half 19 (50.00%) had flame burns, 12 (31.58%) had scald injury and a few 3 (7.89%) had electrical burns. (Table 4.1 below).

Variable	Frequency (N=38)	Percentage
Age group	**13.5 years**	
2 -14 years	22	57.89
15 - 45 years	16	42.11
Gender		
Male	13	34.21
Female	25	65.79
Educational status		
None	7	18.42
Primary	21	55.26
SHS	5	13.16
Vocational	5	13.16
Religion		
Christian	28	73.68
Muslim	10	26.32
Aetiology		
Chemical burn	4	10.53
Electrical burns	3	7.89
Flame	19	50.00
Scald	12	31.58

Table 4. 1: Demographic status of patients

Source: Field Data, 2023

The figure (Figure 4.4) below shows the normality of the Age distribution

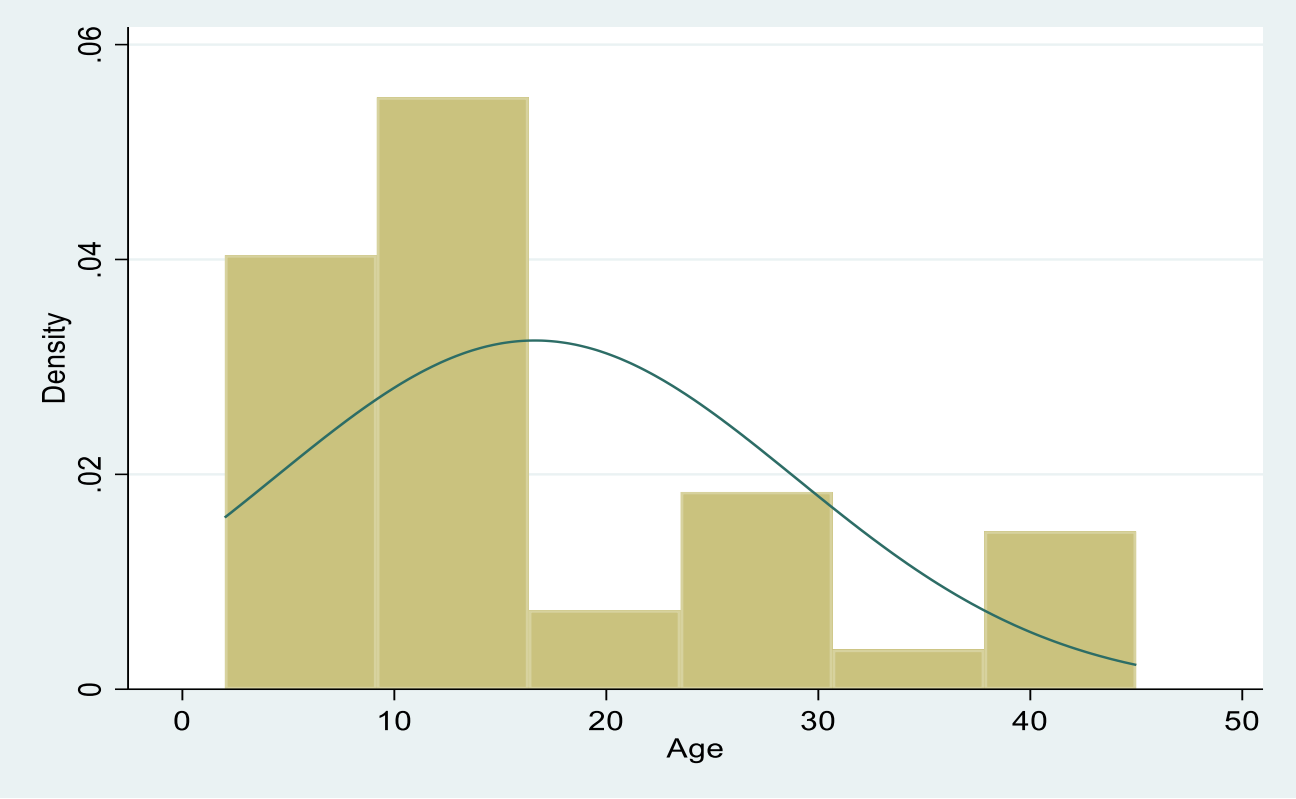


Figure 4. 4: Normality of Age distribution

Source: Field Data, 2023

4.3 Aetiology of Burns

19 (50%) patients were involved in flame burns, 12 (31.58%) had scald injury, 4 (10.53%) and 3(7,89%) patients were involved in chemical and electrical injuries respectively (Figure 4.5).

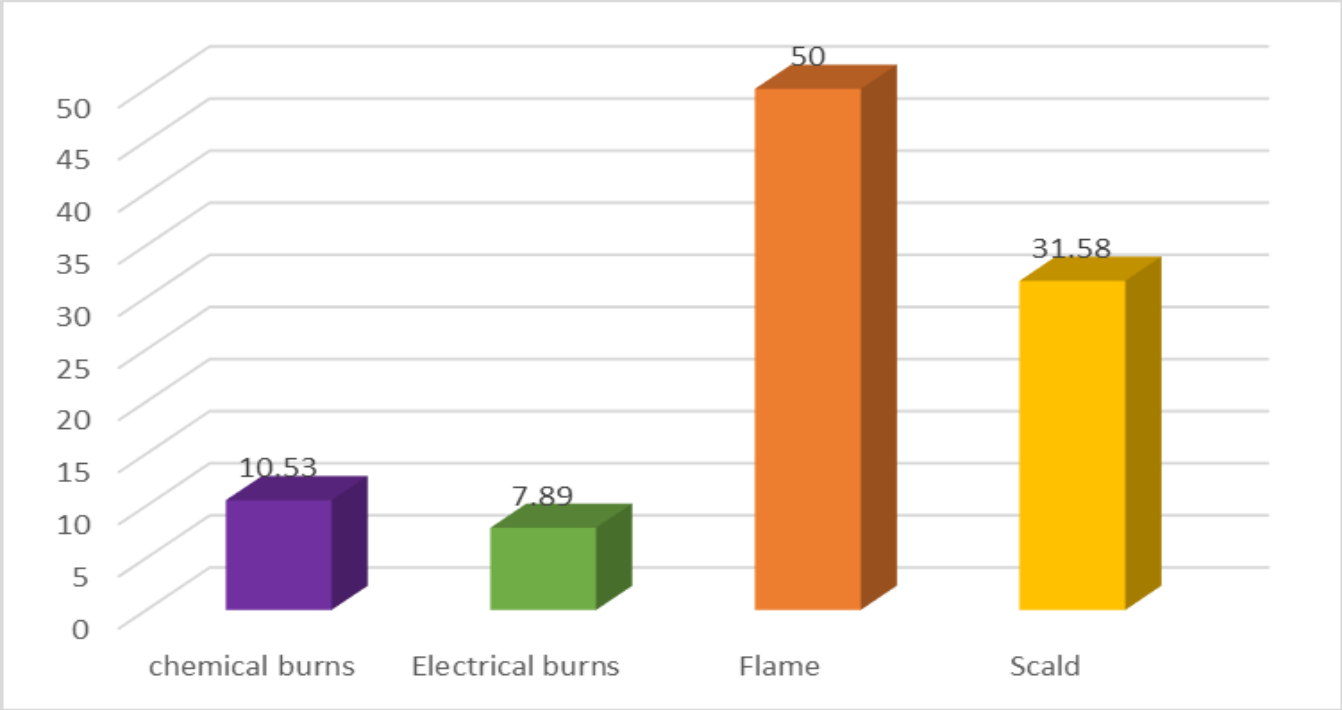


Figure 4. 5: Aetiology of Burn injuries

Source: Field Data, 2023

4.4 Co-existing medical disease

Patient were assessed on their history of existing medical disease that could have impacted on their sustaining the burn injury, specifically any seizure disorder. Almost all patients 36 (94.74%) had no existing medical disease whiles just 2 (5.26%) had some history of medical disease (seizure disorder).

4.5 Duration of injury

The duration of injury ranged from 2 months to 50 months with a median of 20.9 months. Majority of the patients 24 (63.15) had their injury less than two years (Figure. 4.6). This was required as the definition of a matured scar was that of six (6) months and above

Figure 4.6 shows the time between injury and presentation to out-patients clinic with normal distribution.

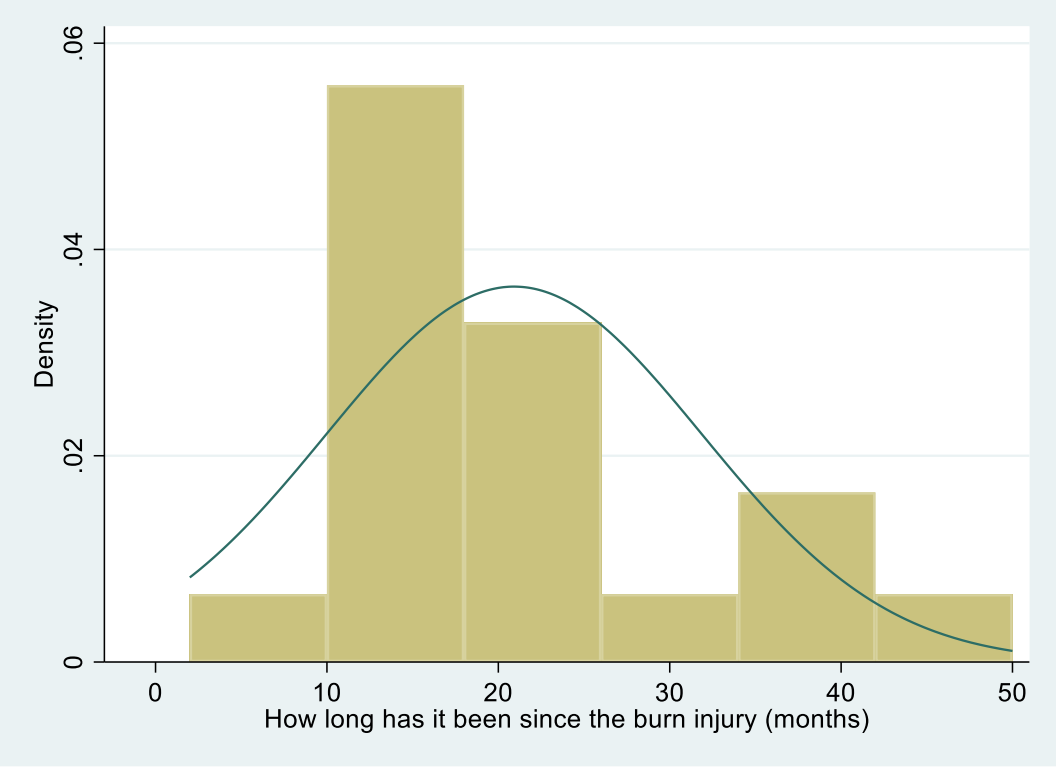


Figure 4.6: Duration of injury

Source: Field Data, 2023

4.6 Shoulder joint involved in burn injury

A little over half of the patients operated on. (52%) had the left shoulder joint involved in the contracture with 45% with right axillary contracture. Only 3% had involvement of both shoulders involved in scarring. (Figure. 4.7)

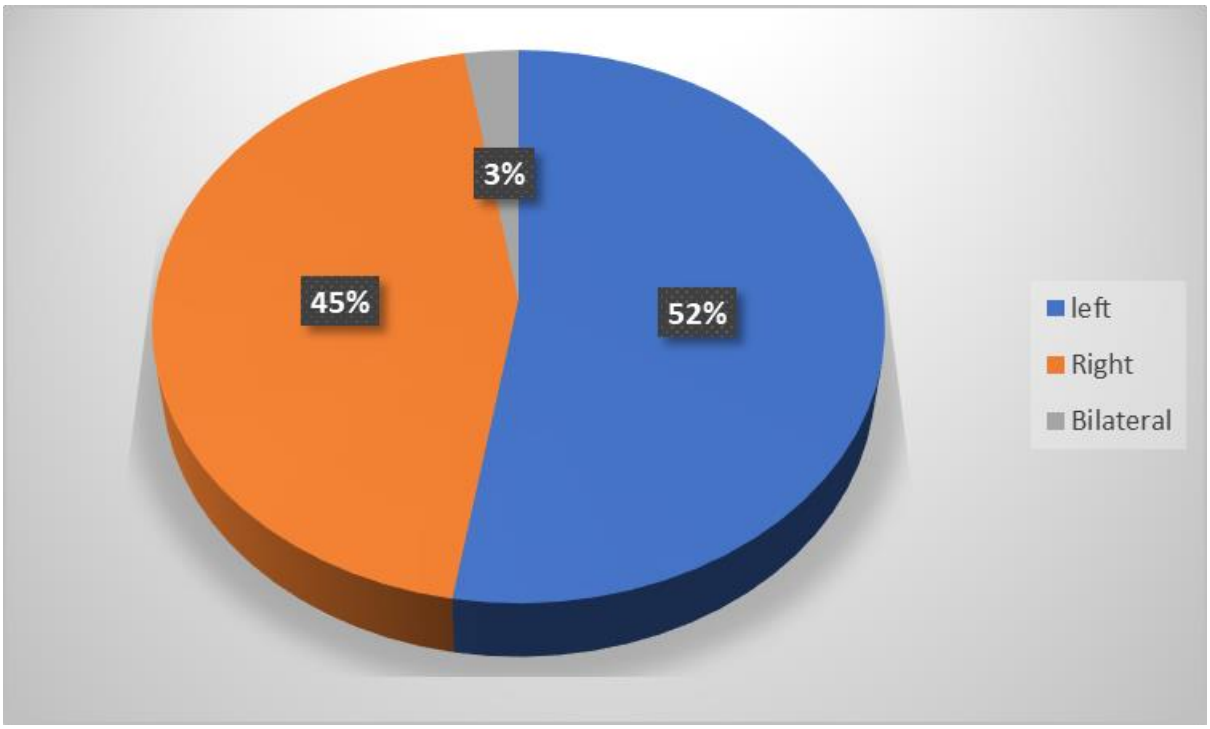


Figure 4.7: Laterality of Burn injury

Source: Field Data, 2023

4.7 Classification/ Type of Contracture

With respect to axillary fold involvement, 23(61%) patients had type Ia and 15(39) patients with type Ib axillary contractures respectively. (Figure.4.8)

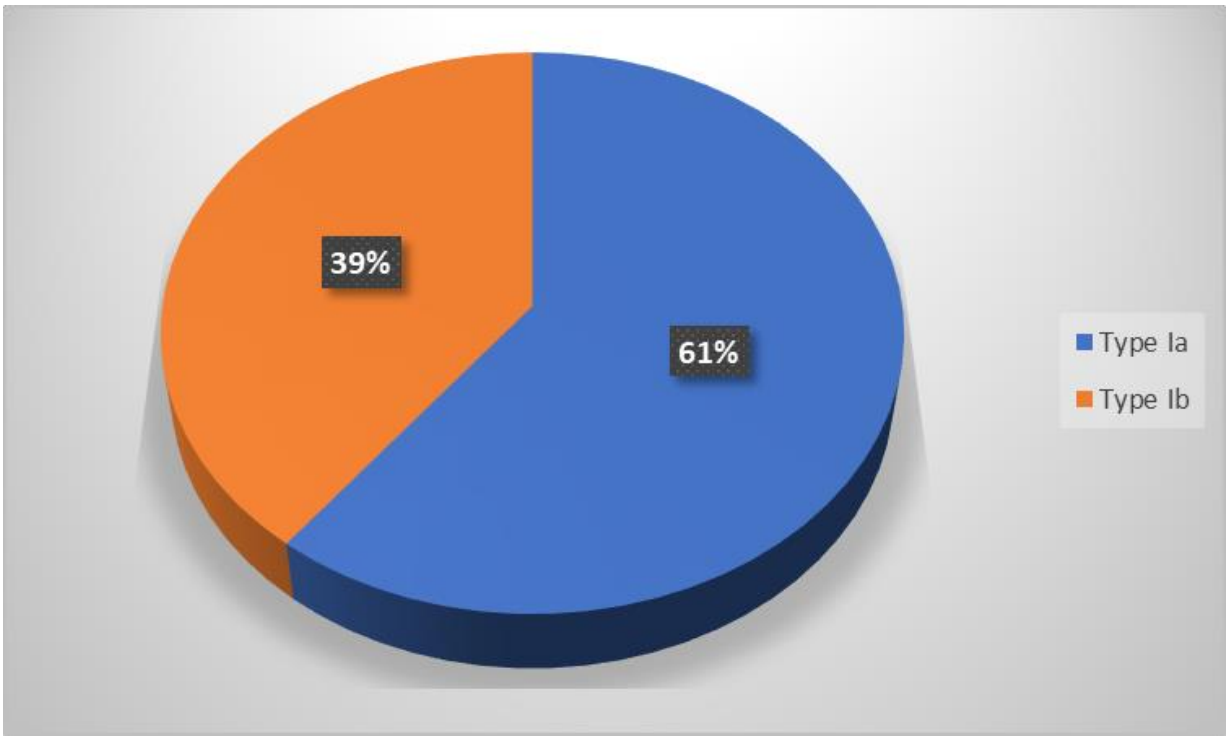


Figure 4.8: Contracture type

Source: Field Data, 2023

4.7 Arm abduction measured pre- and post- operatively

Arm abduction as a function in this study was assessed pre- and post- operatively. Shapiro normality test shows data was not normally distributed for arm abduction measured post operatively. There was however a normal distribution of measured results pre-operatively (Table 4.2).

Variable	W	V	Z	P - Value
Preoperative	0.96484	1.336	0.608	0.27154
Post operatively immediate	0.82584	6.618	3.965	**0.00004***
2 weeks Post-operative	0.89666	3.927	2.870	**0.00205***
4 weeks Post operatively	0.91935	3.065	2.350	**0.00939***

Table 4. 2: Shapiro Wilk W test for normal data Source: Field Data, 2023

4.7.1 Pre-operative arm abduction

Figure. 4.9 shows pre-operative arm abduction (in degrees) measured using the goniometer with normal distribution

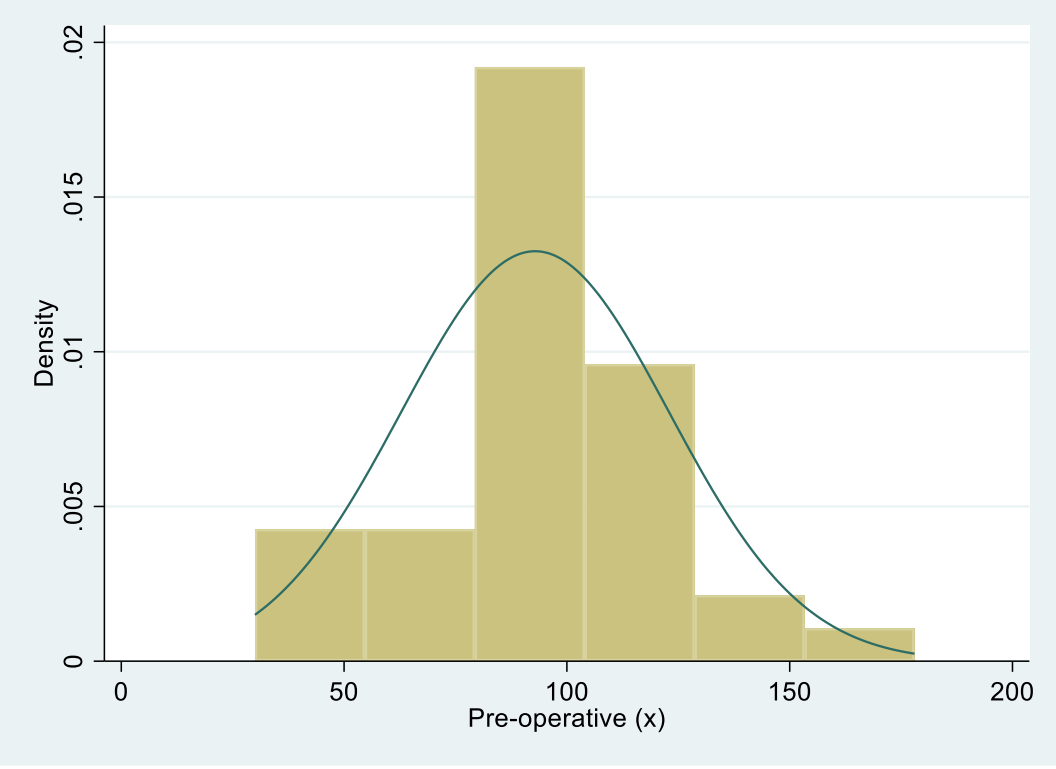


Figure 4.9: Pre-operative arm abduction (in degrees)

Source: Field Data, 2023

4.7.2 Post-operative Arm abduction

Figure.4.10 is a representation of the results of measurement of the post-operative arm abduction done immediately, at two (2) and four (4) weeks respectively.

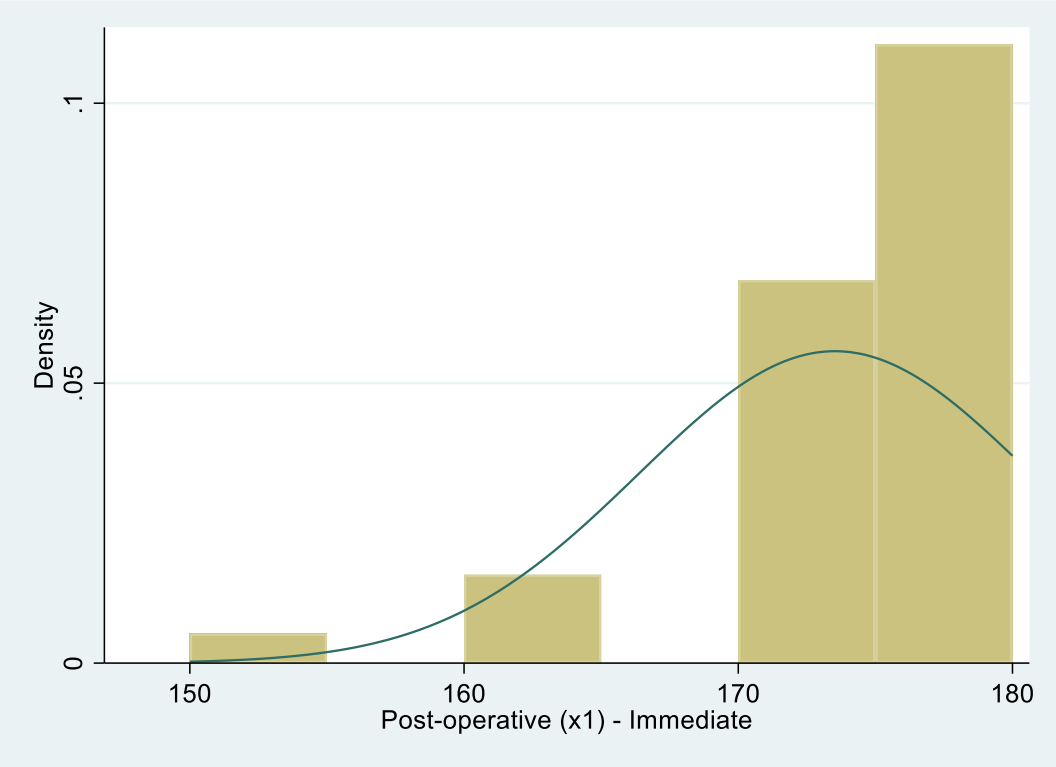


Figure 4. 10: Immediate post-operative arm abduction (in degrees)

Source: Field Data, 2023

Figure. 4.11 shows the arm abductions measured two (2) weeks post operatively and noted not to be normally distributed

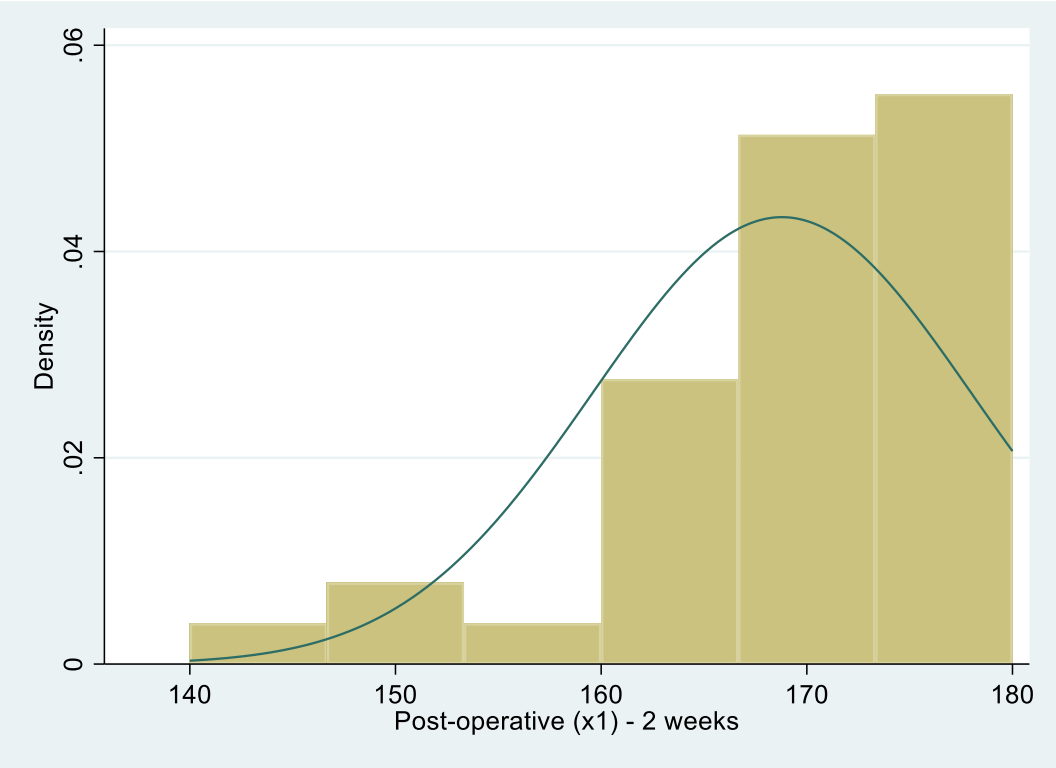


Figure 4. 11: Two (2) weeks post-operative arm abduction (in degrees)

Source: Field Data, 2023

Figure.4.12 represents post-operative measurement of arm abduction done at four (4) weeks

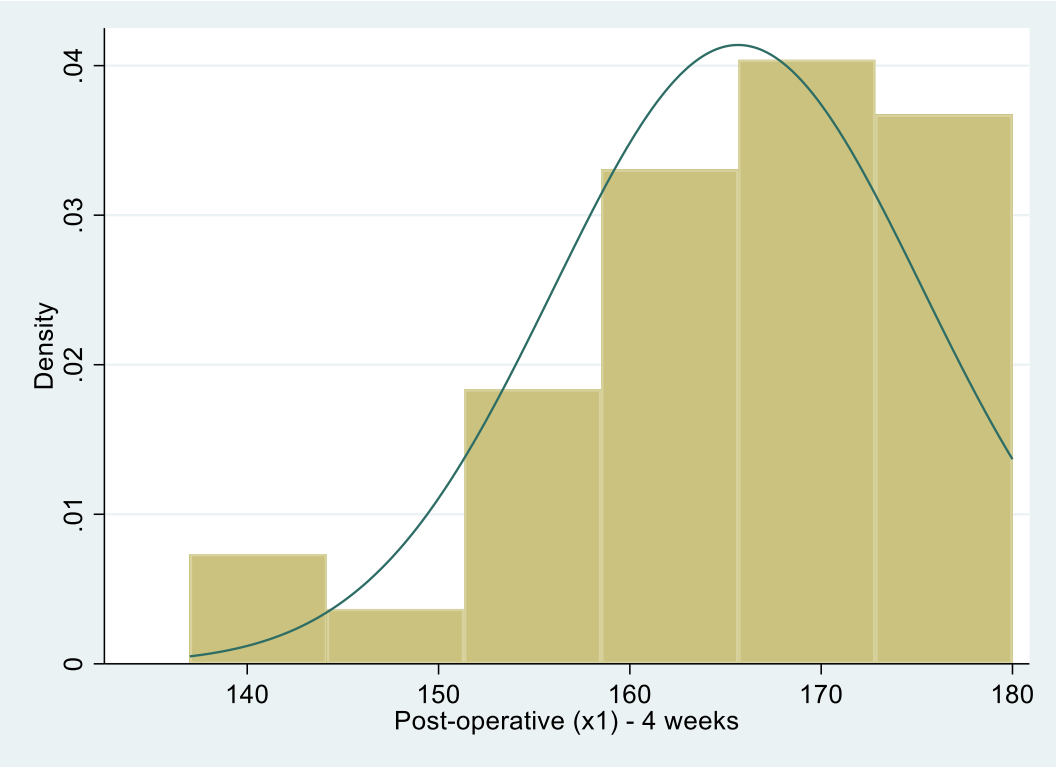


Figure 4.12: Four (4) weeks post-operative arm abduction (in degrees)

Source: Field Data, 2023

The table below (Table 4.3) represents the change in arm abduction measured pre- and post-operatively quantifies their mean and or median where appropriate. The pre-operative measurements on account of their normal distribution had a mean of 92.86 (Standard Deviation (SD 30.10). The post-operative measurements, in contrast were not normally distributed and the median was observed to gradually decrease from 175 (51.28 Variance) immediately post-operatively, 170 (84.76) two (2) weeks post-operatively to 168 (92.93) at four (4) weeks.

Variable	**Mean (SD)**	**Median (Variance)**	**CI**
Preoperative	92.86 (30.10)		82.96 – 102.75
Post operatively immediate		175 (51.28)	34.08 – 85.83
2 weeks Post-operative		170 (84.76)	56.33 – 141.86
4 weeks Post operatively		168 (92.93)	61.76 – 155.54

Table 4. 3: Change in arm abduction (in degrees)

Source: Field Data, 2023

4.8 Surgical modality employed for contracture release

For the purpose of this study Z-plasty and full thickness skin grafting were the modalities of choice.

20 patients representing 52.63% had release of contracture with full thickness skin grafting done whiles 18 (47.37%) has Z- plasty as the technique employed for release of contracture.

4.9 Association(s) between Post-operative arm abduction and surgical modality using Two-sample Wilcoxon rank-sum (Mann–Whitney) test

The distribution of the association between post-operative arm abduction modalities is illustrated in table 4.4. Post-operative arm reductions were seen in both operating modalities used in this study. Patients operated with Skin grafting model had an immediate post-surgery rank sum of 411 while patients operated with Z plasty had 330. In a two week follow up, there was a decrease in patients operated with the Skin grafting model to 408.5 while there was an increase in the rank sum of patients operated with the Z plasty model. Additionally, there was a further decrease in the rank sum of patients operated with skin grafting to 402.5 and an increase in the rank sum of patients operated with the Z plasty model to 338.5. However, there was no statistical significance between the post-operative arm movement in patients operated using the two modalities (p-value immediate, 0.53, 2 weeks 0.59 and 4 weeks 0.72).

Variable	Rank sum	Expected	p-value
	Post operatively immediate		
Surgical modality			0.53
Skin grafting	411	390	
Z plasty	330	351	
	2 weeks Post-operative		
Surgical modality			0.59
Skin grafting	408.5	390	
Z plasty	332.5	351	
	4 weeks Post-operative		
Surgical modality			0.72
Skin grafting	402.5	390	
Z plasty	338.5	351	

Table 4. 4: Association(s) between surgical modality and post-operative arm abduction using two-sample Wilcoxon rank-sum (Mann-Whitley) test. Source: Field Data, 2023

4.10 Association(s) between complication and Surgical modality

Each method employed in the release of the axillary contractures resulted in some post-operative complications. Out of 20 cases of skin grafting done, nine developed some form of complications compared to Six (6) out of twenty (20) z-plasty procedures. A P-value of 0.46 implies no statistical significance when the values are compared.

Table 4.5 gives the association between the modalities employed in the release of the axillary contractures and the complications resulting from these modalities.

Variables	No complication	complication	X^2	P-value
Surgical Modality			0.53	0.46
Skin grafting	11 (47.83)	9 (60.00)		
Z plasty	12 (52.17)	6 (40.00)		

Table 4. 5: Association(s) between surgical modality and complications

Source: Field Data, 2023

CHAPTER FIVE

DISCUSSION

5.1 Introduction

Axillary contractures can cause severe limitations due to the unique joint movement compared to other regions. Flexion, extension, adduction, abduction, internal and external rotation are the movements of this joint that can be limited when either the anterior or posterior fold or the axillary dome is scarred.

Data on axillary contractures is deficient and most fall under a larger umbrella of contractures and are not comparable enough. Most deal with specific surgical modalities to ascertain its success.

Release of type Ia or Ib (Kurtzman and Steins' classification) axillary contracture is done with varying modalities ranging from skin grafting to the use of free flaps in some cases depending on the status of the surrounding skin and even the deeper tissues involved in the scarring, and may also be operator dependent.

The idea for this study is to assess, from the results deduced from the data, can form a basis for a standardized protocol which can be used not only in the teaching hospital but at the peripheries

5.2 Demographics of patients

5.2.1 Age.

A total of thirty-eight (38) patients were recruited for this study. The median age was 13.5 years. In this study, that is the paediatric population which seems to be supported by literature. Kraemer et al, in 1988, published, in a study of fifty-three (53) patients found that majority of people involved in post burns sequel were children and the scarring were mostly in the axilla as well as the upper body[52].

In a review of burns in Sub-Saharan Africa, the average age after reviewing over thirty thousand (30,000) patients was 15.3 years, comparable to the median age in this study majority were children, also in line with the findings in this study[53].

This stresses the distressing issue about children being the most vulnerable population involved in post burns complications such as contractures and the need for measures to protect.

The design of the rural houses (compound house design) and even the low class urban settlements is such that the kitchen set-up is not child friendly. Children are able to run towards open fires or cooking pots or pans whiles playing around these un-protected areas. They are thus susceptible to hot splashes and dressing catching fire.

Anna Tyson et al found the median age of 454 patients involved in a study to be 4 years in contrast to 13.5 years found in our study. The difference compared to this study is wide but still reiterates the fact that the dominant group with respect to burns and post burns possible contracture formation is children[54].

The axillae of 30 patients (24 females and 6 males) were affected on the right side in 20 patients and the left side in 10 cases. There were 7 men (22.6%) and 24 women among the patients with axilla contracture, whose mean age was 16.4 years (within a range of 3 to 62 years) (77.4%). With a mean age of 16.4 years, the shoulder range of motion increased noticeably from 111.0° of abduction to 149.4° of adduction postoperatively. The elbow range of motion increased from 76.6° of flexion to 108.6° of extension preoperatively to 18.5° postoperatively, with a considerable decrease in the residual elbow contracture from 60.5° preoperatively to 18.5° postoperatively. A three-month follow-up was typical (range, 1.5-7 months)[81].

There is paucity of age incidence when it comes to post-burns axillary contractures as the general study looks into contractures in general and only mentions the axilla as a foot note. This study, in assessing strictly, axillary contractures and being able to confirm that as with other areas involved in scarring, children form the highest age group in this form of contractures is most revealing.

5.2.2 Gender disparity

With a sample space of thirty-eight (38), 25 (65.8%) were females and 12 (34.2%), males with a ratio of 2.1:1. This presupposes that majority of those involved in post burns axillary scarring are females. The typical settlement in Ghana is about females working in the kitchen or being involved in domestic burn accidents so it is not too far-fetched to think that they would commonly be in the majority of any study involving burn injuries

This fits in with a study done by Kumaran in 2008 which reported a 3:1 ratio of females to males[4]. In contrast, a study in 2021 by Mehta et al reported more males (62%) than females (38%) involved in burn injuries although females received less hospital surgical treatment compared to males[58].

Most studies report a more male preponderance as also suggested by Anna Tyson et al who found 53% of the 454 patients studied were males[54].

Although females might be thought to be more susceptible to burn injury due to their work in the domestic environment, most of the data in literature dealt with children who were not active workers. Male children are very active during play and are more likely to run around open fires or actively cooking environment. Out of curiosity, they are likely to play towards and tip over pans on fire.

In this study, most of the patients co-opted into the study were older children and adults. These older children help their parents in the kitchen or run errands so they could easily be involved in domestic accidents.

5.3 Pre-existing medical Condition

2 (5.3%) of our respondents were found to have a seizure disorder. No respondent reported any medical condition that was in any way linked to the burn injury and subsequent scarring.

In a review by Zahid Ansari et al, results showed people with seizure disorders were three (3) times most likes to be involved in burns that the general population[82].

Patients with seizure disorders involved in burn injuries are more likely to have full thickness burns which is more associated with contracture formation[83]. The seizures occurring just before the injury or caused but the flickering flames lead to the patient lying unconscious in the, or around the aetiological agents perpetuating the damage process such that the higher likelihood of post-burns sequelae such as contractures.

One of the two respondents had bilateral axillary scarring which underscores the severity of the injury in patients with seizure disorders who are unable to extricate themselves from the injurious agent and thus have a more extensive total body surface area (TBSA) involved.

This study result, 3%, compares positively with one done by Jiburum et al. in Nigeria where in a study a period of 10 years, 18 (3.7%) of 485 patients studied had full thickness burns which were caused by flame burns[84].

E.J.K Adu and Koranteng, in a ten-year review of burn injuries in Kumasi confirmed epilepsy as becoming a leading cause of burn morbidity in their results which found that peri-operative deaths occurred in four (4) patients with the disorder[35].

5.4 Aetiology of burns

Thirty-eight (38) patients with axillary contractures were recruited into this study of which 19 (50%) had flame burns, 12 (31.58%) had scald injuries, 4 (10.53%) were involved in chemical injuries and 3 (7.89%) electrical burns. The research done by Kobayashi in 2005 reported a similar finding of flame burns as the primary cause of injury (45.6%) followed by scalds (32.0%)[60].

Mehta et al in a study of childhood burn injuries and domestic risk factors confirmed flame burns as the leading cause of burns in households[63]. Olaitan PB et al, in an article about the epidemiology and prevention of burns in a developing country, published in the Nigerian journal of medicine, tabled flame burns (49.1%) as the topmost aetiology followed by scalds (37.9%) and the second most common[85]. This compares to the results obtained in this study.

The use of wood and charcoal for cooking, thus, open fires which are low-set in terms of height in open areas devoid of protective mechanisms results in these two aetiological agents being on top of the ladder.

In contrast to the findings obtained from this study, a publication by Peter Nthumba in 2015 found scald injury (59%) accounting for the commonest cause followed by flames associated burns (33%)[53]. Another study done in East Africa which analysed data from about 14 countries determined scalds (61%) is the commonest cause of injury, with flame burns (17%), in second place[86].

Another publication confirmed flame as the commonest aetiological agent in a study which revealed Initial burn insults included flame burns in 174 instances (81.69%), electrical burns in 21 cases (9.85%), scalds in 17 cases (8.45%), and acid burns in one case (0.1%)[87].

Although there is data about aetiology of burns in general in literature, the aetiology specifically associated with post-burns axillary contracture still remains deficient although same can be adduced from general burn injuries.

5.5 Laterality of Injury

Out of the 38 patients assayed, scarring involved the left shoulder in 20 (52%) patients, the right shoulder in 17 (45%), and only 1(3%) patient had bilateral involvement. The comparable values go to show that the mechanism of injury does not have an effect on which side of the body is most affected.

Out of these 30 individuals studied in this research, 20 had involvement of the right axilla and 10 had involvement of the left. There were 7 males (22.6%) and 24 females among the patients with axilla contracture, whose mean age was 16.4 years (within a range of 3 to 62 years) (77.4%). With a mean age of 16.4 years, the shoulder range of motion increased noticeably from 111.0° of abduction to 149.4° of adduction postoperatively. The elbow range of motion increased from 76.6° of flexion to 108.6° of extension preoperatively to 18.5° postoperatively, with a considerable decrease in the residual elbow contracture from 60.5° preoperatively to 18.5° postoperatively[81].

5.6 Contracture Type

Of the sample analysed, 23(61%) patients had type Ia contractures (Anterior axillary fold) make this form of scarring the commonest contractures. 15 (39%) patients presented with type Ib axillary contractures.

Ahmed Walash et al in a study in 2014 corroborated the presentation of type Ia axillary contracture as the commonest scar type with 48% compared to 16% of type Ib scars[14]. In a review of 16 patients presenting to an out-patients clinic in Kolkata, the findings were about the same with 4 and 3 patients having type Ib and Ia contractures respectively[88].

The anterior axillary fold contracture (type Ia) is confirmed as the commonest site of scarring in a publication by Ngim RC et al in The Annals of Academy of Medicine, Singapore in 1983[89]. Another contradictory study reports type Ib contracture (36%) as the commonest type with type Ia contracture following (28%)[10].

5.6 Modality of Release and results

The methods of release for post-burns axillary contractures are numerous and differ with respect to the type of contracture, the surrounding tissue integrity, possible complications and sometime operator preference. This study sought to compare the modalities of skin grafting and z-plasty.

Out of a total of 38 patients recruited for this study, skin grafting was employed as the surgical modality for release in 20 (52.63%) and z-plasty in 18 (47.37%).

The pre-operative arm abduction measured ranged from 30 degrees to 178 degrees with a normal distribution and a mean of 90.86 degrees (30.10 SD). Normal shoulder abduction is stated around 150 degrees so analysis in this study was to ascertain which surgical modality produced the highest change in arm abduction over the pre-operative levels.

Immediate post-operative arm abduction was remarkable with both modalities ranging from 150 degrees to 180 degrees (the maximum normal angle of abduction permissible) and a median of 175 degrees (51.28 Variance) as the values were not normally distributed. It must be stated that, immediate post-operative abduction was done and measured passively as patients had still not recovered from general anaesthesia.

Results at two (2) weeks post operatively, also not normally distributed gave a median of 170 degrees (84.76 Variance).

At four (4) weeks post operatively, the median abduction value was 168 (92,93 Variance). After full-thickness skin grafting, the aeroplane splint was used till the end on review of four (4) weeks but same was not done after z-plasty. This compares with that published by Karki et al, who after the use of local flaps to release axillary contractures, no splinting regimen was employed[56].

5.6.1 Complications

Out of twenty (20) skin grafting done, there were 9 complications which mainly graft loss and donor-site morbidity as opposed to six (6) complications out of the eighteen cases which were managed with z-plasty. The complications had to do mainly with flap tip necrosis leading to wound dehiscence, these complications were managed conservatively with regular wound dressing at the out-patient clinic.

5.6.2 Comparative analysis

Increased shoulder mobility and reduction in compensatory movements are a result of the surgical relief of the axillary contracture. At long term follow-up, improvements remain. All shoulder movements, excluding shoulder flexion during high reach tasks and shoulder abduction with the hand at the back, were not statistically different from normal values. The short- and long- term effects of axillary contracture release procedures increases shoulder function[13].

No one procedure (either skin grafting or z-plasty) was observed to have an advantage over the other in terms of improvement in function. One distinct feature noticed was that, as the rank sum for skin grafting reduced over the four (4) week period following surgery (411 -408-402), that for z-plasty increased steadily (330-332.5-338.5). It could be inferred that, in the very long term z-plasty as a modality can improve arm abduction better than skin grafting but a large sample space might be needed to make this inference.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Axillary contracture as a subset of post-burn contractures have been studied into detail with respect to methods of release. Most modalities analysed are flaps of different orientations. Data on comparative analysis of various modalities employed in contracture release are deficient at least.

This study has shown that skin grafting and z-plasty are modalities that can be used efficiently in the release of Kurtzman and Steins' type Ia and Ib axillary contractures with no advantage of one over the other.

6.2 Recommendations

Anterior and posterior axillary fold contractures can be released using either z-plasty or full thickness skin grafting so far as the surgeon is capable.

Before using any surgical technique, formal consent is always required, along with patient or guardian information of potential consequences and how such issues would be managed. More studies on the demographics of post-burn axillary contractures is needed as a stand-alone analysis to be able to make definite pronouncements.

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APPENDIX I

CASE REPORT FORM

COMPARISON OF THE FUNCTIONAL OUTCOME IN THE RELEASE OF AXILLARY CONTRACTURES USING EITHER Z-PLASTY OR SKIN GRAFTING

This case report form is to determine the advantage of one modality over the other, after the release of post burns posterior and anterior axillary fold contractures

SECTION A

Study ID: [___] [___]

Date (*DD/MM/YYYY*) [___] [___] / [___] [___] / [___] [___] [___] [___]

PATIENT DERMOGRAPHICS	
1. Age *(at last birthday in* years*)* **[___] [___]**	
2. Sex *(please circle the appropriate)*	Male……..1 Female……..2
3. Where do you live? **…….**	
4. Last level of education completed	Primary……....1 Secondary……2 Tertiary……3 Post graduate……...4 Professional…….5 Vocational…….6 None…… 9
5. What is your religious status *(circle one)*	Muslim……1 Christian…….2

Traditional……...3

MEDICAL HISTORY OF PATIENT

6. **How long has it been since the burn injury** *(months)*

   a. [___] [___]

7. **What caused the burn injury** *(circle one)*

   Hot liquid…….1

   Fire …….2

   Electrical burn…….3

   Chemical burn…….4

   Frictional burns……...5

   Others *(state)*…….

8. **Have you had any previous surgery for the contracture?** *(Circle one)*

   Yes…….1

   No……...2

9. **Do you have any coexisting medical disease?** *(Circle one)*

   Yes…….1

   No……...2

   If Yes, please state

   ……..

   ……..

ANTROPOMETRIC ASSESSMENT (using the double arm Goniometer)

10. Axilla involved

Left…….1

Right……...2

Bilateral……..3

11. Limit of angle of arm abduction *(in degrees)*

Pre-operative *(x)*…….

Post-operative*(x_1)* immediate…….

@ 2 weeks…….....

@ 4 weeks……

12 Limit of arm abduction ***(x, x_1/180(in percentages)***

Pre-operative…….

Post-operative (immediate)……

@ 2 weeks…….

@ 4 weeks…….

13. Change in angle *(in percentages)*

Post-operative (immediate)**……%**

@ 2 weeks……%

@ 4 weeks……..%

14. Complications *(Circle one)*

Graft loss……1

Donor site morbidity……2

Re-contracture……3

Others *(State)*…….

APPENDIX II

CONSENT FORM

Research investigator: Kwadwo Adae-Aboagye

Research Investigator contact: Directorate of Surgery, Komfo Anokye Teaching Hospital, Kumasi. 0206300637

Research Supervisors: Dr. Joseph Akpaloo/ Dr. Hoyte-Williams.

Research Title: Comparison of the functional and aesthetic outcomes in the use of two different modalities (z-plasty and skin grafting) in the release of Kurtzman and Steins type 1a and 1b post burns Axillary contractures

Please read through the document carefully and do not hesitate to ask questions where necessary before you append your signature of thumbprint in the space provided at the end of the document. Do inform the individual administering this document if for any reason you need adequate time out or the assistance of relations to help in decision making

Research Purpose:

In the management of the surgical condition you have, there are various surgical procedures that can be employed to achieve the same result but none has been found to have a better outcome or advantage over the other. We are thus, going to employ two modalities commonly used to find out if one gives a better outcome so that we can apply it to others as an official guideline or protocol

What would happen during the study:

Should you agree to be part of this study, we would place you in one of the two surgical modality category by randomly balloting. Your data would be collected before the start of the pre- surgery processes and would be kept in confidence. You would go through the routine laboratory

investigations which would include taking a bit of your blood to make sure you can perform the surgery, and measuring your current range of motion in your affected limb and anaesthetic assessment and when given the green light, you would be admitted and the surgery performed, as per the modality chosen by you. Immediately after the surgery you would be placed in a cast (POP), which would be kept for a minimum 7 days which is also the maximum time you might have to be kept in the hospital. We would monitor you when you leave the hospital with regular wound dressing for a maximum one (1) month at which time we would assess your range of motions again and compare to when we initially saw you

Would my information be used for any future projects?

There is a possibility but you can be assured that any information which could identify you would be taken out to protect you (or your child). Your confidentiality is at the very top of our list.

Are there any risks involved in this study?

It is possible that you would feel some discomfort when we are measuring the range of motions after the surgery but on the whole those movements would help in faster healing

Benefits:

This study would help the hospital standardize the type of procedure(s) used to manage this type of condition.

Compensation:

You would be paid if you we have to see you any number of times outside the routine schedule you would be given

Can I opt out at any point in this study?

You are at liberty to opt out at any time and we can assure you it would not affect the standard of care we would continue to give you although we hope you would be part of the study.

What happens if I have any concerns during the study?

We would be happy to listen to any concerns you might have. Feel free to call the principal investigator, Kwadwo Adae-Aboagye on 0206300637 or contact my supervisors Dr. Joseph Akpaloo or Dr Hoyte-Williams on 0208362768 or 0246766466 respectively

PARTICIPANTS' CONSENT

PARTICIPANTS' STATEMENT

I confirm that I have read through the statement in this document and have I am satisfied with the answers to all my questions, explained in the_____ language. I understand that at any point I can change my mind, even after signing this document and withdraw from the study with no change in the standard of care I would require

I hereby agree to be part of this study

Signature---------- OR

Thumb Print----------

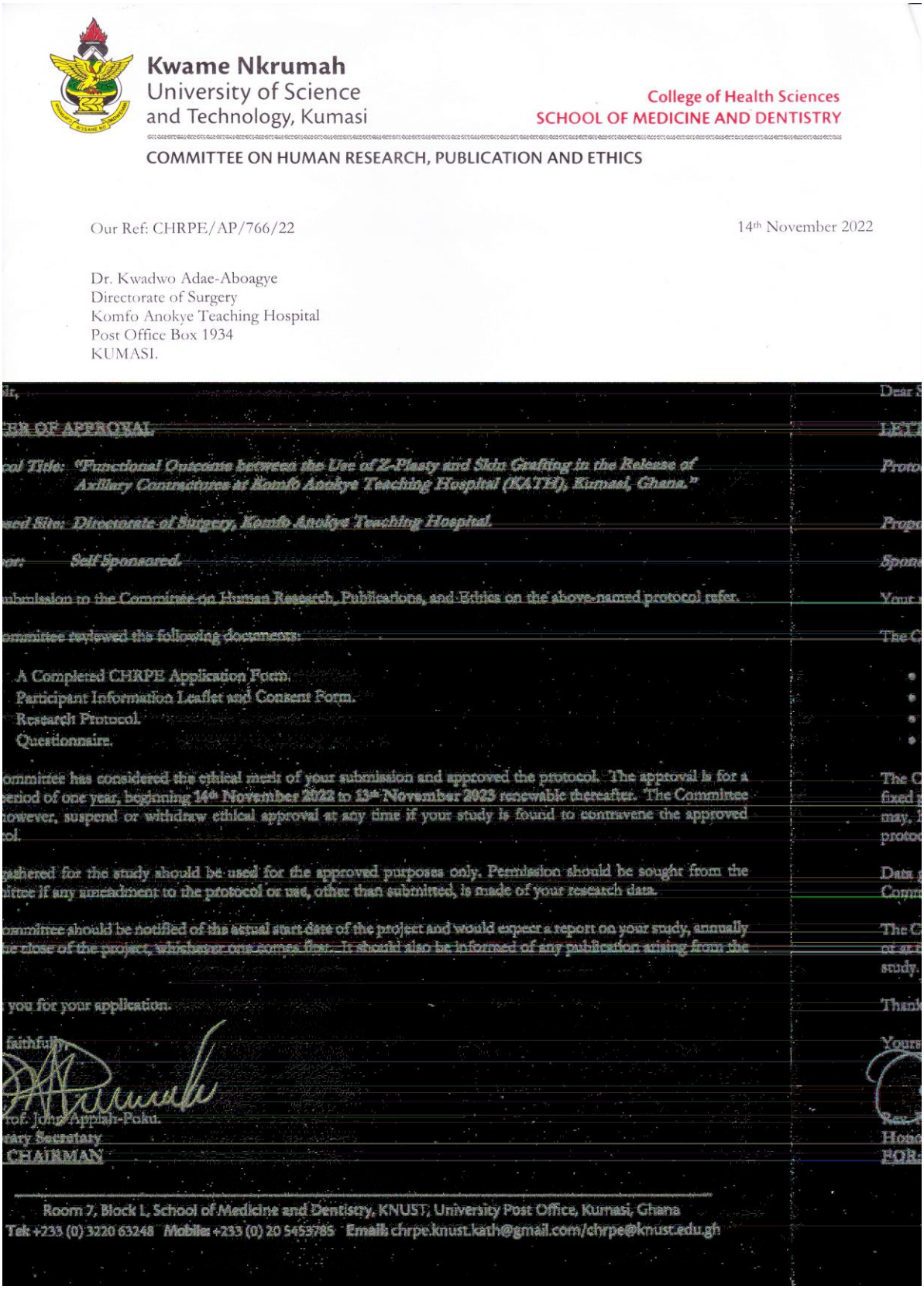
RESEARCHER STATEMENT

I acknowledge that I have explained to the participant the details of the study and all questions and concerns have been duly addressed

Researcher’s name----------

Signature----------

Date----------



Kwame Nkrumah
University of Science
and Technology, Kumasi

College of Health Sciences
SCHOOL OF MEDICINE AND DENTISTRY

COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS

Our Ref: CHRPE/AP/766/22

14th November 2022

Dr. Kwadwo Adae-Aboagye
Directorate of Surgery
Komfo Anokye Teaching Hospital
Post Office Box 1934
KUMASI.

Dear

LETTER OF APPROVAL

Protocol Title: "Functional Outcome between the Use of Z-Plasty and Skin Grafting in the Release of Axillary Contractures at Komfo Anokye Teaching Hospital (KATH), Kumasi, Ghana."

Proposed Site: Directorate of Surgery, Komfo Anokye Teaching Hospital.

Sponsor: Self Sponsored.

Your submission to the Committee on Human Research, Publications, and Ethics on the above-named protocol refer.

The Committee reviewed the following documents:

- A Completed CHRPE Application Form.
- Participant Information Leaflet and Consent Form.
- Research Protocol.
- Questionnaire.

The Committee has considered the ethical merit of your submission and approved the protocol. The approval is for a period of one year, beginning 14th November 2022 to 13th November 2023 renewable thereafter. The Committee may, however, suspend or withdraw ethical approval at any time if your study is found to contravene the approved protocol.

Data gathered for the study should be used for the approved purposes only. Permission should be sought from the Committee if any amendment to the protocol or use, other than submitted, is made of your research data.

The Committee should be notified of the actual start date of the project and would expect a report on your study, annually or at the close of the project, whichever one comes first. It should also be informed of any publication arising from the study.

Thank you for your application.

Yours faithfully,

Prof. John Appiah-Poku.
Honorary Secretary
FOR: CHAIRMAN

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