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MANAGEMENT STRATEGIES FOR NECK CONTRACTURES FOLLOWING BURNS: A COMPREHENSIVE REVIEW

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Abstract

Burns to the head and neck can lead to several serious complications, including difficulties with swallowing and speaking, swelling in the airways, and severe problems with taste, hearing, smell, and vision. Reconstruction of the face and neck is among plastic surgery's most complex and critical procedures. This region demands a large volume of soft tissue for functional restoration and requires high-quality tissue to achieve optimal cosmetic outcomes. Post-burn contractures in the neck are particularly challenging, as they can severely limit motion, disrupt facial harmony, and lead to profound aesthetic and functional deficits.

The neck is the critical connector between the head and body, and mobility is essential for daily functions like breathing, swallowing, and visual orientation. Burn-induced flexion contractures in this region can cause severe functional limitations (e.g., restricted head movement) and aesthetic deformities, significantly impacting the patient's quality of life.

Introduction:

Facial burn scar:

Burns and fires cause over 300,000 deaths every year worldwide, with nearly 11 million people needing medical care for burn injuries. Advances in burn treatment during the 20th century shifted the focus from preventing deaths to reducing long-term effects. This is especially important for facial burns, as the face plays a key role in identity and communication. Facial burns can also lead to psychological issues, social challenges, and reduced quality of life. Burns to the head and neck are common, with reported rates ranging from 6% to 60%. (1)

Globally, burns are a major public health issue, causing about 180,000 deaths each year, mostly in low- and middle-income countries. Nearly two-thirds of these deaths happen in the WHO African and South-East Asia regions. Burns are also a leading cause of disability in developing and underdeveloped countries. (2)

Burn injuries are a serious public health issue, leading to high rates of illness and death. These injuries happen when surfaces, fire, hot liquids, chemicals, gases, electricity, or radiation damage tissues inside or outside the body. The World Health Organization reports that burns are the fourth most common traumatic injury, causing 180,000 deaths each year, with the highest rates in low- and middle-income countries. Burns can lead to many complications and long-term effects. (3)

Every year, burns result in 300,000 deaths and require medical care for 11 million people. Advances in burn treatment have reduced death rates but burns still cause significant long-term issues, especially when they affect the face and neck. Facial burns can lead to serious functional and psychological challenges. Studies report varying rates of facial burns, ranging from 6% to 60%, with one study in Portugal finding that 47% of burn unit patients had face or neck burns. (4)

The differences in prevalence rates may be due to variations in populations, settings, recording methods, and definitions of facial burns. However, research focusing specifically on facial burns is limited, with only a few studies conducted in specific groups, such as French children, Nigerian burn unit patients, or U.S. pediatric burn center cases. Most studies on facial burns examine specific causes, like injuries from flambé drinks or airbag deployment. Comprehensive data on burns across healthcare settings, including emergency departments, hospitals, and burn centers, is scarce. While some statewide studies include multiple settings, most research is limited to one type of facility or even a single hospital. (5,6)

Burn scars form when injuries to the dermis heal slowly, often leading to complications. These complications may include tightening the skin (contractures), itching, problems with temperature regulation, and discomfort from scar treatments. (7)

Burns affecting the head and neck are common, occurring in about 60% of patients with burns covering more than 50% of their body. The skin on the face is generally thick, except for areas like the eyelids and neck, and has a good blood supply, which helps it heal well in most cases. As a result, many head and neck burns can be treated without surgery. However, burns to the face and neck may need skin grafts and surgical removal of damaged tissue if they don't heal in three weeks, which is frequently the result of deeper injuries or infection. When burns in these areas are left unhealed, the wounds may shrink in size, but this can lead to issues like the pulling of eyelids outward (ectropion), lips turning outward (eversion), neck tightening (contractures), shrinking of the corners of the mouth (oral commissures), and deformities of the ears and nose. Unlike the scalp and forehead, the skin in most parts of the head and neck is more mobile, making it more prone to scarring and contraction. (8)

The face is more likely to be burned because clothing or protective gear usually does not cover it. As a result, exposure to heat near the face can easily cause burns. For example, flash burns from explosive fumes (like propane, natural gas, or butane) will burn exposed skin but not areas protected by clothing. Similarly, hot liquids spilled from a height can reach the face and head, especially in children.

Fortunately, the face has features that can help reduce the severity of burns. Four main factors affect how deep a burn injury is: 1. Temperature of the source: This is fixed and cannot be changed. 2. Duration of contact: This can often be minimized because people instinctively protect their faces by quickly shaking off or wiping away hot materials. The absence of clothing on the face also helps prevent heat-trapping, reducing contact time. 3. Skin thickness: Facial skin is thicker in most areas except the eyelids, making it less prone to deep burns than thinner-skinned regions. 4. Blood supply: The face has a very rich blood supply, which helps dissipate heat and reduces the severity of injuries. However, this vascularity means that facial burns tend to bleed more heavily during surgical procedures like tissue removal. These characteristics provide the face with some natural protection, even though it is highly exposed to burn risks. (9)

Anatomy plays a significant role in the outcomes of facial burns. The skin on the forehead lies directly over bone and has limited flexibility, so burns in this area contract less than in other parts of the face. However, deep forehead burns can expose the skull, creating a particularly challenging issue. The rest of the face, supported by fat and muscle, is highly mobile. Deep burns in these areas tend to shrink easily, leading to contractures. This is especially problematic for sensitive areas like the eyelids and lips, which offer little resistance to contraction. Eyelids are prone to ectropion (outward turning), and lips may experience shrinkage at the corners (commissures) or outward turning (eversion). Even minor burns, like those from chewing an electric cord that affects the commissures, can leave permanent scars. Neck contractures are also common since the head is usually neutral or flexed. This issue is more severe in children because their skin is less elastic, whereas aging skin, being looser, tolerates shrinkage better. Controlled skin tightening, such as during facelifts or chemical peels, mimics reducing skin laxity. Certain parts of the face, like the nose, are particularly vulnerable because the skin is thin, has little fat, and lies over cartilage and bone. Burns in these areas can easily expose underlying structures, which are difficult or impossible to graft. (9)

Burns to the head and neck can lead to several serious complications, including difficulties with swallowing and speaking, swelling in the airways, and severe problems with taste, hearing, smell, and vision. These burns may also leave discolored skin, noticeable scars, and deformities even after the healed wounds. (10)

The face plays a central role in a person's identity, self-image, and communication. As a result, people with facial burns, especially severe ones, are more likely to face both physical challenges and psychological issues. (11)

Studies show many burns from flames, electricity, chemicals, or explosions occur in workplaces. This is particularly true for men, who are likelier to work in industries where such injuries happen.

Flame burns are especially common as work-related injuries. Larger total body surface area (TBSA) burns are often associated with a higher risk of facial burns. The severity of these injuries is primarily influenced by the extent of full-thickness burns, which are the most damaging. (12)

Burn injuries accounted for about 5% of evacuations during the past decade of Overseas Contingency Operations, with 10% of combat-related injuries affecting the unprotected head and neck areas. Among these cases, facial burns were present in 77% of combat-related burn admissions. Severe facial burns can have profound cosmetic and psychological effects, as well as hinder a patient's functional recovery. Since the face is closely tied to identity, burn scars can impact essential functions like vision, hearing, speech, swallowing, and breathing. (13)

Common signs of facial burn scars include outward turning of the lower eyelid (ectropion), a shortened nose with flared nostrils, a shortened and recessed upper lip, an everted lower lip (sometimes with microstomia), flattened facial features, ear deformities, restricted neck movement, and loss of jawline definition. These deformities can result from both full- and partial-thickness burns, often leading to long-term challenges and requiring multiple reconstructive surgeries. (14)

Research on combat-related burns highlights that these injuries often result from conventional or improvised explosive devices. Combat burns tend to be deeper, have a higher rate of inhalation injuries, and are often accompanied by other non-burn injuries. These factors lead to higher overall injury severity than burns in civilian settings. Despite these findings, studies have not specifically focused on facial burns within combat injuries. (15)

Scarring on the lower part of the face, especially around the mouth, is a common complication of facial burns. Severe scarring in this area poses significant challenges for reconstructive surgeons. Tightening the tissue around the mouth can lead to functional problems such as lip ectropion (outward turning of the lips), difficulty controlling saliva, and drooling. (16)

Burns are sudden, severe, and unpredictable injuries. With advances in medical care, more burn survivors now benefit from treatments focused on physical, functional, and psychological recovery. However, individuals with burns in visible areas, especially the face, often face lifelong social stigma. Many patients seek plastic surgery to restore a normal appearance, regardless of the effort or cost involved. (17)

The face is central to identity and communication, and facial burns can affect these roles, leading to negative self-perceptions. Head and neck burns are common because these areas are more exposed than regions typically covered by clothing, like the trunk or legs. Facial burn prevalence varies widely, ranging from 6% to 60% globally. In Dutch burn centers, nearly half of admitted patients had facial burns, putting them at risk of visible scarring. About 20% of these patients required facial surgery for deep burns, and 5% underwent reconstructive surgery. (18)

Hypertrophic scars are a common complication of skin injuries, especially among Asian and Chinese populations. Over half of the world's pediatric burns occur in Asia, and the face is one of the areas most vulnerable to burns, with prevalence rates ranging from 6% to 60%. Children's facial skin differs from that of adults in ways that increase the risk of hypertrophic scarring. It has a higher density of dermal appendages, which can lead to an overactive healing response, and the dermis is thinner, making partial-thickness burns that take more than two weeks to heal more likely to develop into hypertrophic scars. (19)

Facial hypertrophic scars often cause significant deformities, leading to profound psychological effects. In children, these scars are particularly impactful because they can disrupt the development of facial structures during a critical time for forming self-identity. Scar contractures can deform facial features and affect a child's sense of self, increasing the risk of long-term psychological challenges. Reconstructing the face is especially difficult for plastic surgeons due to its complex anatomy, and pediatric facial reconstruction presents even greater challenges. Children's growing and developing faces require precise interventions to minimize lasting deformities and support their physical and emotional well-being. (20)

Burn injuries can cause physical changes, such as alterations in appearance, scarring (especially on the face), and even the loss of organs, all of which can lead to significant psychological and social challenges. These changes often affect the quality of life for burn victims, particularly in terms of their self-esteem, which is a critical aspect to address. (21)

According to Rosenberg, self-esteem is "a sense of self-sufficiency to face life's fundamental challenges and be worthy of happiness." He believes self-esteem is determined by the gap between one's perceived and ideal selves, with lower self-esteem occurring when this gap widens. In other words, self-esteem influences how a person feels about various aspects of life, and if it is damaged, it becomes difficult for individuals to cope with difficult situations. Self-esteem develops from birth and is shaped by various experiences and factors throughout life. (22)

Like anyone else, Burn patients are affected by their self-esteem, which demographic, clinical, and psychological factors can influence. Thanks to advances in burn treatment, survival rates have improved. However, burns can still lead to lasting complications that affect a person's appearance and can result in long-term social and psychological challenges, such as low self-esteem. Unfortunately, the emotional needs of burn patients often receive less attention than their physical survival and recovery. As a result, low self-esteem can negatively impact their interpersonal relationships, focus, emotions, and overall performance. (23)

Given the variety of deformities that can result from burns, it is helpful to have a classification system for these deformities that can be applied to any part of the body. Here are some common categories: 1. Pigmentary disturbances: Hypopigmentation (lightening of the skin), Hyperpigmentation (darkening of the skin), and Mixed pigmentation (a combination of both). 2. Redness: Hyperemic (excessive redness) and plethoric (flushed) scars, 3. Excessive scar bulk and prominence: Hypertrophic scars (raised scars), Keloids (overgrown scars), 4. Texture problems: "Cobblestone" or "crocodile" texture of meshed skin grafts, Irregular scar surface contours, 5.Contractures: Broad, diffuse contractures versus linear and well-defined ones, Simple contractures (affecting only the skin) versus complex ones (affecting underlying tissues like fascia or muscle), 6.Distortion of free margins: Distortion of features like lips or eyelids (e.g., ectropion of the eyelids), 7.Stability: Unstable scars prone to repetitive breakdown. This classification helps in understanding and addressing the various deformities that burn patients may face, as well as the challenges these can present in their recovery process. (24)

Facial aesthetic units:

When performing facial surgery, a key consideration is the appearance of the final scar. Gonzales-Ulloa introduced the concept of "regional aesthetic units" of the face to highlight the importance of restoring the skin in complete facial regions rather than using a patchwork approach. He identified 14 distinct regions of the face based on skin thickness and histology, and these regions were further classified by examining "relief lines, folds, and changes in skin texture." The original 14 aesthetic units, as defined by Gonzales-Ulloa, include the forehead, right and left cheeks, nose, right and left upper eyelids, right and left lower eyelids, lower lip, upper lip, right and left ears, chin (mental region), and the neck. (25)

The aesthetic units of the face can also be divided into two categories: facial content and facial frames. The facial content refers to the central functional organs, such as the eyes, nose, lips, and mouth. The facial frame, which defines the contour of the face, can be separated into the anterior and posterior facial frames. Anterior facial frame: This is outlined by a line connecting several key points: the trichion (the hairline), the temporal line of the frontal bone, the lateral rim of the orbit, the outer edge of the zygomatic bone, the anterior border of the masseter muscle, and the lower border of the chin. Posterior facial frame: This is outlined by a line connecting the hairline, the zygomatic arch, and the area where the ramus and gonial angle of the mandible meet. Together, the anterior and posterior frames define the overall facial form. While the posterior facial frame is typically wider than the anterior one, individuals with a brachycephalic facial form (short and wide) will have both frames proportionally short and wide. In contrast, a dolichocephalic facial form (long and narrow) will have longer, narrower anterior and posterior frames. (16)

Gonzales-Ulloa first introduced the concept of regional aesthetic units of the face to emphasize the importance of restoring facial skin in complete units rather than using "patchwork" approaches. He believed that superior surgical outcomes could be achieved in complex facial reconstructions by replacing lost skin with grafts or flaps that match the skin's histology, thickness, and texture. Through cadaver dissections, he developed a system identifying 40 regions of the body and 14 regions of the face based on skin characteristics. His pioneering work allowed surgeons to inconspicuously hide surgical scars within the natural boundaries of each facial unit. (25)

Burget and Menick later revitalized the concept with their "subunit theory." Menick incorporated psychological principles and visual perception into surgical techniques, noting that we tend to ignore minor visual details and focus on the more noticeable abnormalities when we observe others. He analyzed facial surfaces and described ridges and valleys that form convex and concave regions, allowing for different light reflections. He theorized that by matching a graft or suture line to the natural shape of a specific subunit, the appearance of lights and shadows on the face would be restored, making the scar blend seamlessly with the facial topography. This approach has since been applied in reconstructive nasal surgery, with minor modifications proposed by other surgeons. (26)

The Facial Aesthetic Units: The current understanding of facial aesthetic units, as illustrated in Figure 1, builds upon the original work of Gonzales-Ulloa. However, further modifications have been suggested to refine the classification of each facial region into specific subunits. These additional classifications help provide a more detailed and precise approach to facial reconstruction and aesthetic surgery. (27)

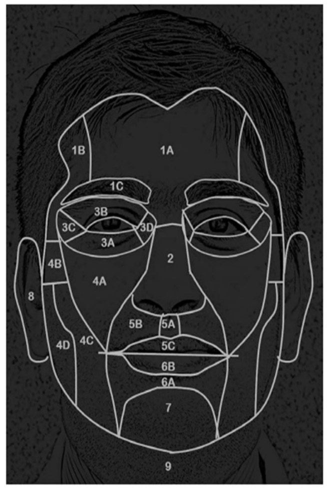

Fig.1: aesthetic units of the face.

NECK UNIT:

The neck unit refers to the area beneath the jawline, encircling the entire neck circumference and extending inferiorly to the sternal notch and the medial aspect of the clavicles. It includes the platysma muscle, the suprahyoid and infrahyoid muscles, and the neck's internal structures. Angrigiani first introduced the concept of treating the neck as a single aesthetic unit, defining its boundaries by the lower border of the mandible superiorly, the sternal notch and clavicles inferiorly, and laterally extending to an imaginary line from the earlobe to the middle of the clavicle. Observing that neck contractures often affect the chin and lower lip, leading to lip eversion, it was concluded that the chin/lower lip region is a critical subunit for neck reconstruction. Building on this, it was noted that the hyoid bone, located at the cervicomental angle, functions as the pivot point of the neck. As a result, the neck unit has been redefined into two primary regions: the submental region (suprahyoid) and the anterior neck region (infrahyoid). Treating these two portions as distinct anatomical subunits allows optimal restoration of the cervicomental angle. In summary, the neck for post-burn reconstruction is defined as follows: Superior boundary: the oral commissure; Inferior boundary: the sternal notch and clavicles; lateral boundary: the midaxial plane. The neck is subdivided into three anatomical subunits for treatment: 1. Lower lip/chin subunit, 2. Submental subunit, 3. Anterior neck subunit. This subdivision forms the basis for the current treatment strategy. (28)

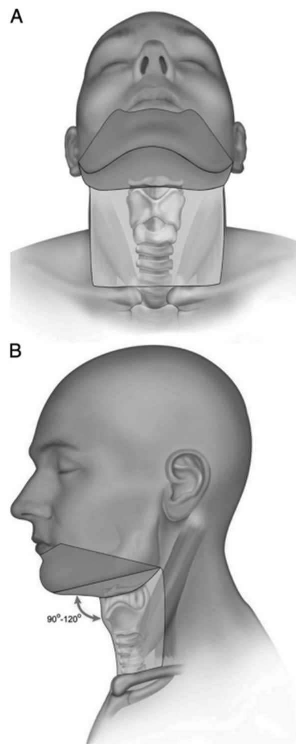

Fig.2: aesthetic units of the neck.

Neck contracture, a common and challenging complication of neck burns, can significantly affect the function and mobility of the head, neck, and lower face. This condition, characterized by the tightening of scar tissue following a burn injury, often results in restricted neck motion, difficulty swallowing, and impaired lower facial function. Several factors contribute to the development of neck contracture: 1. Initial Positioning: During the acute phase of burn care, patients who are intubated or require a tracheostomy are at higher risk due to restricted movement caused by advanced airway management. This limited movement during their hospitalization can contribute to contracture formation. 2. Upper Extremity Burns: Patients with burns to the upper extremities are especially susceptible to neck contracture. When arms are positioned in abduction to maintain shoulder mobility, this posture can lead to a shortened neck, increasing the potential for scarring. (29)

Prevention and Treatment: Positioning in Hyperextension: In the acute phase, keeping the neck in hyperextension and performing frequent neck range of motion exercises with physical therapy are crucial in preventing the development of neck contracture. Delayed Reconstruction: For patients with long-term contractures that do not respond to physical therapy, surgical intervention may be necessary. This can involve scar release procedures, followed by skin grafting, local flaps, or regional/free flap reconstruction, depending on the extent and location of the contracted skin. Overall, the management of neck contracture requires careful attention to positioning during the acute phase and may necessitate surgical reconstruction for long-term functional improvement. (30)

Cervical contractures resulting from burns often present complex challenges in plastic and reconstructive surgery due to the significant functional and aesthetic impairments they cause.

These contractures, characterized by the formation of bands, webs, and strings of scar tissue, can severely limit a patient's range of motion, including neck rotation, flexion, and extension. Moreover, they may lead to secondary complications such as lip ectropion (outward turning of the lips), which can compromise oral function and facial expression, contributing to both disfigurement and psychological distress. (31)

The impact of these complications extends beyond the physical domain, affecting a patient's economic productivity and social interactions. Functionally debilitating and aesthetically distressing, cervical contractures often require intricate surgical interventions, including tissue release, grafting, or flap reconstruction. Achieving optimal outcomes demands a multidisciplinary approach to address the condition's functional, cosmetic, and psychosocial aspects. (32)

Burn scar contractures in the cervical region are particularly challenging in pediatric patients, as they can lead to growth disturbances of the mandible and spine, with long-term developmental implications. Anterior cervical contractures are especially problematic due to their significant restriction of neck extension and overall range of motion, further compounding functional impairments. These physical limitations are often accompanied by profound aesthetic deformities, which can contribute to psychological distress and depression, severely affecting the patient's quality of life and psychosocial well-being. (33)

The disabling nature of neck contractures stems from their impact on essential movements, such as neck extension and lateral rotation. Additionally, severe scarring can cause extrinsic contractures, pulling on adjacent soft tissues and resulting in complications such as ectropion of the eyes, oral incompetence, drooling, and distortion of the breast and axilla. These secondary deformities underscore the importance of prioritizing the correction of cervical contractures before addressing associated conditions like everted lips or eyelid ectropion. This staged approach is crucial to restoring both function and aesthetics effectively. (34)

The classification system for burn-related cervical contractures is designed to evaluate the severity and anatomical position of the contracture, providing a structured framework for surgical planning. It includes four major numeric categories (1 to 4), which consider the range of motion, the neck's anatomical positioning, and the contracture's extent. Subgroups within each numeric category denote the contracting band(s) width and influence the reconstructive options available.

Category Breakdown: Type 1: Mild Anterior Contracture: Patients can flex and align the neck and jaws to the anatomical position. However, extension to view an object directly overhead (180° in the erect position) is restricted.

Subtypes: 1a: Narrow contracting band (< 2 fingers' breadth), sufficient supply adjacent neck skin for local transposition flaps., 1b: Broad band, with adequate adjacent skin for defect coverage after excision., 1c: Broadband or multiple bands, insufficient supply adjacent skin for reconstruction.

Type 2: Moderate Anterior Contracture: Neck flexion to the anatomical position is possible, but extension causes significant pulling on the lower lip.

Subtypes: 2a: Narrowband (< 2 fingers' breadth), with adjacent supple neck skin available for flaps., 2b: Broadband, but sufficient supple skin remains for reconstruction., 2c: Broadband or multiple bands with insufficient supple skin for defect coverage.

Type 3: Severe Anterior Contracture: The neck is contracted flexibly; the chin and sometimes the lower lip are tethered to the anterior chest. Anatomical position cannot be achieved, and attempts to extend it result in eye displacement and lower lip pulling.

Subtypes: 3a: Adequate supple skin for reconstruction. 3b: Insufficient supple skin for reconstruction.

Type 4: Posterior Contracture: Involves contractures at the back of the neck, limiting neck flexion and often causing an extended neck posture. Less common than anterior contractures, typically resulting from full-thickness burns or corrosive injuries.

Subtypes: 4a: Narrowband (< 2 fingers' breadth), with sufficient adjacent skin for flaps. 4b: Single broadband or multiple bands with insufficient supple skin. 4c: Posterior contracture combined with an anterior neck contracture.

Clinical and Surgical Implications: Anterior Contractures (Types 1-3): The surgical focus is on releasing the contracture and restoring mobility while ensuring adequate coverage with local flaps or skin grafts. Posterior Contractures (Type 4): Often require complex planning due to limited skin availability and the unique challenges posed by combined anterior-posterior involvement (4c).

Usage of Classification: This classification aids surgeons in assessing contracture severity and planning interventions tailored to each patient's anatomical and functional needs. Proper categorization ensures that priorities are systematically managed, such as addressing anterior contractures before secondary deformities like ectropion or lip incompetence. (34)

Airway management in patients with cervical contractures, especially during intubation, presents significant challenges that vary by the type and severity of the contracture. The distance between the chin and the thyroid prominence (< 6 cm in adults) is a critical indicator for potential intubation difficulty, particularly in severe cases. Airway Management by Contracture Type: Type 3 (Severe Anterior Contracture), Key Challenges: Chin-to-thyroid distance is significantly reduced., Contracture often involves deeper tissues, including the strap muscles., Cervical spine distortion and tracheal alterations may further complicate respiration and intubation.

Approach: Division of the contracture is often required before intubation to gain access to the airway.

In extreme cases, a tracheotomy may be necessary. Surgical release of the contracture can transform the classification to Type 1, improving both airway access and functional outcomes.

Type 2 (Moderate Anterior Contracture): Reduced mobility may make direct visualization during intubation difficult. Approach: Preferred Method: Fiberoptic-assisted intubation is recommended for safe airway management. Alternative: Blind intubation may occasionally succeed if fiberoptic equipment is unavailable. If intubation fails, division of the contracting band should be performed as in Type 3.

Types 1 and 4a/4b (Mild Anterior or Posterior Contracture): Minimal or no significant difficulty is anticipated with intubation. Approach: Standard intubation techniques can usually be employed without complications. For Type 1, surgical release focuses primarily on skin and subcutaneous tissues, typically providing adequate airway management.

Type 4c (Combined Anterior and Posterior Contracture): A combination of anterior and posterior restrictions may complicate neck mobility and airway access. A comprehensive surgical plan is required to address both contracture sites.

Clinical Implications: Surgical Release: In Type 3, addressing both the skin and deeper tissues (e.g., strap muscles) is crucial for complete release and restoration of functionality. Preparation: Patients with severe contractures should be preoperatively evaluated for airway management risks, with plans for fiberoptic intubation or emergency tracheotomy if necessary.

Post-Surgical Reclassification: Successful surgical intervention can improve neck mobility and airway accessibility, often reclassifying severe cases (Type 3) to a more manageable category (Type 1).

This systematic approach to airway management and surgical release optimizes immediate and long-term outcomes for patients with cervical contractures. (35)

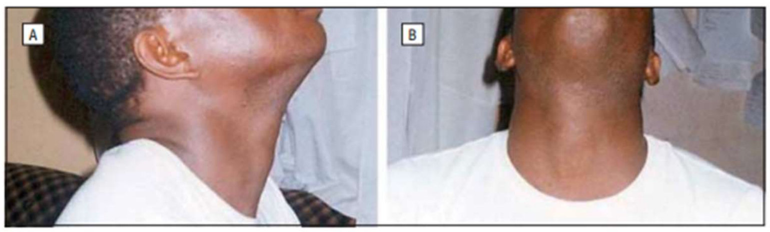

Fig.3: normal neck.

Fig.4: type 1 neck contracture. A& b &

Fig.5: type 2 neck contracture.

Fig.6: type 3 neck contracture.

Fig.7: type 4 neck contracture.

Surgical correction of cervical contractures should prioritize local flap techniques whenever possible, as these methods optimize functional and aesthetic outcomes. Utilizing the excessive and adjacent tissue in the contracture region provides a practical and effective solution for restoring neck mobility and appearance. (36)

Types of management:

Reconstruction of the face and neck is among plastic surgery's most complex and critical procedures. This region demands a large volume of soft tissue for functional restoration and requires high-quality tissue to achieve optimal cosmetic outcomes. Post-burn contractures in the neck are particularly challenging, as they can severely limit motion, disrupt facial harmony, and lead to profound aesthetic and functional deficits. (29)

The neck is the critical connector between the head and body, and mobility is essential for daily functions like breathing, swallowing, and visual orientation. Burn-induced flexion contractures in this region can cause severe functional limitations (e.g., restricted head movement) and aesthetic deformities, significantly impacting the patient's quality of life. (4)

Surgical Techniques for Contracture Release: Excision and Primary Closure: Suitable for mild contractures with limited scarring. Excision and Skin Grafting: Split Thickness Skin Grafts (STSG) are useful for larger areas but may result in suboptimal aesthetic and functional outcomes due to differences in color and texture. Full-Thickness Skin Grafts (FTSG): Preferred for better cosmetic outcomes, especially in visible areas like the face and neck, but limited by donor site availability.

Local or Distant Flaps: Ideal for moderate to severe contractures; they provide superior aesthetic and functional results using adjacent or remote tissue with similar characteristics.

Free Flaps: Best suited for large defects or cases where local tissue is insufficient. These flaps offer ample, well-vascularized tissue but require advanced microsurgical expertise.

Principles of Surgical Release: Complete excision of scar tissue to healthy, uninjured layers is crucial to achieve durable and uniform results. Reconstruction should prioritize tissue uniformity in color, texture, and thickness to restore natural appearance and functionality.

Advantages of Flap Reconstruction: Flaps offer better functional and aesthetic integration than grafts, particularly in regions requiring movement or high cosmetic standards. Flaps, whether local, distant, or free, ensure robust vascularization and durability, enhancing long-term outcomes. (37)

Skin graft: Reconstruction of facial skin defects after burn injuries occurs during rehabilitation and follows three distinct stages. The first stage, preventive rehabilitation, occurs during the acute post-injury phase and focuses on reconstructing damaged skin. Achieving optimal results over the long term depends on selecting the right autografts and timing their application. The second stage, conservative rehabilitation, begins after wound epithelialization and involves physical therapy and other non-surgical methods. If scar tissue formation becomes unavoidable, the third stage of surgical rehabilitation is required to address functional and aesthetic issues. Surgical interventions are typically performed one to one and a half years post-injury, once scars have fully matured, to avoid stimulating further scar growth. Early surgical reconstruction is reserved for severe functional impairments. (38)

The selection of autografts is critical for successful outcomes. Autografts, harvested from healthy skin at uninjured donor sites, may include non-meshed split-thickness or full-thickness skin grafts transferred to the recipient site. While free split-thickness non-meshed autografts are commonly used, they have notable drawbacks. Over time, granulation tissue regenerates into scar tissue, leading to secondary graft retraction. Traditional skin grafting often produces a corrugated "woody texture" with poor color matching, creating a "mask-like" appearance that restricts facial movement and imparts an artificial look. (39)

Full-thickness skin grafts (FTSGs) are considered the most suitable among the various grafting techniques. In the long term, FTSGs closely resemble intact skin, offering good elasticity and mobility with underlying tissues and a reduced risk of retraction. However, they also come with challenges, such as longer surgical procedures for manual harvesting, a higher metabolic demand that increases the risk of incomplete graft survival, limited donor site availability, difficulty using a single large graft, and slower integration with granulation tissue.

Surgeons can optimize functional and aesthetic outcomes in facial burn reconstruction by carefully selecting graft types and applying appropriate techniques. (40)

Acellular Dermal Matrix (ADM): ADM is a biologically derived material composed of a basement membrane and an acellular dermal collagen layer. It can be sourced as an allograft from human donor skin or a xenograft from other mammalian skin. ADM allografts serve as a collagen framework that supports mucosal epithelialization and neovascularization, making them highly effective in reconstructing large soft tissue defects. , ADMs offer several advantages, including flexibility and the ability to conform to the surrounding tissue defect while reducing donor site morbidity. They are widely used in head and neck reconstruction, with options such as AlloDerm, Integra, and DermaMatrix among the available products. Of these, AlloDerm is the most commonly utilized.

The field has further evolved to include cellular dermal matrices and non-dermal matrices (NDMs), such as porcine small intestinal mucosa (PSIS) and Poly-N-acetyl Glucosamine (pGlcNAc). These biologically-derived implants have significantly enhanced the reconstructive capabilities of surgeons by integrating seamlessly with the patient's native tissues, increasing biocompatibility and overall success rates in head and neck reconstruction. This innovative technology has revolutionized surgical practices, providing versatile solutions for complex tissue defects. (41)

Tissue Expansion in Facial Reconstruction: While recent advancements like free tissue transfer have improved facial reconstruction, achieving optimal long-term results with high patient satisfaction remains challenging. One technique that has notably enhanced outcomes is the pre-expansion of free and regional axial island flaps. This approach has contributed significantly to better surgical results. (42)

Pre-expanding flaps allow for the development of larger surface areas with thinner, more pliable tissue than traditional tissue transfer methods, which can help achieve a more natural contour. However, despite these advantages, desired outcomes are often difficult to achieve due to the significant differences between the transplanted tissue and the recipient site. (43)

The technique of expanded flaps (or skin expansion) offers ideal tissue for reconstructing head and neck lesions while minimizing donor site morbidity. An expanded transposition flap provides well-matched skin and the reliability of an axial flap. Maintaining the continuity of tissue at the base of the pedicle when elevating the flap is crucial, ensuring the capsule remains connected to the pedicle on the underside of the expanded flap. Another significant benefit of this technique is its ability to close both the defect and the donor site reliably. Unlike simple advancement flaps, the expanded flap is essentially an axial flap based on vascular structures such as the superficial temporal, occipital, cervical, pectoral, and transverse cervical vessels. For head and neck reconstruction, this flap can be designed as a pedicle or an island flap, which can be transferred in a single step. The thickness and color of the expanded flap can be adjusted to meet the functional and aesthetic requirements of facial construction. (44)

Locoregional Flaps: The Supraclavicular Artery Island and Trapezius Myocutaneous Flaps in Head and Neck Reconstruction: The concept of using shoulder-based flaps for head and neck reconstruction dates back to 1842, when Mutter first described the shoulder flap, originally harvested as a random-patterned flap. In 1903, the anatomist Toldt identified and named the arteria cervicalis superficialis, a branch of the thyrocervical trunk which exits between the sternocleidomastoid and trapezius muscles.

In 1949, Kazanjian and Converse described this flap in the context of burn scar contracture resurfacing. They referred to it as the "in character" or acromial flap "character," referring to the region on the shoulder where military honors are displayed. Mathes and Vasconez further refined the flap in 1978, renaming it the cervicohumeral flap following their anatomical studies. In 1979, Lamberty, and later Cormack in 1983, introduced the supraclavicular fasciocutaneous island flap. (45)

This flap, however, fell out of favor in the 1980s due to concerns about distal flap necrosis and the increasing popularity of the pectoralis major flap for head and neck reconstruction. The supraclavicular artery island flap was rediscovered in the late 1990s by Pallua and colleagues, who demonstrated its utility in reliably addressing post-burn mentosternal contractures. (46)

In 2004, Di Benedetto described the supraclavicular fascial island flap, where a fascial pedicle was preserved to protect the vessels from excessive stretch or compression, thereby reducing the risk of distal flap tip necrosis. (47)

Saint-Cyr and Chiu, in 2010, published a study on the vascular anatomy of the supraclavicular flap, identifying direct linking vessels between perforators and recurrent flow through the subdermal plexus, which ensured reliable perfusion to the distal edge of the flap. (48)

The trapezius muscle is a versatile source for various myocutaneous flaps used in head and neck reconstruction. These include the superior trapezius, lateral island trapezius, vertical trapezius, lower island trapezius, and extended vertical lower trapezius island flap. In 1972, Conley described the superior trapezius flap based on the paraspinous perforating branches of the posterior intercostal vessels. Panje and Demergasso later described the lateral island trapezius flap based on the transverse cervical vessels, while Mathes and Nahai introduced the vertical trapezius myocutaneous flap in 1979. In 1980, Baek and colleagues described the lower island trapezius flap as being based on transverse cervical vessels. (19)

The lower island vertical trapezius flap is commonly used for resurfacing lateral neck and lateral skull defects. However, its use may be limited following ipsilateral radical neck dissection due to the absence of the transverse cervical vessels. The superior trapezius myocutaneous flap, however, remains a highly reliable option for lateral neck reconstruction, particularly following radical neck dissection, and is used to cover exposed major neck vessels and repair wound breakdowns after radiotherapy. Literature supports the superior trapezius as the most reliable flap variant, owing to the "choke" vessel angioma concept proposed by Taylor and Palmer. (19)

TDAP Flap: The thoracodorsal artery perforator (TDAP) flap is a relatively recent advancement in reconstructive surgery, although it has yet to establish a clear and consistent role in clinical practice. It has been successfully employed in various reconstructive settings, including limb salvage, head and neck reconstruction, and trunk reconstruction, particularly for cases involving trauma, burns, and malignancy. Notably, the flap has shown significant utility in cranial base reconstruction and resurfacing the face and oral cavity. Additionally, it has been applied effectively in reconstructing traumatic defects of the upper and lower extremities and can be used both as a pedicled flap or free tissue transfer. (49)

First described in 1995, the TDAP flap is based on one or more perforating vessels originating from the thoracodorsal artery. It was initially referred to as the latissimus dorsi musculocutaneous flap without muscle or as the thin latissimus dorsi perforator flap. However, this terminology is both confusing and inaccurate. Since the flap is supplied by perforating vessels from the lateral or medial branch of the thoracodorsal artery, the correct nomenclature is the thoracodorsal artery perforator flap. (50)

This flap is often classified as an indirect muscular perforator-type flap, and, like other perforator-based flaps, it allows for maximal preservation of donor-site structures. Unlike other perforator flaps from the buttocks or abdomen, which tend to be bulky, the TDAP flap provides a thin and flexible skin-soft tissue paddle, making it ideal for resurfacing shallower defects. Its flexibility is advantageous for reconstructing complex structures, allowing for easier manipulation and contouring.

The advantages of the TDAP flap are its ease of elevation simultaneously with ease, straightforward dissection, minimal donor-site morbidity, and reliable vascular anatomy supported by a long pedicle. As a result, the TDAP flap has gained increasing popularity among reconstructive surgeons in recent years. (18)

Free Tissue Transfer for Burns Reconstruction:

Burn wound reconstruction is often a complex and challenging issue in plastic surgery. Free Tissue Transfer (FTT) is the surgical technique of isolating and detaching a specific tissue region, including its vascular supply and transferring it to another part of the body. The vessels are then reconnected to the recipient site using anastomosis of the artery and vein. Initially, FTT was primarily used for secondary reconstruction, which refers to non-acute or late-stage reconstructions. In this context, it offers the advantage of providing unscarred tissue for functional restoration and aesthetic improvement, particularly in cases of scar contracture. (51)

Recently, FTT has also been utilized in primary or early-stage reconstruction of burn wounds, which can offer a one-stage solution for complex injuries. This approach has been shown to reduce the risk of complications, such as infection or amputation, by ensuring stable wound coverage. In turn, this can lead to shorter hospital stays. Key benefits of FTT include minimal donor site morbidity and the ability to use vascularized tissue from outside the injury zone, where the surrounding tissue may be damaged. (52)

A systematic review of FTT use in burn reconstruction indicated a notable difference in failure rates between primary and secondary stages, with primary reconstruction showing a failure rate of 12.7% and secondary reconstruction a significantly lower rate of 1.5%. Though primary FTT has traditionally had higher failure rates, there has been an improvement in recent years. One notable study by Sauerbier showed a higher failure rate, but this was due to the extreme nature of the primary reconstruction of severely traumatized burns. (53)

While FTT has faced challenges due to these higher failure rates, advances in surgical techniques and a better understanding of the physiology behind systemic responses have greatly improved its success. As a result, more burn survivors are now eligible for reconstructive surgery, a procedure once considered too risky for many patients. Today, FTT is increasingly regarded as the gold standard for reconstructive surgery in areas such as the head, neck, and breast, which were previously seen as high-risk for such procedures. (54-56)

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