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Instruction to authors

The Nigerian Journal of Plastic Surgery is the official Journal of the Nigerian Association of Plastic Reconstructive and Aesthetic Surgeons and also of the Nigerian Burn Society. Its object is to publish original articles about developments in all areas related to plastic and reconstructive surgery as well to burn trauma and to provide a forum for correspondence, information and discussion. It is a peer review journal. All correspondence should be sent to O.M. Oluwatosin, Editor NJPS oluwatosinom@yahoo.com

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Hypertrophic scars and keloids: a review of the current literature on the aetio-pathogenesis and management strategy

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Summary
Background: Hypertrophic scars and keloids result from an abnormal fibrous wound healing process in which tissue repair and regeneration-regulating mechanism control is lost. Patients typically present with cosmetic concerns, although they can also cause pruritus, pain, and pressure. They present a major therapeutic challenge to the plastic surgeon. This article reviews various treatment modalities for these abnormal scars and the updated findings of molecular scar biology.

Method: A computerized literature search using MEDLINE was conducted for review articles in the English language on hypertrophic scars and keloids. The medical subject headings of "hypertrophic scar" or "keloid" were combined with "aetio-pathogenesis" or "therapy" using the Boolean operator "AND" to narrow the searches. Two hundred and fifty seven articles were brought up out of which less than one half were found relevant and reviewed.

Conclusion: The growing understanding of the molecular processes of normal and abnormal wound healing is promising for discovery of novel approaches for the management of hypertrophic scars and keloids. Although optimal treatment of these lesions remains undefined, successful healing can be achieved only with combined therapeutic regimens.

Keywords: Hypertrophic scar, keloid, pathogenesis, management

Introduction
Hypertrophic scars and keloids are significant public health problems in the tropics and it is important to have an up to date knowledge of relevant advances in their etiology and treatment. They result from an abnormal fibrous wound healing process in which tissue repair and regeneration-regulating mechanism control is lost. They present a major therapeutic challenge to the plastic surgeon. This article reviews the updated findings of molecular scar biology as well as various treatment modalities for these abnormal scars. The growing understanding of the molecular processes of normal and abnormal wound healing is promising for discovery of novel approaches for the management of hypertrophic scars and keloids. The optimal treatment of the lesions remains undefined and only combined therapeutic regimens have been found to offer a measure of disease control.

Method
A computerized literature search using MEDLINE was conducted for review articles in the English language on hypertrophic scars and keloids. The medical subject headings of
"hypertrophic scar" or "keloid" were combined with "aetio-pathogenesis" or "therapy" using the Boolean operator "AND" to narrow the searches. Two hundred and fifty seven articles were brought up out of which less than one half were found relevant and reviewed.

**Review**

**Normal Scar Formation**

A scar in the skin is defined as a macroscopic disturbance of the normal structure and function of the skin architecture resulting from the end product of a healed wound. Scarring is a consequence of dermal injury due to trauma or surgery. A preferred scar is one that has matured rapidly without contracture or increase in width, and without forming more collagen than is necessary for its strength.

The 3 well known stages of wound healing are:

a) Inflammation
b) Proliferation
c) Matrix remodelling/scar formation

The early inflammatory cascade that ensues immediately after injury dictates much of the later outcome of scar development. Neutrophils infiltrate the wound site and elaborate matrix metalloproteinases that cause excessive tissue loss in the wound area, leaving an area of tissue devoid of matrix that is subsequently replaced with scar tissue. The final stage of wound healing includes migration and proliferation of fibroblasts, collagen production and deposition, and angiogenesis.

Myofibroblasts containing myofilaments (α-SMA, desmin) are responsible for physiologic wound contraction. Growth factors and cytokines, such as tumour necrosis factor (TNF)-α, platelet-derived growth factor (PDGF), transforming growth factor (TGF), basic fibroblast growth factor (bFGF), vascular endothelial growth factor (VEGF), insulin-like growth factor (IGF), keratinocyte growth factor, mitogen-activated protein (MAP) kinases, matrix metalloproteinases (MMPs), and tissue inhibitors of metalloproteinases (TIMPs) play a significant role during the inflammatory and remodeling phases.

The role of stem cells in cutaneous wound healing

Recently, the contribution of stem cells towards tissue regeneration and wound healing is increasingly being appreciated and a rising number of stem cell therapies for cutaneous wounds are currently under development. A recent review by Lau et al. summarizes wound healing principles and related key molecular and cellular players, discusses the potential participation of different cutaneous stem cell populations in wound healing, and lists corresponding stem cells markers.

**Healing by first or second intention**

The vast majority of surgical wounds are incisions that are re-approximated by sutures or adhesives and in the absence of complications will heal primarily or by first intention. Generally such wounds heal with a normal scar and do not require special wound care or the involvement of a specialist in wound healing. This is in contrast to wounds that are not re-approximated (for any reason) where the subsequent defect “fills in” initially with granulation tissue and then gets re-epithelialised. This is referred to as healing by second intention and generally results in a delay in the appearance of a healed or “closed” wound. Often these wounds require special dressings and treatments and have a higher likelihood of progressing to a chronic wound.

**Foetal Wound Healing**

Tissue repair in the foetus is different from normal postnatal healing. Regenerative healing occurs, characterised by minimal or no scarring. The study of fetal wound healing may result in the discovery of an optimal method that would allow wounds to heal without scar formation. Wounds occurring in foetuses of early gestational age can heal without
any scar formation. The difference in the wound environment in fetal wounds occurring in early gestation may account for the absence of scar formation. Possible factors are the presence of fewer neutrophils and more monocytes during the inflammatory period, different concentrations of cytokines, and a greater proportion of type III collagen in contrast to adult wounds.\(^2\)

**Scar pathology**

The final appearance of a scar is dependent on many factors, including the following: (a) differences between individual patients that we do not yet understand and cannot predict; (b) the type of skin and location on the body; (c) the tension on the closure; (d) the direction of the wound; (e) other local and systemic conditions (as mentioned above); and, lastly, (f) surgical technique.

**Relaxed Skin Tension Lines**

Elective incisions or the excision of lesions are planned when possible so that the final scars will be parallel to the relaxed skin tension lines. Maximal contraction occurs when a scar crosses the lines of minimal tension at a right angle. Wrinkle lines are generally the same as the relaxed skin tension lines and lie perpendicular to the long axis of the underlying muscles.

**Abnormal/excessive scar formation**

It is the dysregulation of the previously mentioned delicate interplay of molecular and mechanical factors that lead to wound healing disorders resulting to abnormal scars referred to as either hypertrophic and keloidal. Keloids are known to occur only in the human race, and the African, especially the Negro race, is particularly predisposed\(^3\). Oluwasanmi found an incidence of 6.2% in a survey of 4,877 individuals in a rural African community\(^4\). The male-to-female ratio is approximately the same. The incidence of hypertrophic scars, on the other hand, is probably higher than that of keloids, but definitive figures are unknown.

Hypertrophic scars and keloids are abnormal wound responses in predisposed individuals and represent a connective tissue response (fibroproliferative) to trauma, inflammation, surgery, or burns.\(^5\) Hypertrophic scars, figure 1, are typically raised, red or pink (in lighter skinned individuals), and sometimes pruritic but do not exceed the margins of the original wound. Keloids, figure 2, on the other hand, infiltrate into surrounding normal tissue and rarely regress. Keloids may have an unrecognized origin. Hypertrophic scars usually regress with time, whereas keloids continue to evolve over time, without a quiescent or regressive phase.

Table 1 shows the essential differences in the clinical manifestations of the two conditions. Histologically, normal skin contains collagen bundles running parallel to the epithelial surface. In hypertrophic scars, the primarily type III collagen bundles are flatter, with the fibers arranged in a wavy pattern but predominantly oriented parallel to the
epithelial surface. In contrast, in keloids, collagen bundles are virtually nonexistent, and the collagen type I and III fibers lie in haphazardly connected loose sheets.

**Table 1. Clinical Features of Hypertrophic Scars and Keloids**

<table>
<thead>
<tr>
<th>Hypertrophic Scars</th>
<th>Keloids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop soon after surgery</td>
<td>May develop months after the trauma</td>
</tr>
<tr>
<td>Usually improve with time</td>
<td>Rarely improve with time</td>
</tr>
<tr>
<td>Remain within the confines of the wound</td>
<td>Spread outside the boundaries of the initial lesion</td>
</tr>
<tr>
<td>Occur when scars cross joints or skin creases at a right angle</td>
<td>Occur predominantly on the ear lobe, shoulders, sternal notch, rarely develop across joints</td>
</tr>
<tr>
<td>Improve with appropriate surgery</td>
<td>Are often worsened by surgery</td>
</tr>
<tr>
<td>Are of frequent incidence</td>
<td>Are of rare incidence</td>
</tr>
<tr>
<td>Have no association with skin colour</td>
<td>Are associated with dark skin colour</td>
</tr>
</tbody>
</table>

**Aetiology of keloids and hypertrophic scars**

The major factors are genetic predisposition and some form of skin trauma. Skin or wound tension has also been implicated as a critical factor in hypertrophic scars and keloids, as have been incisions beyond the relaxed skin tension lines. Scars that cross joints or skin creases at a right angle are predisposed to form hypertrophic scars because of the constant tension forces that occur. Keloids tend to develop more readily during and after puberty. The regions of the body most prone to keloids are the presternal area, the back and the posterior aspect of the neck. These areas form the most severe keloids. The beard area of the face, anterior chest, deltoid area and ears are moderately susceptible while the abdominal skin and forearms are mildly susceptible. On the other hand, keloids on the palms and soles of the feet are almost unknown.

Keloids are 15 times as likely to occur in darker skinned individuals which points to genetic influences. Strong evidence for a genetic component to keloids is perhaps best demonstrated by its varied incidence in different ethnic populations, a familial history of the disease, its prevalence in twins and development of aggressive disease in multiple sites in those individuals with a family history. However, no single disease-causing gene has been identified. The keloid scar appears to be a complex oligogenic condition rather than a simple monogenic Mendelian disorder. Currently, the potential importance of immunogenetic factors in the aetiology of abnormal wound healing is receiving increasing attention, i.e., the major histocompatibility complex (MHC). A positive association between the HLA-DRB1*1501 allele and KD susceptibility has recently been established in Caucasians of northern European ancestry. Lu et al also found a positive association of HLA-DQA and DQB alleles with keloid susceptibility in the Chinese Han population to further support a potential role for the MHC in keloid scar aetiology. Elevated levels of HLA-DR have also been found in hypertrophic scarring; however, no positive associations have been established.

Immunohistochemical studies by Santucci et al in keloidal and hypertrophic scars demonstrated the continuous presence of an immune cell infiltrate (lymphocytes associated with mostly CD1a cells), with the probable effect of prolonged inflammation, cell recruitment to the wound site and extracellular matrix deposition. These findings were less pronounced in hypertrophic scars, which may help explain the ‘continued growth’ of keloid lesions beyond the margins of the original, wound.

**Pathophysiology of hypertrophic scars and keloids**

In the normal maturation phase, the nodularity and redness of the wound soften and flatten due to ongoing simultaneous collagen synthesis and degradation and the connective tissue elements regress after the third week. It has been shown that the rate
of collagen synthesis in keloids is 20 times more than in normal unscarred skin and three times more than in hypertrophic scars.\textsuperscript{12} It has also been shown that not only is collagen production high in hypertrophic scars and keloids, but the ratio of type I to type III collagen is also high.\textsuperscript{13}

Keloid fibroblasts also show a four-fold increase in the rate of biosynthesis of fibronectin as that from normal scars or dermis.\textsuperscript{14} In keloidal tissue, TGF-\(\beta\) is overproduced and poorly regulated through normal autocrine signalling mechanisms. At the same time, keloid fibroblasts have greater numbers of growth factor receptors and respond more intensely to growth factors such as TGF-\(\beta\) and PDGF.\textsuperscript{15} Less synthesis of molecules that promote matrix breakdown (e.g., MMPs) may also explain the lack of scar regression seen in keloids.\textsuperscript{16} It has been shown that there is significantly higher rate of apoptosis in normal skin fibroblasts than in keloidal fibroblasts.\textsuperscript{17}

\textit{Prevention of hypertrophic scars and keloids}
This is the most important factor in abnormal scar formation. Avoiding all unnecessary wounds, especially in keloid-prone patients, remains an obvious but imperfect solution. All surgical wounds should be closed with minimal tension, incisions should not cross joint spaces, midchest incisions should be avoided, and incisions should follow skin creases whenever possible. An atraumatic operation technique should be used, followed by efficient haemostasis, and wound closure should include eversion of the wound edges. It is also crucial to properly debride contaminated wounds and limit foreign bodies in the form of polyfilamentous sutures. Wound healing and the aesthetic outcome of scar formation can be improved with massage or greasing ointments.

\textit{Treatment of hypertrophic scars & keloids}
Ogawa\textsuperscript{18} recently published a review of previous articles and proposes algorithms for the treatment and prevention of hypertrophic scars and keloids. The following parameters should be considered before the treatment of keloids/hypertrophic scars is planned:
- A biopsy should be conducted in anomalous cases.
- Corticosteroid injections should be performed only after carefully excluding the possibility that malignancies or infections may be present.
- It should be remembered that it is particularly challenging to accurately differentially diagnose dark skinned individuals because the colour of their skin scars and tumours (e.g. dermatofibrosarcoma protuberans) is often similar.

\textit{Treatment of hypertrophic scars}
\textbf{Surgery} – Scar revision as a treatment achieves two aims: excision and narrowing of scars as done for wide-spread scars and Z- or W-plasty designed to change the direction of the scar. Since scar behaviour is unpredictable, it is usually prudent to wait for scar maturation, which may be up to 24 months, before surgery. Earlier intervention is indicated for hypertrophic scar cases with scar contractures (especially joint contractures) that could result in functional dysfunction.
\textbf{Compression therapy} – The mode of action is not well understood. Theories include\textsuperscript{21}:
- a decrease in blood flow with a resultant decrease in \(\alpha_2\)-macroglobulin and a subsequent increase in collagenase-mediated collagen breakdown, normally inhibited by \(\alpha_2\)-macroglobulin,
- hypoxia leading to fibroblast degeneration and collagen degradation,
- lower levels of chondroitin 4-sulfate, with a subsequent increase in collagen degradation,
- decreased scar hydration, resulting in mast cell stabilization and a subsequent decrease in neovascularization and matrix production.

Recent experimental studies have shown that pressure therapy in hypertrophic scars partly restores the extracellular matrix organization\textsuperscript{16}, causes a significant reduction in
epilysin (MMP-28) and a reduction in levels of TNF-α and an increase in the rate of apoptosis.

Pressure garments tend to accelerate scar maturation. The ear lobe keloid is quite amenable to compression therapy with use of pressure clips. Pressure therapy should be started immediately after reepithelialisation of the wound, and patients should wear these pressure devices for continuous 8 to 24 hours a day for the first 6 months of scar healing. Success rate depends on patient compliance.

**Topical silicone therapy** - Gel sheeting therapy can be used in two settings, namely, to prevent hypertrophic scars after surgery and to treat hypertrophic scars. Silicone gel sheeting helps to reduce the thickness, pain, itchiness, and rigidity of severe hypertrophic scars. The mechanism of action is unknown, but it has been suggested that the greater wound hydration achieved using occlusive therapy (silicone and non-silicone based) affects local keratinocytes to alter growth factor secretion and, secondarily, influences fibroblast regulation. It is also believed that hydration decreases capillary permeability, inflammatory and mitogenic mediators, and collagen synthesis.

**Corticosteroid injections** - Synthetic corticosteroids decrease the production of inflammatory cytokines, chemokines, adhesion molecules, lysosomal enzymes, and tissue inhibitor of metalloproteinase, and inhibit fibroblast proliferation. Systemic side effects that have been reported include menstrual dysfunction in women, the suppression of adrenal cortical function, and the development of cataracts or glaucoma. Triamcinolone acetonide (Adcortyl® or Kenalog®) is the most commonly used.

**Laser** – Few studies have shown the efficacy of Laser therapy in treating hypertrophic scars. The pulsed dye Laser has been used and on its own may be useful in treating hypertrophic scars. It is based on the principle of selective photothermolysis, which causes thermal injury to the scar microvasculature, leading to thrombosis and ischaemia, ultimately resulting in reduced collagen within the scar. Laser therapy has also been found useful in reducing the itching and pain, and optimization of the skin texture.

**Others** – Itching and pain, which are troublesome symptoms of hypertrophic scars, could be reduced by corticosteroid ointments, tape, and nonsteroidal anti-inflammatory drugs. To manage the psychological stress of patients, makeup or camouflage therapy should be considered.

**Treatment of Keloids**
The size and number are important when planning the treatment of keloids. Are they small and single or large and multiple? Small (early) and single keloids can be treated radically. Nonsurgical conservative therapies alone do not seem to be effective for treating keloids.

**Surgery** - Surgery can be used to treat keloids in two ways: first, radically resecting keloids; and second, reducing keloid mass. Radical resection should be combined with adjuvant therapy because keloid excision alone is associated with a high rate of recurrence (45 to 100 percent). Excision may be intrallesional or extralesional. Some advocate the former technique because it is said that the adjacent unscarred skin is not violated and as a result, reducing the chance of recurrence.

**Corticosteroid injections** - Corticosteroid injections can be used to treat keloids in three ways: first, as an adjuvant therapy that is to be combined with surgery; second, as a monotherapy for the radical treatment of keloids; and third, as a component of multimodal therapy for the treatment of symptoms.

**Cryotherapy** - Cryotherapy has been used to treat keloids either as a monotherapy or in combination with intrallesional triamcinolone injection or surgical excision. Cryotherapy works by inducing tissue necrosis. Cryotherapy should be limited to small regions, as it induces severe pain and hypopigmentation.

**Radiation** - Combining surgery with postoperative radiation therapy has been suggested to more effectively treat keloids than radiation monotherapy. The success rate of this combined approach varies between 67 and 98 percent. Radiation is initiated right after surgery and is superficial and of low-dose. High-dose-rate brachytherapy has also been
used. The main drawback of radiation therapy is the risk of radiation-induced malignancy. However, large treatment cohorts with extensive follow-up have provided no evidence to substantiate the risk of carcinogenesis. Nevertheless, radiation therapy is contraindicated in children, as well as in areas of high carcinogenic potential, namely the breast and thyroid.

**Antitumor/Immunosuppressive Agents** – 5-fluorouracil inhibits fibroblast proliferation. Bleomycin reduces collagen synthesis and/or increased destruction because of inhibition of lysyl oxidase or TGF-β1. Studies have shown that intradermal injection or the multipuncture method of Bleomycin injection results in significant improvement in keloids and hypertrophic scars.

In the African setting (for example in Nigeria) where resources are not readily available to carry out many of the above named modalities, combination therapy is the cost-effective approach. Intraleisonal or extraleisonal excisions of keloids are combined with early postoperative superficial low-dose radiotherapy and weekly sessions of Triamcinolone injections into the surgical bed (triple therapy). This approach appears to provide reasonable treatment outcomes with low recurrence rates. Table 2 shows emerging scar-reducing therapies.

<table>
<thead>
<tr>
<th>Emerging Agents</th>
<th>Proposed Mechanism</th>
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<tbody>
<tr>
<td>Anti–TGF-β1 and -β2 agents</td>
<td>Decreased collagen production and fibroblast proliferation</td>
</tr>
<tr>
<td>Enhanced TGF-β3</td>
<td>Decreased collagen synthesis</td>
</tr>
<tr>
<td>COX-2 inhibitors and NSAIDs</td>
<td>Inhibition of inflammatory mediators</td>
</tr>
<tr>
<td>Collagen synthesis inhibitors P4H and PCP inhibitors</td>
<td>Decreased collagen production and fibroblast proliferation</td>
</tr>
<tr>
<td>ACE inhibitors and angiotensin receptor blockers</td>
<td>Inhibition of inflammatory mediators. Locally functioning cutaneous angiotensin system</td>
</tr>
<tr>
<td>Minocycline</td>
<td>Unknown; ? MMP inhibition, inhibition of inflammatory mediators, or antibacterial activity in a contaminated wound</td>
</tr>
<tr>
<td>Gene therapy</td>
<td>Target fibroblasts with truncated TGF-β2 receptor and fibromodulin</td>
</tr>
</tbody>
</table>

Key: TGF-transforming growth factor, COX-cyclooxygenase, NSAIDs-nonsteroidal anti-inflammatory drugs, PCP-procollagen C-proteinase, ACE-angiotensin converting enzyme, MMP-matrix metalloproteinase

**Conclusion**

Wound healing is an essential aspect of surgery and abnormal scars, inevitably, come with the territory. The growing understanding of the molecular processes of normal and abnormal wound healing is promising for discovery of novel approaches for the management of hypertrophic scars and keloids. Although optimal treatment of these lesions remains undefined, successful healing can be achieved only with combined therapeutic regimens.

**References**

Socioeconomic factors affecting presentation of patients with post burn contractures of the hand in an Indian population– a review of 196 cases


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SUMMARY

Background: As the etiological factors of burn injuries vary considerably in different communities, careful analysis of the epidemiological features in every community is needed to formulate a sound prevention programme. The present study attempts to analyze the demographic factors affecting the presentation of post burn contractures of hand in a developing country.

Material and Methods: The study was conducted prospectively and retrospectively between 2004 and 2009. The patients were analyzed for their demographic profile. The patients and their family were asked to state the reason for seeking treatment and the patient’s narrative was recorded in his or her own language.

Result: The age of presentation ranged from three to 65 years. Agricultural workers were the most common affected group of population (32%) followed by students (16%). Sixty four percent of all cases had injury due to flame burns. Electric burns were the second most common group (12%). Job related disability was the most common reason for seeking treatment amongst males (59%). Females most commonly sought treatment because of the inability of the family to find a suitable matrimonial alliance (57%). Forty four of the 102 males had a delay of less than six months in seeking treatment. Overall, 75 of 102 males sought treatment in the first year while only 13 of the 94 females reported for treatment within the first six months.

Conclusion: We suggest that preventive community programmes for burn contractures of the hand should be based on sound epidemiological studies and should take into account the socioeconomic requirements of the given society.

Key words: Burn contractures, Socio-economic factors, Felt need.

Introduction

Hand is the most important functional tool of the human race.\(^1\) Burn injuries of the hand are a common occurrence as hand injuries are inflicted not only on the burn victims but also on people attempting to save the burn victims. Often accompanying more extensive injuries, the hand injuries get neglected, resulting in an enormous spectrum of deformities ranging from ‘the sparingly used’ to ‘the completely non-functional’ hand. If contractures affect the dominant hand, as they do on most occasions, the vocation and thereby the economic status of the patient suffers. Prevention of the burn contractures of hand is thus important. It is imperative that the demographic profile of burn contracture hand is understood for preventive methods to be applied. As the etiological factors of burn injuries vary considerably in different communities, careful analysis of the epidemiological features in every community is needed before a sound prevention programme can be planned and implemented.\(^1\)
Material and Methods
The study was conducted prospectively and retrospectively between 2004 to 2009. Patients of post burn contracture hand were admitted and treated as in patients in the Department of Plastic Surgery. The patients were analyzed for their demographic profile, age, sex, dominance of hand, side of injury, cause of injury, time of presentation since injury, occupation, and presenting complaints. The patients were asked to state the reason for seeking treatment and the patient’s narrative was recorded in his or her own language. Separate history and opinion were sought from the patient’s immediate family members and the findings were recorded. The data thus collected was subjected to descriptive analysis.

Result:
Age: the age of presentation ranged from three to 65 years. The most common age group was the third decade of life (36%) followed by the fourth decade (24%), table 1.

<table>
<thead>
<tr>
<th>Age of Presentation (Years)</th>
<th>No. of patients (n=196)</th>
<th>Male (n=102)</th>
<th>Female (n=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 10</td>
<td>27 (14%)</td>
<td>11 (10.8%)</td>
<td>16 (17%)</td>
</tr>
<tr>
<td>11 – 20</td>
<td>31 (16%)</td>
<td>7 (6.9%)</td>
<td>24 (25.5%)</td>
</tr>
<tr>
<td>21 – 30</td>
<td>70 (36%)</td>
<td>48 (47.1%)</td>
<td>22 (23.4%)</td>
</tr>
<tr>
<td>31 – 40</td>
<td>47 (4%)</td>
<td>26 (25.5%)</td>
<td>21 (22.3%)</td>
</tr>
<tr>
<td>41 – 50</td>
<td>16 (8%)</td>
<td>8 (7.8%)</td>
<td>8 (8.5%)</td>
</tr>
<tr>
<td>51 – 60</td>
<td>5 (2%)</td>
<td>2 (1.96%)</td>
<td>3 (3.2%)</td>
</tr>
</tbody>
</table>

Sex: Males slightly outnumbered the females. Out of 196 patients studied, 102 were males and 94 females.
Hand Dominance: Of all the patients studied, 180 were right handed, 92%, while 16 were left handed, 8%.
Hand Involved: Right hand was involved in 57 cases while 61 cases had involvement of left hand. Both the hands were involved in 78 cases with varying severity.
Occupation: Agricultural workers were the most common affected group of population, 32%, followed by students, 16%, children, 14% and industrial workers, 14%, table 2.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>No. of patients (n=196)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Workers</td>
<td>62 (32%)</td>
</tr>
<tr>
<td>Students</td>
<td>30 (16%)</td>
</tr>
<tr>
<td>Industrial Workers</td>
<td>28 (14%)</td>
</tr>
<tr>
<td>Children (&lt;12 yrs)</td>
<td>28 (14%)</td>
</tr>
<tr>
<td>Housewives</td>
<td>24 (12%)</td>
</tr>
<tr>
<td>Merchants</td>
<td>16 (8%)</td>
</tr>
<tr>
<td>Professionals</td>
<td>8 (4%)</td>
</tr>
</tbody>
</table>

Etiology: Sixty four percent of all cases had injury due to flame burns. Electric burns were the second most common group, 12%, table 3.
Reason for seeking treatment: Job related disability was the most common reason for seeking treatment amongst males, 59%. Females most commonly sought treatment because of the inability of the family to find a suitable matrimonial alliance, 57%, table 4. Most patients however had more than one reason for seeking treatment. Amongst females the second most common reason for seeking treatment was the attached social stigma, 23%.
Table 3: Etiology of Burns

<table>
<thead>
<tr>
<th>Etiology</th>
<th>No. of patients (n=196)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame Burn</td>
<td>124 (64%)</td>
</tr>
<tr>
<td>Electrical Burn</td>
<td>24 (12%)</td>
</tr>
<tr>
<td>Chemical Burn</td>
<td>16 (8%)</td>
</tr>
<tr>
<td>Contact Burn</td>
<td>16 (8%)</td>
</tr>
<tr>
<td>Scalds</td>
<td>12 (6%)</td>
</tr>
<tr>
<td>Friction Burn</td>
<td>4 (2%)</td>
</tr>
</tbody>
</table>

Table 4: Reason for seeking treatment

<table>
<thead>
<tr>
<th>Reason for seeking treatment</th>
<th>No. of patients (n=196)</th>
<th>Male (n=102)</th>
<th>Female (n=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inability to do daily activities</td>
<td>26 (13.2%)</td>
<td>17 (16.7%)</td>
<td>9 (9.6%)</td>
</tr>
<tr>
<td>Job related disability</td>
<td>65 (33.2%)</td>
<td>60 (58.8%)</td>
<td>5 (5.3%)</td>
</tr>
<tr>
<td>Inability to find matrimonial alliance</td>
<td>68 (34.7%)</td>
<td>14 (13.7%)</td>
<td>54 (57.4%)</td>
</tr>
<tr>
<td>Social stigma</td>
<td>31(15.8%)</td>
<td>9 (8.8%)</td>
<td>22 (23.4%)</td>
</tr>
<tr>
<td>Others</td>
<td>6 (3.1%)</td>
<td>2 (1.96%)</td>
<td>4 (4.3%)</td>
</tr>
</tbody>
</table>

Delay in seeking treatment: Patients were assessed for the delay in seeking treatment from the time when the contracture was first noticed. Forty four of the 102 males had a delay of less than six months in seeking treatment. Overall, 75 of 102 males sought treatment in the first year. Thirteen of the 94 females reported for treatment within the first six months, table 5. Males sought treatment earlier than females, 75 of 102 males (73.5%) sought treatment within the first year while only 30 of 94 females (32%) sought treatment in the same duration. Eight out of 11 males which reported for treatment with a delay of more than five years were more than 40 years of age while 23 of the 31 females with a delay of more than five years had sustained burns in the first decade of life. Our results suggest that because of economic needs, males tend to seek treatment early.

Table 5: Delay in seeking treatment

<table>
<thead>
<tr>
<th>Duration</th>
<th>No. of patients (n=196)</th>
<th>Male (n=102)</th>
<th>Female (n=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 months</td>
<td>57 (29.1%)</td>
<td>44 (43.1%)</td>
<td>13 (13.8%)</td>
</tr>
<tr>
<td>6 months – 1 year</td>
<td>48 (24.5%)</td>
<td>31 (30.4%)</td>
<td>17 (18.1%)</td>
</tr>
<tr>
<td>1-5 years</td>
<td>49 (25%)</td>
<td>16 (15.7%)</td>
<td>33 (35.1%)</td>
</tr>
<tr>
<td>&gt;5 years</td>
<td>42 (21.4%)</td>
<td>11 (10.8%)</td>
<td>31 (33%)</td>
</tr>
</tbody>
</table>

Discussion:
Burn contractures of hand are still a common presentation to plastic surgery institutes in developing countries. The social and economic dynamics of developing economies influences the presentation of these cases to the hospital. It is imperative to understand the various presentation parameters of these deformities in terms of age of presentation, area of injury and time delay since injury to be able to make directed efforts to prevent development of contractures. Often, in developing economies, an affected hand means an affected family. It has long been realized that the contractures of the hand are a significant complication of burn injury. Clinicians can use the contracture predictors like severity of initial burn, duration of hospitalization, presence of inhalational injury, size of the graft applied, amputation, paediatric age group, size of burn wound and others to help target interventions for those patients most at risk of developing hand contractures. Given the functional importance of the hand in daily living, the burn care community is challenged to find new ways of preventing and treating hand contractures.

Sixty percent of the cases studied by us belonged to the 20-40 year age group. This finding is in variance with results reported by Glasheen et al. in the United States of...
In the 11–20 years age group, 24 of the 31 patients studied (77%) were female. This finding is reflective of the complex social structure of India with respect to marriages. India still has a tradition of so called “arranged marriages” wherein the bride and the groom are selected by family consent. The boy and girl have limited say in the selection process. The society being male dominated requires the female to be most presentable and the male to be most economically sound. This is reflected in the presenting age group of the patients. Seventy seven percent of all cases in the 11-20 years age group were females while 74 of the 117 patients (63%) in the age group of 20-40 years were male. In rural India, late teens and early 20's is the common age of marriage for females whereas 20-40 years is usually the economically most productive years and hence this pattern in the age of presentation. Sen R et al reported a female preponderance in burn patients in 20-40 year age group in another Indian hospital. Similar results have been reported by other authors in other developing countries like Jordan.

It has been suggested that to reduce the incidence of contractures, rural health personnel should be encouraged to consider early referral of patients with burns likely to lead to contracture formation. Females on the other hand report for treatment with a greater time delay despite seeking treatment at a relatively earlier stage of life.

Our findings suggest that the epidemiological profile of the patients is largely dependent on the complex socio economic interactions prevalent in the society. Joint contracture does impact burn patients’ quality of life, especially with respect to physical functioning, physical role limitations, bodily pain, and vitality. Women also differed from men in a number of socio-demographic factors. Social and demographic differences exist between men and women admitted for treatment of acute burn injury. These differences influence admission after burn injury. Additional efforts are needed to better measure and evaluate the role of social capital in burn injury epidemiology, management, and outcomes. Each society has its inherent chores, traditions and customs especially in the rural setting. Adherence to these traditions is the “felt need” of the society. Felt needs and problems are defined as needs and problems perceived by individuals experiencing the problem, may be equated with want and are phenomenological in character. Preventive and treatment modalities should cater to these felt needs to be successful. Preventive programmes need to be specifically targeted to be successful. Wide prevalence of burn contractures are a stigma on the face of health care system of any society. With the growing reach and availability of Plastic Surgery facilities it is a matter of international responsibility that such crippling yet preventable deformities should be reduced to a minimum possible incidence level.

Conclusion:
We suggest that preventive community programmes for burn contractures of hand should be based on sound epidemiological studies and should take into account the “felt needs” of the given society.
References:
Extensive calvarial exposure and full thickness sequestration following electrical burn injury presenting after one year: case report

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SUMMARY
Background: Calvarial osteomyelitis is an uncommon complication of burn injury due to electricity.
Patient: A case of electrical injury that progressed from full thickness scalp loss to calvarial osteomyelitis and sequestration of outer and inner tables seen after one year of calvarial exposure is presented.
Result: The patient had calvarial sequestrectomy which exposed a four-centimetre diameter inner table defect, and a 13 cm diameter full thickness scalp and outer table defect. A single stage closure with Orticochea flaps and split skin grafts was achieved. There was an uneventful post operation course.
Conclusion: Late presentation in electrical burn injury of the scalp complicated by calvarial loss has been managed without intracranial complications.

Key words: electrical burns, calvarial exposure, sequestrectomy, late presentation

Introduction
Electricity is an uncommon cause of burn injury. Some authors put the incidence at 6%¹. At National Orthopaedic Hospital in Enugu, a five year review of hospital admissions through the trauma unit for burns indicates an incidence of 1.6%. High voltage injury is a commoner cause for admission and commonly results in full thickness burns. Skull exposure following scalp electrical injury has been reported previously and its fate is subject to discussion. Presentation after a year long calvarial exposure has not been documented to our knowledge, hence this report.

Case report
A.M. was a 25 year old male who was effecting an unauthorized connection from a power cable when an overhead faulty 11,000-volt cable went up in sparks, and detached giving him an electrical injury. He sustained arc burn of the scalp, trunk and upper limbs and was treated at a peripheral hospital where the full thickness scalp defect became evident. Despite referral to the National Orthopaedic Hospital, Enugu he did not present for a full year for financial reasons. On presentation he had a 12 cm diameter full thickness scalp defect in the occiput exposing a desiccated calvarium with purulent exudates at the wound edges (figure 1). Clinical examination revealed exaggerated deep tendon reflexes with ankle clonus. He had no clinical or radiological evidence suggestive of a brain abscess and the wound cultures grew Staphylococcus aureus. The X-ray revealed a skull
defect, figure 2. He was referred to the neurosurgeons for assessment. Because of financial constraints CT scan was not done and the neurosurgeon was therefore unable to review him.

At surgery, the wound margins were excised, the sequestrum consisting of a 13 cm diameter outer table and a four-centimetre inner table piece was lifted off, figure 3. A rim of granulation tissue separated them from the rest of the skull. The Orticochea technique of three flaps from the rest of the scalp was employed for closure (figure 4), each anterior flap having a width of approximately 8 cm. A dog ear resulted. The remaining secondary defects were immediately grafted with partial thickness skin grafts. Two units of autologous blood (pre deposit) were transfused intra-operatively. There was 100% graft take and flap survival (figure 5), with superficial non-progressive tip epidermolysis of the posterior flap. He had an uneventful postoperative period though transient right pupillary dilation was noted the first post-operation day. He was discharged after two weeks on antibiotics, and with a note to also see the ophthalmologist. He defaulted on his appointments and is lost to follow up. It is therefore not known if he was later reviewed by the ophthalmologist.

Discussion

“Train surfers” standing on top of the train as it passes by mega-voltage wires have been reported to experience electricity shocks². The clothing of victims of mega-voltage injury often ignites leading to additional injury from the flames²,³,⁴. This can become a full thickness injury if the clothes are difficult to remove.

The sequelae of electrical burn injury can be early or late⁵,⁶. The CNS sequelae include osteomyelitis which is not a usual sequel to burn injury but regularly follows mega-voltage injury to the scalp. A literature search revealed few reports⁷. Treatment follows the general principles of the management of Cierny-Mader IV stage of osteomyelitis i.e. radical debridement of the sequestrum, provision of an adequate soft tissue envelope, bone transport/grafting, and prolonged antibiotics. Some authors recommend up to a six month interval between calvarial debridement and replacement⁸. This patient had Beasley stage Ib scalp defect. It is recommended that free muscle flaps are transferred in the reconstruction of such defects⁹. However, as was done in this patient, carefully designed local flaps can cover up to 50% of the surface area of the scalp where bone is exposed, including defects of the calvarium and dura⁹,¹⁰.
Scalp burn injury is however not usually accompanied by osteomyelitis of the calvarium. Early adequate treatment of scalp electrical burn injuries should prevent desiccation and infection of the underlying bone. Nevertheless, it has been reported that osteomyelitis occurred despite free flap cover following scalp burn injury. This suggests that primary damage to the calvarium may have occurred following full thickness burn of the scalp, particularly in mega voltage injury. The patient being reported was involved in mega voltage injury of 11,000 volts. Once the blood vessels to a part of the calvarium become compromised consequent on the electrical injury the bone will necrose. It has also been suggested that the bone if uninfected may be left in situ as a perfect fit graft. The inner table “graft” was not replaced by new bone after one year; rather granulation tissue separated it from surrounding healthy bone. There was no overlying skin cover to protect or nourish it.

Apart from loss of the bone no other long-term complication appears to have resulted from the late presentation. Since neural assessment was not recorded in the referring hospital, it is difficult to place the timing of the increased tendon reflexes and ankle clonus.

Orticochea flaps are in use for coverage of moderate to large full thickness scalp defects. Belmahi has modified the technique to cover defects 10cm or less occurring in the frontal area without skin grafts. Very little advancement occurred with galeal scoring and the resultant dogear settled to an acceptable level within a month without intervention.

Late presentation and poor follow up are common in the West African sub-region as a result of poverty, ignorance, and poor referral systems in a relatively expensive health care system devoid of health insurance. Early adequate treatment of post burn ulcers and flap cover is advocated.

Acknowledgement
Emmanuel Onyenzoputa and Dr Ogbonnaya encouraged the publication; Mr. Ifeanacho assisted in computer work, and the Medical illustration unit, National Orthopaedic Hospital, Enugu retrieved the pictures.

References
Lower limb salvage in Gustillo Type III-b distal tibial fracture with a free flap transfer using loupe magnification – a case report

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Summary
Background: Reconstruction of crushed distal tibia is a challenging ordeal to a plastic surgeon which involved a protracted course of management. Free flaps are often the only viable option to provide a soft tissue cover over exposed and fractured bone.

Patient and Result: We present a case of 32 years old male with Gustillo Type III B fracture of lower end of tibia in whom the limb was salvaged by transferring a free latissimus dorsi muscle flap. The microvascular anastomosis was carried out using binocular loupe magnification. Outcome was satisfactory although there was a prolonged hospital stay.

Conclusion: Free flaps can be safely transferred using commonly available optical loupes.

Key words: Open tibial fracture, free flap, amputation, limb salvage, binocular loupe magnification.

Introduction
Reconstruction of the lower third of tibia after a crush injury is a challenging ordeal for a surgeon. One of the most important goals in the treatment of such injuries of the tibia is to obtain adequate soft-tissue coverage. Soft-tissue closes an open wound and promotes revascularization of the injured bone thereby preventing infection and nonunion that may occur secondary to persistent bone exposure and ischemia. However, the anatomic variations of the area and the lack of local flaps, particularly when treating large mutilating defects, makes the reconstruction demanding. Before the advent of free flaps, some of the injuries would end up in limb amputation. With the refinement of microsurgery over the last three decades, free flaps have evolved as viable solutions to this complex problem.

Free flap surgery is generally believed to involve the use of sophisticated microscopes for achieving magnification but multiple series have been published regarding use of loupes for magnification, thereby potentially extending the benefits of this form of reconstruction to economically deprived regions of the world. This is a report of loupe magnification for microvascular anastomosis.
Case report

A 42 year old male was seen after three weeks of getting involved in a pedestrian accident. He was hit by a car while crossing the road, sustained crush injuries of his left leg, and had been advised to have below knee amputation in a secondary care hospital which he had rejected. The patient did not have any other medical co-morbidity.

On examination, he was generally stable and had two wounds over left leg: (i) 17 by 14 cms over anterior surface of lower third with exposed tibial fragments (Gustillo IIIB) with an external fixator, figure 1a and (ii) 18 by 16 cms over posterior surface of upper third, figure 1c. There were no features suggestive of vascular compromise and sensations over the foot were intact. Plain images of left leg revealed comminuted fracture of distal shafts of tibia and fibula with a segmental loss of distal tibia, figure 1b. Angiograms showed patent anterior and posterior tibial arteries.

Figure 1: Preoperative images (a) Exposed left tibia with external fixator (b) Plain lateral radiogram showing comminuted fracture of tibial shaft with segmental loss (c) raw area over posterior surface of left leg (d) angiogram showing patent tibial arteries

Under general anaesthesia, the wounds were debrided and the vessels isolated for anastomosis. The fracture fragments were realigned and stabilised with external fixators. Free latissimus dorsi muscle flap was harvested from left side, figure 2a and transferred to the left leg wound and vascularity was restored by anastomosis with recipient vessels, figures 2 b,c. To accomplish microanastomosis away from the zone of injury, right long saphenous vein was harvested and interposed between the flap and donor vessels.

Microanastomosis was started under an operating microscope but due to malfunctioning microscope, one arterial and two venous micro-anastomoses had to be done using loupe magnification. The donor site was closed directly. The wound over posterior surface of the leg was debrided and repaired without tension on wound edges. Split thickness skin graft was harvested from right thigh and banked. The flap survived with no complications, figure 2d and was covered with banked graft on seventh postoperative day. The donor site of free flap healed without any complications.

Six months after free flap transfer, the patient was operated upon by orthopedic team and had iliac bone grafting to fill up the five cm segmental loss over distal shaft of left tibia with fixation of bone fragments with screw and plates. Arthrodesis of left ankle and removal of external fixators was undertaken. At one year, the screws/plate was replaced with intramedullary nail. The hospitalization lasted 13 months. Full weight-bearing was achieved 18 months after the injury, figures 3 and 4, when the patient was walking...
without crutches. He had a limited range of motions of left ankle and was being managed by physiotherapists. The patient was satisfied and pleased at having got his leg salvaged. He returned to work 20 months after the injury.

Figure 2: (a) Latissimus dorsi on vascular pedicle (b) Latissimus dorsi free flap after inset over left leg (c) Latissimus dorsi free flap with vessels after anastomosis (d) Free latissimus dorsi 7 days after transfer

Discussion
Crush injuries of lower third of leg are challenging problems and involve multidisciplinary approach aimed at restoration of normal pattern of life of the patient in the shortest possible time. Various systems have been devised to classify these injuries and Gustillo's Open Fracure Classification\(^1\) is one of such. The patient had Gustilo Type III B fracture. In this type of fracture, reduction with external fixation and soft tissue coverage with free flaps has proved to be very effective in limb salvage\(^2\). Both fasciocutaneous and muscle flaps serve this purpose well. However muscle flaps adequately cover the exposed bone and are pliable enough to fill bone cavities as well. Furthermore, they improve the blood supply and induce leukocyte and macrophage migration and hence decrease the incidence of infection\(^3\).
The goal of our treatment was to attain a stable, painless limb with intact sensation so that our patient could engage in everyday activities at the earliest possible time. The patient however remained hospitalised for 13 months and had to undergo major operations three times, was under the care of physiotherapists even after 18 months and it was after 20 months the patient could join his work. Due to this protracted course of management, many workers who support the idea of below-knee amputation as a better rehabilitative and cost effective option. Limb salvage cannot be considered as guarantee of functionality or employability. About half of the patients with a salvaged lower extremity were found by Frencel\textsuperscript{4} to have required an assistive device to walk and walking with devices like crutches and a non-functioning lower extremity has been estimated to require about 15% more energy than below-knee prosthesis. In the same study\textsuperscript{4}, only 28% of the patients with salvaged limbs were able to achieve long-term employment, compared with 67% of early amputees in a study by Pedersen and Damholt\textsuperscript{5}.

A decision to amputate a limb is rarely clear-cut and several factors need to be considered including objective elements related to the patient's injury and physical condition as well subjective considerations related to patient's psychological, social, and economic status, including such aspects as attitude, wishes, reliability, support system, life-style, occupation, and financial resources\textsuperscript{6}. Since our patient had rejected the idea of amputation to the referring surgeon and since we work in a system which does not lay burden of health care on the patients and rather provides an adequate social and economic support, salvage of the limb was the only option left for us to attempt.

The magnification required for free flap transfer is conventionally achieved in major centers including ours with sophisticated and costly operating microscopes. However, after our first arterial micro-anastomosis, a technical fault in the microscope forced us to complete the procedure using binocular loupes. We personally did not find any difficulty in working using loupes. Regarding use of loupes in free flap, multiple series from highly respected pioneers of free flap surgery have proved that most of the common flaps (including the one we used) can be successfully transferred with the use of optical loupes with no negative effect on outcome\textsuperscript{7,8}. These series and our own experience prove that mere non availability of sophisticated operating paraphernalia should not deter the reconstructive surgeon from free flap transfer to salvage a limb in economically deprived regions of the world. Besides mention needs to be made of another welcome series published by S. Rajasekaran et al in 2009\textsuperscript{9} where soft tissue coverage in selected cases of Gustillo Type IIIB was achieved satisfactorily by immediate primary skin closure.

In conclusion, free flaps provide a viable option for soft tissue coverage and limb salvage in distal tibial Gustillo Type IIIB fractures and free flaps can be safely transferred using commonly available optical loupes.

References

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Experience in the management of axillary post-burn scar contractures

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Summary
Background: Axillary post-burn scar contracture is a challenging problem to the reconstructive surgeon owing to the wide range of abduction that should be achieved. The aim of this paper is to highlight the various management options used in managing axillary contractures in our hospitals and to itemize the complications commonly encountered.
Method: This is a retrospective study of cases of axillary contractures managed at the Komfo Anokye Teaching Hospital, Global Evangelical Mission Hospital and South Tongu District Hospital all in Ghana, from 2003 – 2007.
Result: Sixteen patients made up of 10 males and 6 females presented with axillary contractures that involved 25 axillae. The mean age of the study was 25.2 years. Injuries involved the anterior axillary fold in seven (28%), posterior fold in nine (36%), both folds in five (20%) and both folds plus axillary dome in four (16%) axillae. Surgical treatment included split-thickness skin graft in seven (28%), random pattern local skin flaps in five (36%) including z-plasties, parascapular flaps in six (24%), while scapular flaps and posterior trunk skin flap were used in two (8%) and one (4%) axillae respectively.
Conclusion: The choice of surgical procedure for reconstruction of post-burn axillary contractures can be made according to the pattern of scar contracture and the state of surrounding skin. The choice of a flap should have priority over skin graft because of the superior functional and cosmetic results of flaps.

Keywords: Axillary contracture; Skin grafting; Parascapular flap; Z-plasty; Physiotherapy.

Introduction
Axillary burn represents a frequent complication in the total management of burned victims. In order to minimize or prevent axillary contractures, the initial management of burns in this region should include proper positioning of the shoulder joint in an abduction splint and aggressive physiotherapy1. Early surgical excision and skin grafting of deep and full-thickness burns will further reduce the development of contractures2. Active and passive exercises and the application of pressure garments after wound healing and/or graft take are essential in the management of these injuries3,4.

The main problem of axillary contractures is the inelasticity of either or both of the axillary folds which prevents the full extension and/or abduction of the shoulder joint. In addition to the scarring of the fold(s), there are two local anatomic conditions that must be taken into consideration when surgical correction is contemplated. They are: (i) the extent of scarring of the adjacent skin and (ii) the involvement of the hair-bearing area of the axilla. It is unusual for the hair-bearing area to be involved in thermal injury due to its anatomic
location and because in most instances, the upper extremities are maintained in adduction, protecting the axillary hair-bearing area. According to Kurtzmann and Stern, axillary contractures are classified on anatomical basis into three categories. These are:

- Injuries involving the anterior axillary fold (Type 1A);
- Injuries involving posterior axillary fold (Type 1B);
- Injuries involving both anterior and posterior axillary folds (Type 2) and type 2 plus axillary dome (Type 3).

Proper treatment of axillary contractures can be planned in the light of this classification. Contracture release should therefore encompass the entire axis of rotation of the shoulder to facilitate complete range of motion. A variety of reconstructive methods have been reported for treatment of axillary contractures. Once surgical correction is indicated, the choice of procedure must be individualized in order to achieve this goal. In this paper, we present our surgical approach in the reconstruction of post-burn axillary scar contractures in a multicenter setting.

**Patients and method**

This is a retrospective study of axillary contractures managed at the Komfo Anokye Teaching Hospital in Kumasi, Global Evangelical Mission Hospital at Apromase and the South Tongu District Hospital at Sogakope, Ghana from 2003 – 2007. The sources of information were the operation registers and the case notes of the patients.

Preoperative assessment: The history was taken, with special concern about the cause of the burn and the initial management in the acute phase. General examination was performed to indicate the site of contracture, degree of limitation of abduction, state of the surrounding skin of the adjacent chest, shoulder and back and to exclude other problems and deformities. Preoperative marking was done while the patient was standing and the arm abducted maximally to delineate the contracture and the expected release incisions. Photographs were taken preoperatively. Preoperative broad spectrum antibiotics were given intravenously two hours prior to surgery. Operations were done under general anaesthesia.

Operative Procedures:

1. **Z-plasty:** was the procedure of choice for linear scar contractures of the anterior or posterior axillary folds if the surrounding skin was healthy. Multiple z-plasties were employed for long linear scars while single z-plasty was done for a short web. If one of the defects could not be closed after release, a split thickness skin graft was added to that site.

2. **Other random pattern local skin flaps:** from the arm, anterior chest, axilla or back were chosen for cases of localized moderate bands of contractures of anterior or posterior axillary folds, provided that the donor site was not scarred. We used advancement or transposition flaps from the normal uninvolved skin adjacent to the scar. The specific design of the flap was dependent upon the distribution and extent of the scar. The donor sites were either in the arm, anterior chest wall, back or armpit. The donor sites of the flaps were covered by split thickness skin graft.

3. **Fasciocutaneous flap:** This was the flap of choice to cover the defect after release of the axilla if the width of the defect was less than 8 cm provided that the scapular and parascapular areas were not scarred. Donor site was closed directly after proper undermining.

4. **Skin grafting:** Split-thickness skin grafting was performed after release of contractures of the axilla involving one or both axillary folds. This operation was done if the surrounding skin was scarred and could not provide any local or fasciocutaneous flaps that could cover the resulting defect or if the defect was bigger than any available flap as in severe axillary contractures. Skin grafts were taken from the thigh and tie-over dressing was placed over the graft to secure it in place.
Postoperative broad spectrum antibiotic was given to all cases for one week. Long term splinting and physical therapy was the rule in all cases.

**Result**

Sixteen patients made up of 10 males and 6 females presented with axillary contractures, involving 25 axillae. The ages ranged between 11 and 57 years with a mean of 25.2 years. The cause of burn was mostly flame burn (12 cases = 75.0%), and less commonly due to scald burn (4 cases = 25.0%). Injuries involved the anterior axillary fold in seven (28%), posterior fold in nine (36%), both folds in five (20%) and both folds plus axillary dome in four (16%) axillae. All the patients gave history of no or minimal physiotherapy or splinting for their axilla during the acute burn stage treatment. The degree of contracture ranged between mild and severe. The degree of abduction ranged between 20º and 100º with a mean of 60º, table 1.

<table>
<thead>
<tr>
<th>Degree</th>
<th>Number of Axillae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild (&gt; 90º)</td>
<td>3 (12.0%)</td>
</tr>
<tr>
<td>Moderate (30º -90º)</td>
<td>16 (64.0%)</td>
</tr>
<tr>
<td>Severe (&lt;30º)</td>
<td>6 (24.0%)</td>
</tr>
</tbody>
</table>

The commonest reconstructive technique was split-thickness skin grafting, table 2. There was no significant change over six months of postoperative follow up.

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Number of Axillae (%)</th>
<th>Range of abduction 1 month after surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin grafting</td>
<td>7(28%)</td>
<td>110º - 140º</td>
</tr>
<tr>
<td>Z-plasty</td>
<td>4(16%)</td>
<td>130º-160º</td>
</tr>
<tr>
<td>Other random pattern local flaps</td>
<td>5(20%)</td>
<td>120º-160º</td>
</tr>
<tr>
<td>Fasciocutaneous flap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Parascapular flaps</td>
<td>6(24%)</td>
<td>120º-180º</td>
</tr>
<tr>
<td>• Island scapular flap</td>
<td>2 (8%)</td>
<td>125º-155º</td>
</tr>
<tr>
<td>• Posterior trunk skin flap</td>
<td>1(4%)</td>
<td>130º</td>
</tr>
</tbody>
</table>

Post-operative complications included failure of the split-skin graft to take, resulting in further surgery or repeated dressings, leading to a delay in healing and longer stay in the hospital; painful skin graft donor area was a very major problem for patients who needed multiple re-admissions for contractures in different parts of the body. Long-term splinting often used to reduce graft contracture was cumbersome.

**Case Presentations and Complications**

Figures 1 – 4 show photographs of some of the studied cases and the various surgical procedures used for the corrections of the axillary contractures. Complications included one case of wound infection, keloids and a small area of patchy skin graft non-take. All the complications were mild and were managed by repeated dressing until healing occurred.
Discussion
The rehabilitation of patients who have suffered burns in the large joint, in particular, the shoulders remains a difficult problem in reconstructive surgery. Allowing such wounds to heal by second intention results in various kinds of scar formation and contractures. This significantly restricts physical and social rehabilitation. Many techniques have been described for the release of contracted axillary scar. Skin grafting is the simplest reconstructive method but it has several disadvantages.

Type 1B axillary contracture

Z-plasties and other random pattern local flaps such as transposition or advancement flaps tend to be required for Types 1 and 2, but they are not effective in severe axillary contractures or when adjacent tissues are scarred. Z-plasties are generally the procedures of choice for linear scar contractures. However, a single z-plasty is not suitable in axillary contractures, because it requires large skin flaps in a limited area where displacement of the hair bearing area will become significant. The functional improvement and the cosmetic result obtained in this study were both satisfactory to the patients and surgeons. The disadvantage of this procedure, which was identified in our study, is that unless the scar is a discrete band, it will not provide the desired release without skin grafting. This disadvantage has also been reported by Bretteville-Jensen and others.

Local flaps alone or in combination with split-thickness skin grafts are helpful in correction of burn scar contractures. The specific design of the flap is dependent on the distribution and extent of scar or the more specifically the availability of normal uninvolved skin adjacent to it. In 20% of the cases in this study, the contracture was a moderate localized scar with healthy surrounding skin that required local flaps.

With the introduction of fascio-cutaneous flaps by Ponten, there are now a number of larger flaps available around the axilla which allows closure of total axillary defects. Fascio-cutaneous flaps are usually considered for type 3 axillary contractures. Parascapular flaps were the most commonly used fascio-cutaneous flaps in this study.

Type 2 axillary contracture

The choice of procedure in these cases was based on the state of the skin of the scapular and parascapular areas as well as the size of the defect. If scapular or parascapular flaps were considered insufficient, generous release was made and the defect was covered by split-thickness skin graft. Although skin grafting is the simplest reconstructive method, it
has several disadvantages. Frequently there is a patchy take of skin graft due to the anatomy of the defect, and the prolonged splinting in abduction and faithful postoperative physical therapy are always necessary to avoid recurrent contracture. Furthermore the cosmetic result after skin grafting is poor.

**Type 3 axillary contracture**

**Conclusion**

Contracture release with skin grafts has the highest re-contracture rate and parascapular flaps give good results with minimal complications.

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