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# OUTCOME OF TISSUE EXPANSION FOR RECONSTRUCTION OF POST-BURN SCARRING/CONTRACTURES OF HEAD AND NECK REGION

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## Abstract

**Purpose Of the Study:** In the H&N region, the study investigates tissue expansion as a reconstructive approach to post-burn scarring and contractures. By assessing its efficacy, identifying potential issues, developing solutions, and boosting safety, it seeks to enhance the treatment of patients and burns reconstructive surgery outcomes. The study also offers evidence-based suggestions, clarifies the benefits and difficulties of tissue growth, and offers advice on therapeutic approaches.

**Methodology**: 22 patients between the ages of 8 and 55 participated in the head and neck reconstruction trial. The central neck, left face, lower jaw, neck, chest, and right side of the face were all afflicted. Infection, seroma, excruciating pain, and an open wound were all postoperative consequences. The investigation used a cross-sectional questionnaire design.

**Results**: The study revealed a varied patient population with an average age of 15 years and ages ranging from 8 to 55. 54.5% of the patients are male and come from Quetta. The part of the left face that sustains damage most commonly has scars that endure for two to forty years. Treatment for burn-related disorders is widely used to cure "Post-burn Contracture" and "Post-burn Scar." The majority of patients did not encounter problems, however, infection was the most frequent, occurring in 22.6% of cases. Seroma (9.1%), wound dehiscence (4.5%), and excruciating pain (4.5%) were among the other consequences. With 16 out of 22 cases being successful, the success percentage was 72.7%.

**Conclusion:** The current study concludes that tissue expansion, particularly in the H&N region, is a very beneficial strategy for post-burn regeneration with a very low complication rate. More research is needed to understand its advantages.

**Keywords:** Tissue Expansion, Burn injury, Scar and Contractures, Burn injuries in Head and Neck Region, Limitations, Complications

## INTRODUCTION

Burn injuries are a serious threat to people around the globe, and affect millions of individuals each year (Seth et al., 2017). Even though advances in burn care have raised the survival rate, many patients still experience severe side effects, such as contractures and hypertrophy scarring, particularly in the sensitive and obvious head and neck region (Reza et al., 2015). These consequences have major psychological ramifications that negatively affect an individual's perception of self-worth and standard of life along with compromising physical function (Żwierełło et al., 2023). Consequently, it is necessary for surgical reconstruction to tackle post-burn contractures and scarring, especially in the head and neck area.

For the treatment of post-burn scars and contractures in the H&N region, a variety of surgical techniques, such as skin grafts, local flaps, and free tissue transfers, have been employed in the past (Golpanian & Kassira, 2023; Joseph & Christopher, 2020; Mo et al., 2014; Żwierełło et al., 2023). Despite some success, these methods typically result in morbidity at the donor's location, an absence of tissue, and unsatisfactory cosmetic outcomes (Cook et al., 2022; Jeschke et al., 2020a). Tissue development, which has a number of unique advantages, has emerged as a viable alternative for the repair of post-burn sequelae (Orgill & Ogawa, 2013; Wagh & Dixit, 2013).

This study investigates the efficacy and outcomes of tissue expansion as a reconstructive treatment for post-burn scarring and contractures in the H&N region. In this area, contractures and post-burn scarring may result in functional restrictions, cosmetic problems, and lower donor site morbidity. Tissue expansion can provide more pliable and functioning tissue for restoration, which can enhance functional outcomes. Comprehensive studies on its effects are limited, especially with regard to contractures in the H&N region and post-burn scarring. The goal of the study is to provide meaningful data about tissue expansion's application in this specific clinical setting, leading to improved patient care and burn reconstructive surgery outcomes. In addition to evaluating tissue expansion's effectiveness in curing post-burn scarring and contractures in the H&N region, the study intends to uncover potential problems, create remedies, and enhance safety. Additionally, it aims to provide evidence-based recommendations, comprehend the advantages and difficulties of tissue growth, and offer guidance on how to include it in therapy strategies.

## LITERATURE REVIEW

### Burn Injuries; An Overview

Burn injuries have a significant morbidity and mortality rate that is frequently ignored, according to(Jeschke et al., 2020). Due to inflammatory reactions, metabolic anomalies, and distribution shock, burn injuries are complicated, leading to organ failure and lowering patient quality of life. Immediate and critical treatment, sustained treatment, and rehabilitation are difficult for burn care professionals to handle.

A review of the classification of wounds was done by (Abazari et al., 2022), highlighting several categories of burn wounds. These include radiation, friction, electricity, heat, cold, chemicals, and electricity. The American Burn Association's Grading System classifies burns into first-degree, second-degree, third-degree, and fourth-degree severity-based categories depending on the percentage of total body surface area.

### Impact of Burn Injuries on Head and Neck Region

Substantial physical and functional problems, including soreness, stiffness, and restricted movement, can result from burns to the H&N area (Hoogewerf et al., 2013). These wounds can also worsen the risk of respiratory issues and damage crucial senses like vision and hearing. Additionally, sensory alterations brought on by burns may impact daily activities and recuperation (Edward A. Bittner et al., 2015). Burn injury victims frequently have emotional and mental challenges, such as low self-esteem, PTSD, melancholy, and worry. It can be challenging to regain

confidence and a positive self-image when the face and neck are scarred since this can lead to a significant sense of anxiety and low self-esteem. Burn patients may experience social exclusion and difficulty reintegrating into their communities, and post-injury memories might exacerbate stress and emotional separation. Feelings of loneliness and worthlessness may become more intense during the difficult process of recovery and rehabilitation (Sethi et al., 2014).

**Development of Scar and Contracture**

Burn injuries can result in contractures and the development of scar tissue, which has an impact on the medical and rehabilitation professions. The human body's innate healing processes are initiated by fibroblasts, and collagen production becomes increasingly significant as the injury heals (Ferland-Caron et al., 2023). Joint mobility and efficiency are impacted by joint contractures, which also lead to fatality and functional limitations in the medical environment. Scarring is crucial to this process because it limits joint mobility and makes the loss of flexibility worse. Long-term immobility as a wound heals affects the formation of contractures as well. The degree of damage and depth of the burn lesion affects the likelihood and extent of contracture formation, with deeper, more severe burns harming the tissues underneath more (Goverman et al., 2017).

**Tissue Expansion**

Pregnancy, puberty-related spurts in growth, and periods of major weight gain are all times when physiologic tissue expansion happens naturally. As a result of the skin's outermost layer thinning to make room for the rapidly developing tissue beneath, this process may result in skin strain and stretch marks. Skin surface area increases as a result of the accumulation of fatty tissue in obesity, whereas the dermis maintains its usual depth and collagen levels (Rojas-Rodriguez et al., 2015; Cuthbertson et al., 2017). Since Neumann invented the first therapeutic application of tissue expansion in 1957, the idea of tissue expansion in treatment has a lengthy history. Later, Radovan expanded and enhanced this approach, expanding its clinical application and opening up fresh possibilities for reconstructive and cosmetic surgery (Larrabee & Bloom, 2007). Due to its capacity to offer sufficient soft tissue covering, maintain the integrity of the epidermis, and do away with the necessity for split-thickness skin grafts, tissue expansion is a useful method in aesthetic and reconstructive surgery(Brodsky et al., 2021; Radwan & Zide, 2019). Furthermore, tissue expansion enhances vascularity, encouraging thicker skin coverage and accelerating tissue fusion and healing (Nikkhah & Bulstrode, 2022).

The technique called tissue expansion uses controlled mechanical stretch to produce tissues that are identical to the biological tissue around it. This method entails placing a particular silicone-made equipment named a tissue expander close to the area that needs to be rebuilt. A sterile saltwater solution is fed into the expander, applying regulated mechanical strain to the tissues around it. Fresh skin cells, vessels for blood, and supporting tissues are developed as a result of tissue adaptation (As'adi et al., 2016; Nikkhah & Bulstrode, 2022). This tissue is flexible and can be employed in a variety of reconstructive procedures to produce results that are both functional and appealing to the eye (Guo et al., 2022).

**Clinical Studies on Tissue Expansion**

Our understanding of this surgical technique, notably in aesthetic surgery, dermatology, and reconstructive surgery, has been greatly increased by clinical investigations on tissue expansion. Tissue expanders (TE), when used prepectorally for breast reconstruction, have been found to lessen postoperative pain and chest wall morbidity while providing a more comfortable recovery for patients (Nikkhah et al., 2015). To properly comprehend the characteristics of this strategy, however, a thorough assessment over time is required.

The clinical outcome and physiological well-being of prepectoral vs. subpectoral tissue expander (TE) breast reconstruction after 90 days were investigated by Nelson et al., (2022). Results indicated that prepectoral TE may lessen the discomfort and morbidity of the chest wall following surgery. Prepectoral TE patients reported less discomfort, but there were no differences in their chest ratings.

Breast seroma was more likely to occur after pre-pectoral reconstruction, but expander loss remained stable. To properly comprehend this method's characteristics, long-term investigation is required.

The quality of life and patient satisfaction following tissue expansion in post-burn head and neck contractures are examined in the study by P. Heidekrueger et al., (2015). The tissue growth of free and local flaps is the main topic. The findings demonstrate the importance of pre-expansion as a key approach in post-burn regeneration, as well as local and distant tissue transfers. The study discovered that by taking into account attractive face components, it was possible to increase the range of motion, aesthetics, and patient satisfaction while lowering donor site morbidity.

In their study, (Song et al., 2019) rebuilt post-burn neck scars and contractures using tissue expansion and Z-plasty methods. For those who were pleased with the procedure, the results showed no problems. According to the study, tissue expansion combined with repeated Z-plasty is a potential treatment for scar contracture, particularly wide contracture close to cervical joints. The look of the scar area and joint performance can both be enhanced by this method.

The study by Farjo et al., (2015) investigates tissue expansion surgery as a potential cure for post-burn alopecia. The study focuses on the potential to greatly enhance lives as it examines the aetiology, process, and consequences. The paper urges more studies to improve surgical techniques and long-term results.

Dzonov et al., 2014) compared tissue expansion procedures for limbs to those for other body regions and found encouraging outcomes. Three patients out of 16 had issues with expanders, and one had a failure. The remaining problems were resolved by either exteriorizing the buried component in cases of infection or by prompt delivery.

**Complications of Tissue Expansion**

A 20-year meta-analysis and systematic review found that infections accounted for 17.44% of all problems in tissue expansion. The head and neck area is especially susceptible to infections because of its rich supply of blood and high level of infection resistance. The study also discovered that hematomas accounted for 2.9% of issues, underscoring the significance of meticulous treatment during tissue expansion surgeries (Huang et al., 2011). According to another study, 0.5% of patients had expanders that ruptured or were perforated, 0.6% had wounds that developed, and 3.0% had expanders exposed. Due to the low levels of migration and seroma, the risk of issues was comparatively low. Tissue expansion is an effective and secure therapy for disorders of the head and neck, according to the review (Azzi et al., 2020).

**Limitation of Tissue Expansion**

For skin healing on the head and face, inherent tissue expansion is an appropriate technique that yields superior cosmetic results. Large flaws, however, result in higher failure rates, necessitating more therapeutic options. Limitations of conventional tissue expansion techniques include pain, risk of infection, and rupture. To solve these problems and stop uncontrolled development, OSMEDTM created an osmotic active self-filling expander in 1999 (Handschel et al., 2013; Uwe Wollina & Yousef Bayyou, 2013).

## METHODOLOGY

The study included 22 patients of which 12 (54.5%) were male and 10 (45.5%) were female. The age of patients ranged from 8 years to 55 years. The primary focus was head and neck reconstruction. The affected areas that undergo tissue expansion are the central neck, left face, left neck, left face and head, lower jaw and neck, neck and chest, and right side of face. The reasons for treatment are post-burn scar and post-burn contractures. The post-surgery complications observed in this study included infection, seroma, severe pain and open wound (wound dehiscence).

**Study Design**

This was a cross-sectional descriptive study conducted at the Plastic surgery and burn unit of Bolan Medical Hospital over a period of six months. The study was questionnaire-based. The questionnaire included the following questions:

1. Duration of scar?
2. What is the affected area? (study of focus is neck region)
3. Reason for treatment which covered two questions like whether it is post-burn scar or post-burn contracture.
4. Which complications were faced by patients? These are minor or major?
5. In case of major complications- wound dehiscence, expander deletion, and skin perforation were asked and focused.
6. In case of minor complications- seroma, hematoma, and severe pain were inquired by patients.
7. And the final question was, is this treatment successful or not? s

**RESULTS**

In the current study, 22 patients with post-burn head and neck scars and contractures were treated with tissue expansion and flap transfer. The age of patients ranges from 8 years to 55 years. the most prevalent age group was found to be 13-17 years age. The ages of the same 22 patients are shown in Table 1 and Graph 1, along with the frequency and proportion of each age group.

Table 1: Age of Patients

| Age Group | Frequency | Per cent |
|---|---|---|
| 8-12 | 3 | 13.63 |
| 13-17 | 6 | 27.27 |
| 18-22 | 4 | 18.18 |
| 23-27 | 3 | 13.63 |
| 28-32 | 3 | 13.63 |
| 33-37 | 1 | 4.54 |
| 38-41 | 1 | 4.54 |
| 42-46 | 0 | 0 |
| 47-51 | 0 | 0 |
| 52-56 | 1 | 4.54 |
| Total | 22 | 100.0 |

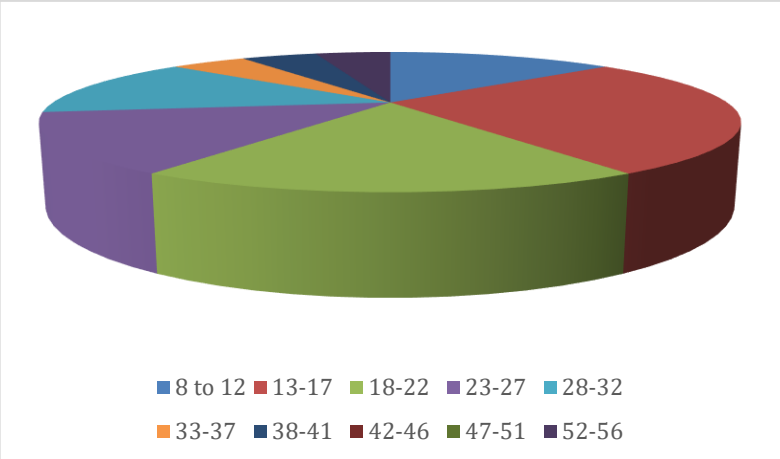
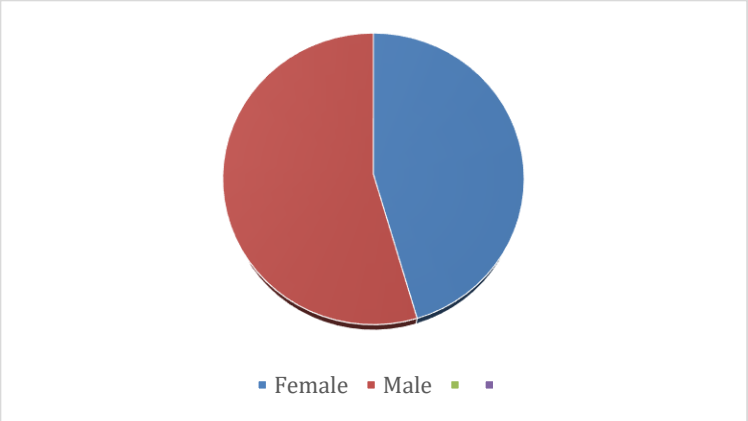



**Figure 1:** Age-frequency of patients

The gender distribution of the patients is shown in Table 2 and graph 2. Ten of the 22 cases are women, and twelve are men. This shows that there are somewhat more men in the dataset than women, with 54.5% of patients being men and 45.5% being women.

**Table 2:** gender Distribution of Patients

| Gender | Frequency | Per cent |
|---|---|---|
| Female | 10 | 45.5 |
| Male | 12 | 54.5 |
| Total | 22 | 100.0 |

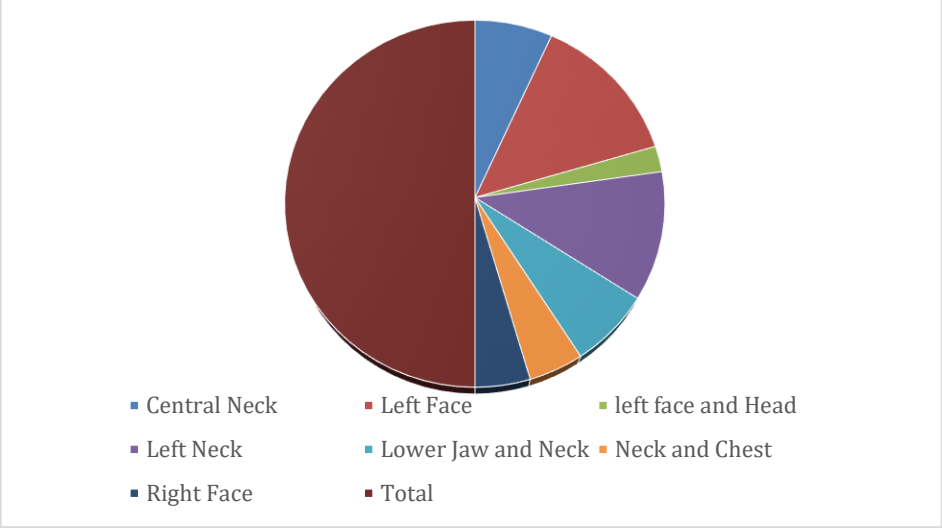



**Graph 2:** Gender Distribution of Patients

Table 3 and Graph 3 lists the body parts that the patients' scars have affected, including the Central Neck, Left Face, Left Face and Head, Left Neck, Lower Jaw and Neck, Neck and Chest, and Right Face, with the Left Face being the most often afflicted area.

**Table 3:** Affected Areas

| | Frequency | Per cent |
|---|---|---|
| Central Neck | 3 | 13.6 |
| Left Face | 6 | 27.3 |
| Left face and Head | 1 | 4.5 |
| Left Neck | 5 | 22.7 |
| Lower Jaw and Neck | 3 | 13.6 |
| Neck and Chest | 2 | 9.1 |
| Right Face | 2 | 9.1 |
| Total | 22 | 100.0 |

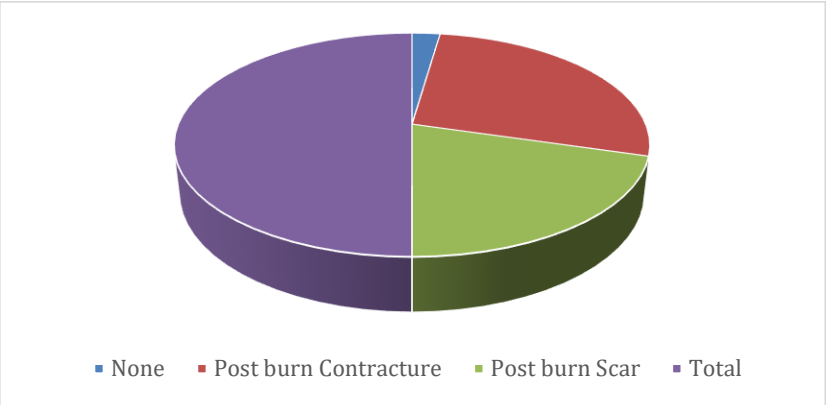



**Graph 3:** Affected Areas

The causes of tissue expansion include post-burn scar and post-burn contracture. Out of 22 patients, 12 patients (54.5%) had post-burn contracture and 9 patients (40.9%) had post-burn scar. Table 4 and graph 4 represent the frequency of post-burn scar and post-burn contracture.

**Table 4:** Reason for Treatment

| Reason | Frequency | Per cent |
|---|---|---|
| None | 1 | 4.5 |
| Post-burn Contracture | 12 | 54.5 |
| Post-burn Scar | 9 | 40.9 |
| Total | 22 | 100.0 |

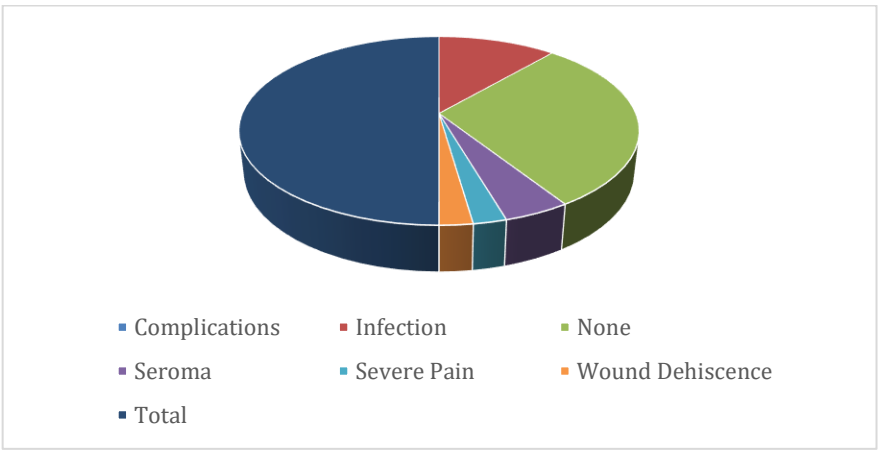



**Graph 4:** Reason for Treatment

Any issues that the patients experienced are described in Table 5 and Graph 5. The following are listed as complications: "Infection," "None," "Seroma," "Severe Pain," and "Wound Dehiscence." The most typical complication is "None," with 13 people reporting this. Less commonly, other problems are recorded.

**Table 5:** Post-Surgical Complications

| Complications | Frequency | Per cent |
|---|---|---|
| Infection | 5 | 22.7 |
| None | 13 | 59.1 |
| Seroma | 2 | 9.1 |
| Severe Pain | 1 | 4.5 |
| Wound Dehiscence | 1 | 4.5 |
| Total | 22 | 100.0 |

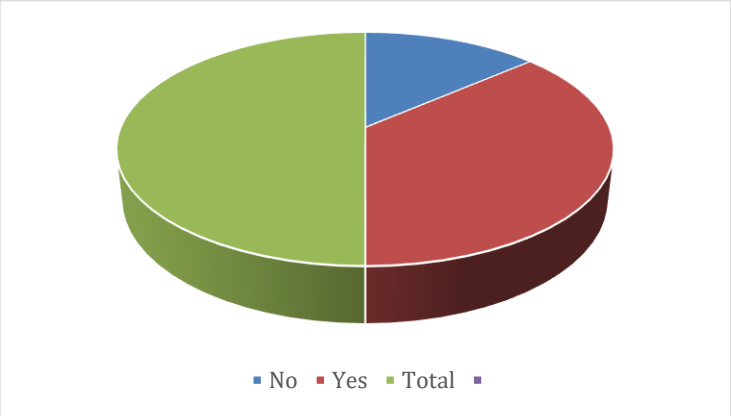



**Graph 5:** Post-Surgical Complications

Information on whether a successful flap transfer occurred during therapy is shown in Table 6 and Graph 6. 16 patients responded "Yes," suggesting a successful flap transfer in their treatment, compared to 6 patients who reported "No," indicating an unsuccessful flap transfer in their instances.

**Table 6:** Success/Failure Rate of Flap Transfer

| | Frequency | Per cent |
|---|---|---|
| No | 6 | 27.3 |
| Yes | 16 | 72.7 |
| Total | 22 | 100.0 |




**Graph 6:** Success/Failure Rate of Flap Transfer

In conclusion, this medical dataset's study reveals a varied patient group. Patients range in age from 8 to 55, with the average age group being 15 years. Geographically, patients come from a variety of places, with Quetta having the highest presence, while the gender distribution in the dataset marginally favours men (54.5% of them are men). The left face is the most often damaged area, with scars lasting anywhere between two and forty years. Burn-related conditions are frequently treated for "Post-burn Contracture" and "Post-burn Scar," which shows how common these conditions are. The majority of patients did not experience any complications, but of those who did, "Infection" was the most frequently mentioned. Additionally, the majority of patients said that their treatment resulted in a successful flap transfer. Healthcare providers can adjust their treatment to the particular requirements of this diverse patient population by using the insights provided by this dataset.

The overall findings of the data that were carefully chosen and gathered revealed that 70% of patients respond to procedures, with the other patients being unable to be cured for the course of the study.

## DISCUSSION

Burn injury is a global health issue that accounts for over 265,000 fatalities annually (Tripathee & Basnet, 2017). Burn injuries are an unappreciated type of trauma that can happen to anybody, anywhere, at any time (Jeschke et al., 2020). Burn injuries can result from a variety of sources, including touch, cold, radiation, heat, chemical, or electric sources, even though hot liquids, solids, or flames account for the majority of burn injuries (ABA, 2016). The system of respiration, metabolic processes, and inflammatory pathways are among the numerous homeostatic mechanisms that are significantly disrupted by burn injuries. Additionally, complex and significant changes to global and local hemodynamics are also brought on by burns (Rex, 2012). The pathophysiology of the burn patient reveals the whole spectrum of intricate inflammation-related reactions. Inflammation may be harmful during the acute phase because of capillary leak, the development of inhalational injury, and the formation of multiple organ failure (Evers et al., 2010). Pakistan

currently has an age-standardized fatality rate for injuries from fire, heat, and hot materials of 5.8 per 100,000 persons, as stated by the GBD report (GBD, 2010).

There are various ways to classify burn injuries. The most common ones are those that consider the origin and severity of the damage. Thermal, electrical, frictional, chemical, and radiation burn injuries are all categorized according to the cause of the burn. First-degree injuries are those that are superficial, second-degree injuries are partial, third-degree injuries are full, and fourth-degree injuries are those that extend to deep tissue. Deep partial-thickness injuries and superficial partial-thickness injuries are two more categories for third-degree or partial-thickness injuries (Lotter et al., 2015; Serrano et al., 2015; Shin & Yi, 2016).

Following an injury caused by burns, a scar forms that makes the tissues under the skin less elastic, constricting and restricting movement. The term "post-burn scar with contracture" refers to this phenomenon. This contracture may require medical care, such as rehabilitative or surgical procedures, to improve mobility and beauty (Mody et al., 2014). Scars and contractures can be treated surgically in a variety of ways. One alternative is scar revision surgery, which reduces the visibility of a scar by removing old tissue and sewing up the region with tiny stitches (Gupta et al., 2014). Skin grafting is an additional method. Skin grafting, which involves transferring healthy skin from a donor site to the wounded area, is particularly successful in treating severe burn scarring or sites where skin requires motion to be restored (Kim et al., 2019). Flap transfer is yet another method that is frequently used. Flap surgery involves transferring blood vessels, tissue underneath, and skin to the affected area, much like skin grafting. It is usually utilized if a scar or contracture seems extensive and severe (Jabir et al., 2014).

Due to its numerous benefits and drawbacks, tissue expansion is the most recent approach for treating scars and contractures. when the burned area is too extensive to be immediately stitched up (Nikkhah et al., 2015), tissue expansion is also utilized to grow additional skin in the injured area to cover extensive burn scars when traditional grafting techniques may not be feasible (Handschel et al., 2013).

22 patients, ranging in age from 8 to 55, who have had a tissue expansion treatment are included in the current study, and a rate of success of more than 72% has been noted. This is consistent with research done by Motamed et al., (2008) The study's findings indicate a 91% success rate (68 out of 72). As'adi et al., (2016) conducted a study that is comparable to this one. The use of endoscopically aided tissue transfer was the sole innovation in this study. The findings revealed a success rate of 99%.

Seroma, wound dehiscence, infection, and excruciating pain were a few of the consequences taken into account in this study. The overall infection frequency was 22% (5 patients) among them, while seroma only affected 2 (9%). Only 1 (4.9%) of the patients experienced significant discomfort, whereas 59.1% of patients experienced no sequelae. The rate of complications of TE in extremities and non-limb locations was compared by (Dzonov et al., 2014). According to the findings, complications are more common in the limbs (14.28%) than in other body parts, including the head and neck (7.1%). In 2016, Duclert-Bompaire discussed the outcome of 45 children's tissue expansion reconstructions, 39% of whom were brought on by burn pathology throughout the body. It was observed that 53% of the burn victims had issues. The fact that this study only includes children may be the reason why it differs from the current study's findings in terms of patient age groups. (Duclert-Bompaire et al., 2017). In patients with cancers, Handschel et al., (2013) conducted TE on the head and neck areas. The study's findings showed that just 29% of patients experienced difficulties while 71% of patients experienced success. These findings resemble the findings of the recent study almost exactly. Only 17 out of the 58 participants in the trial who required H&N TE had significant problems.

## CONCLUSION

In the decision, the current study shows that tissue expansion, especially in the H&N region, is a highly helpful approach for post-burn reconstruction with an extremely low complication rate. To learn more about its benefits, additional research is required.

**Limitations of the Study**

The findings of the study, which concentrate on the head and neck region, might not be relevant to other occurrences of post-burn scarring and contractures. The statistical power and generalizability of the results could be impacted by the small number of participants. The length of the study may make it difficult to evaluate long-term effects because practical constraints on long-term follow-up may make it impossible to do so. The findings could be unpredictable because individuals who have head and neck post-burn consequences can vary greatly in terms of burn severity, age, and a variety of medical issues.

**REFERENCES**


1. ABA. (2016). *NATIONAL BURN REPOSITORY REPORT OF DATA FROM 2006-2015*. www.ameriburn.org
2. Abazari, M., Ghaffari, A., Rashidzadeh, H., Badeleh, S. M., & Maleki, Y. (2022). A Systematic Review on Classification, Identification, and Healing Process of Burn Wound Healing. In *International Journal of Lower Extremity Wounds* (Vol. 21, Issue 1, pp. 18–30). SAGE Publications Inc. https://doi.org/10.1177/1534734620924857
3. As'adi, K., Emami, S. A., Salehi, S. H., & Shoar, S. (2016). A Randomized Controlled Trial Comparing Endoscopic-Assisted Versus Open Neck Tissue Expander Placement in Reconstruction of Post-Burn Facial Scar Deformities. *Aesthetic Plastic Surgery*, *40*(4), 526–534. https://doi.org/10.1007/s00266-016-0644-7
4. Azzi, J. L., Thabet, C., Azzi, A. J., & Gilardino, M. S. (2020). Complications of tissue expansion in the head and neck. In *Head and Neck* (Vol. 42, Issue 4, pp. 747–762). John Wiley and Sons Inc. https://doi.org/10.1002/hed.26017
5. Brodsky, M. A., Rezac, L., Terella, A., & Brown, M. (2021). Tissue Expansion Before Mohs Micrographic Surgery for a Large Scalp Tumor. *Dermatologic Surgery*, *47*(7), 997–998. https://doi.org/10.1097/DSS.0000000000003075
6. Cuthbertson, D. J., Steele, T., Wilding, J. P., Halford, J. C., Harrold, J. A., Hamer, M., & Karpe, F. (2017). What have human experimental overfeeding studies taught us about adipose tissue expansion and susceptibility to obesity and metabolic complications? In *International Journal of Obesity* (Vol. 41, Issue 6, pp. 853–865). Nature Publishing Group. https://doi.org/10.1038/ijo.2017.4
7. Duclert-Bompaire, M., Sallot, A., Lardy, H., & Le Touze, A. (2017). Tissue expansion in children: Indications and management of complications. A 10-year experience. *Annales de Chirurgie Plastique Esthetique*, *62*(2), 146–155. https://doi.org/10.1016/j.anplas.2016.02.003
8. Dzonov, B., Daskalov, O., Noveski, L., Zhivadinovik, J., & Isjanovska, R. (2014). TISSUE EXPANSION IN LIMBS VS OTHER BODY REGIONS. *CONTRIBUTIONS. Sec. Med. Sci., XXXV, 1*.
9. Edward A. Bittner, Erik Shank, Lee Woodson, & Jeevendra Martyn. (2015). Acute and Perioperative Care of the Burn-injured Patient. *Anesthesiology , 122*, 448–464.
10. Evers, L. H., Bhavsar, D., & Mailänder, P. (2010). The biology of burn injury. In *Experimental Dermatology* (Vol. 19, Issue 9, pp. 777–783). https://doi.org/10.1111/j.1600-0625.2010.01105.x
11. Farjo, B., Farjo, N., & Williams, G. (2015). Hair transplantation in burn scar alopecia. *Scars, Burns & Healing*, *1*, 205951311560776. https://doi.org/10.1177/2059513115607764
12. Ferland-Caron, G., Kwan, P. O., & Tredget, E. E. (2023). Free Tissue Transfer in the Reconstruction of Neck Contractures after Burn Injury: A Case Series. *European Burn Journal 2023, Vol. 4, Pages 248-258*, *4*(2), 248–258. https://doi.org/10.3390/EBJ4020022
13. GBD. (2010). *Global Burden of Disease (GBD)*. https://www.healthdata.org/research-analysis/gbd
14. Golpanian, S., & Kassira, W. (2023). Full-Thickness Skin Grafts. *Operative Dictations in Plastic and Reconstructive Surgery*, 199–201. https://doi.org/10.1007/978-3-319-40631-2_48

15. Goverman, J., Mathews, K., Goldstein, R., Holavanahalli, R., Kowalske, K., Esselman, P., Gibran, N., Suman, O., Herndon, D., Ryan, C. M., & Schneider, J. C. (2017). Adult Contractures in Burn Injury: A Burn Model System National Database Study. *Journal of Burn Care and Research*, *38*(1), e328–e336. https://doi.org/10.1097/BCR.0000000000000380
16. Guo, Y., Song, Y., Xiong, S., Wang, T., Liu, W., Yu, Z., & Ma, X. (2022). Mechanical Stretch Induced Skin Regeneration: Molecular and Cellular Mechanism in Skin Soft Tissue Expansion. In *International Journal of Molecular Sciences* (Vol. 23, Issue 17). MDPI. https://doi.org/10.3390/ijms23179622
17. Gupta, S., Garg, S., & Dahiya, N. (2014). Surgical scar revision: An overview. *Journal of Cutaneous and Aesthetic Surgery*, *7*(1), 3. https://doi.org/10.4103/0974-2077.129959
18. Handschel, J., Schultz, S., Depprich, R. A., Smeets, R., Sproll, C., Ommerborn, M. A., Naujoks, C., Kübler, N. R., & Zimmermann, A. (2013). Tissue expanders for soft tissue reconstruction in the head and neck area-requirements and limitations. *Clinical Oral Investigations*, *17*(2), 573–578. https://doi.org/10.1007/s00784-012-0747-8
19. Hoogewerf, C. J., Van Baar, M. E., Hop, M. J., Bloemen, M. C. T., Middelkoop, E., & Nieuwenhuis, M. K. (2013). Burns to the head and neck: Epidemiology and predictors of surgery. *Burns*, *39*(6), 1184–1192. https://doi.org/10.1016/J.BURNS.2013.03.006
20. Huang, X., Qu, X., & Li, Q. (2011). Risk factors for complications of tissue expansion: A 20-year systematic review and meta-analysis. *Plastic and Reconstructive Surgery*, *128*(3), 787–797. https://doi.org/10.1097/PRS.0B013E3182221372
21. Jabir, S., Frew, Q., El-Muttardi, N., & Dziewulski, P. (2014). A systematic review of the applications of free tissue transfer in burns. In *Burns* (Vol. 40, Issue 6, pp. 1059–1070). Elsevier Ltd. https://doi.org/10.1016/j.burns.2014.01.008
22. Jeschke, M. G., van Baar, M. E., Choudhry, M. A., Chung, K. K., Gibran, N. S., & Logsetty, S. (2020). Burn injury. *Nature Reviews Disease Primers*, *6*(1). https://doi.org/10.1038/s41572-020-0145-5
23. Johnson, T. M., Lowe, L., Brown, M. D., Sullivan, M. J., & Nelson, B. R. (2013). *Histology and Physiology of Tissue Expansion*.
24. Joseph, P., & Christopher, C. (2020). *Skin Grafting - StatPearls - NCBI Bookshelf*. https://www.ncbi.nlm.nih.gov/books/NBK532874/
25. Kim, H. S., Sun, X., Lee, J. H., Kim, H. W., Fu, X., & Leong, K. W. (2019). Advanced drug delivery systems and artificial skin grafts for skin wound healing. In *Advanced Drug Delivery Reviews* (Vol. 146, pp. 209–239). Elsevier B.V. https://doi.org/10.1016/j.addr.2018.12.014
26. Larrabee, W. F., & Bloom, D. C. (2007). Biomechanics of skin flaps. *Local Flaps in Facial Reconstruction*, 31–40. https://doi.org/10.1016/B978-0-323-03684-9.50008-6
27. Lotter, O., Held, M., Schiefer, J., Werner, O., Medved, F., Schaller, H. E., Rahmanian-Schwarz, A., Jaminet, P., & Rothenberger, J. (2015). Utilization of laser Doppler flowmetry and tissue spectrophotometry for burn depth assessment using a miniature swine model. *Wound Repair and Regeneration*, *23*(1), 132–136. https://doi.org/10.1111/WRR.12246
28. Mo, J., Park, H. W., & Guan, K. (2014). The Hippo signaling pathway in stem cell biology and cancer. *EMBO Reports*, *15*(6), 642–656. https://doi.org/10.15252/embr.201438638
29. Mody, N. B., Bankar, S. S., & Patil, A. (2014). Post Burn Contracture Neck: Clinical Profile and Management. *Journal of Clinical and Diagnostic Research : JCDR*, *8*(10), NC12. https://doi.org/10.7860/JCDR/2014/10187.5004
30. Motamed, S., Niazi, F., Atarian, S., & Motamed, A. (2008). Post-burn head and neck reconstruction using tissue expanders. *Burns*, *34*(6), 878–884. https://doi.org/10.1016/j.burns.2007.11.018
31. Nelson, J. A., Shamsunder, M. G., Vorstenbosch, J., Polanco, T. O., Matros, E., Coriddi, M. R., Mehrara, B. J., Allen, R. J., Dayan, J. H., & Disa, J. J. (2022). Prepectoral and Subpectoral Tissue Expander-Based Breast Reconstruction: A Propensity-Matched Analysis of 90-Day Clinical and Health-Related Quality-of-Life Outcomes. *Plastic and Reconstructive Surgery*, *149*(4), 607E-616E. https://doi.org/10.1097/PRS.0000000000008892

32. Nikkhah, D., & Bulstrode, N. W. (2022). Tissue Expansion. *Plastic Surgery - Principles and Practice*, 56–67. https://doi.org/10.1016/B978-0-323-65381-7.00006-X
33. Nikkhah, D., Yildirimer, L., & Bulstrode, N. W. (2015). Tissue expansion. *Plastic and Reconstructive Surgery: Approaches and Techniques*, 51–61. https://doi.org/10.1002/9781118655412.CH6
34. Orgill, D. P., & Ogawa, R. (2013). Current methods of burn reconstruction. *Plastic and Reconstructive Surgery*, *131*(5). https://doi.org/10.1097/PRS.0b013e31828e2138
35. P. Heidekrueger, P. N. Broer, & M. Ninkovic. (2015). LOP21: Optimizing Functional and Aesthetic Outcomes in Post-Burn Head and Neck Reconstruction. *Klinikum Bogenhausen, Plastic Surgery, Munich, Germany*, *136*(2).
36. Radwan, A. M., & Zide, M. F. (2019). Tissue Expansion in the Head and Neck. In *Atlas of the Oral and Maxillofacial Surgery Clinics of North America* (Vol. 27, Issue 2, pp. 167–173). W.B. Saunders. https://doi.org/10.1016/j.cxom.2019.05.010
37. Rex, S. (2012). Burn injuries. In *Current Opinion in Critical Care* (Vol. 18, Issue 6, pp. 671–676). https://doi.org/10.1097/MCC.0b013e328359fd6e
38. Reza, M., Yamin, A., Mozafari, N., Mozafari, M., & Razi, Z. (2015). Reconstructive Surgery of Extensive Face and Neck Burn Scars Using Tissue Expanders. *World Journal of Plastic Surgery*, *4*(1), 40. /pmc/articles/PMC4298864/
39. Rojas-Rodriguez, R., Lifshitz, L. M., Bellve, K. D., Min, S. Y., Pires, J., Leung, K., Boeras, C., Sert, A., Draper, J. T., Corvera, S., & Moore Simas, T. A. (2015). Human adipose tissue expansion in pregnancy is impaired in gestational diabetes mellitus. *Diabetologia*, *58*(9), 2106–2114. https://doi.org/10.1007/S00125-015-3662-0/FIGURES/4
40. Serrano, C., Boloix-Tortosa, R., Gómez-Cía, T., & Acha, B. (2015). Features identification for automatic burn classification. *Burns*, *41*(8), 1883–1890. https://doi.org/10.1016/J.BURNS.2015.05.011
41. Seth, A. K., Friedstat, J. S., Orgill, D. P., Pribaz, J. J., & Halvorson, E. G. (2017). Microsurgical Burn Reconstruction. In *Clinics in Plastic Surgery* (Vol. 44, Issue 4, pp. 823–832). W.B. Saunders. https://doi.org/10.1016/j.cps.2017.05.014
42. Sethi, R. K. V., Kozin, E. D., Fagenholz, P. J., Lee, D. J., Shrime, M. G., & Gray, S. T. (2014). Epidemiological Survey of Head and Neck Injuries and Trauma in the United States. *Http://Dx.Doi.Org/10.1177/0194599814546112*, *151*(5), 776–784. https://doi.org/10.1177/0194599814546112
43. Shin, J. Y., & Yi, H. S. (2016). Diagnostic accuracy of laser Doppler imaging in burn depth assessment: Systematic review and meta-analysis. *Burns*, *42*(7), 1369–1376. https://doi.org/10.1016/J.BURNS.2016.03.012
44. Song, Y., Li, Y., Xia, C., Zhang, ; Mingzi, Yu, N., Huang, J., Long, ; Xiao, & Wang, X. (2019). *Use of Tissue Expansion and Serial Z-plasty for Release of Neck Post-Burn Scar Contracture*. https://doi.org/10.1093/jbcr/irz134/5532827
45. Tripathee, S., & Basnet, S. J. (2017). Epidemiology of burn injuries in Nepal: a systemic review. *Biomedical Central*. https://doi.org/10.1186/s41038-017-0075-y
46. Uwe Wollina, & Yousef Bayyou. (2013). Reconstruction of a Large Scalp Defect by the Sequential Use of Dermal Substitute, Self-Filling Osmotic Tissue Expander and Rotational Flap. *Journal of Cutaneous and Aesthetic Surgery*, *3*(2). https://doi.org/10.4103/0974-2077.69023
47. Wagh, M. S., & Dixit, V. (2013). Tissue expansion: Concepts, techniques and unfavourable results. *Indian Journal of Plastic Surgery : Official Publication of the Association of Plastic Surgeons of India*, *46*(2), 333. https://doi.org/10.4103/0970-0358.118612
48. Żwierełło, W., Piorun, K., Skórka-Majewicz, M., Maruszewska, A., Antoniewski, J., & Gutowska, I. (2023). Burns: Classification, Pathophysiology, and Treatment: A Review. In *International Journal of Molecular Sciences* (Vol. 24, Issue 4). MDPI. https://doi.org/10.3390/ijms24043749