

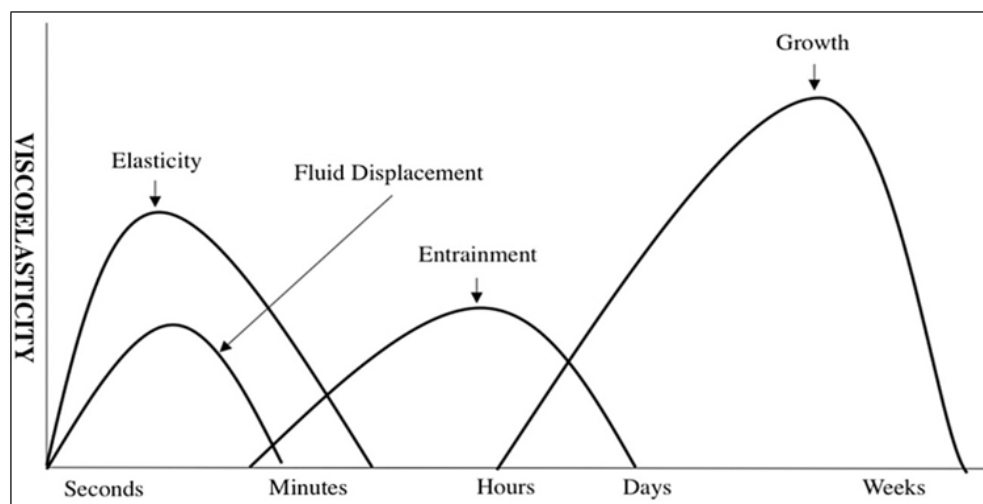


**Table 1.** Advantages and Disadvantages of Tissue Expansion.

Tissue Expansion	
Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Closure of major defects</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple surgical stages (at least two)</li> </ul>
<ul style="list-style-type: none"> <li>• Preparation for expansion of axial, myocutaneous, or fasciocutaneous flaps and free flaps</li> </ul>	<ul style="list-style-type: none"> <li>• The reconstruction is delayed until the expansion is completed</li> </ul>
<ul style="list-style-type: none"> <li>• The donor tissue is adjacent to the defect and shares similar color, texture, thickness, sensation, and appearance</li> </ul>	<ul style="list-style-type: none"> <li>• Significant temporary aesthetic deformity during the expansion process</li> </ul>
<ul style="list-style-type: none"> <li>• Enables primary closure, thereby limiting donor site morbidity</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple outpatient visits</li> </ul>
<ul style="list-style-type: none"> <li>• Relocation of scar</li> </ul>	<ul style="list-style-type: none"> <li>• Risks and complications (pain, exposure or infection)</li> </ul>
<ul style="list-style-type: none"> <li>• Repeated expansion</li> </ul>	

**Mechanical Creep:** This occurs when tissue is acutely stretched, resulting in collagen fiber alignment, micro-

fragmentation of elastic fibers, and redistribution of water within the tissue's elastic fibers [5] (**Figure 1**).

**Figure 1.** Viscoelastic properties of the skin as a function of time.

**Biological Creep:** This occurs with chronic stretching, initiating cellular growth and tissue regeneration, increased collagen production, angiogenesis, and activation of growth factors and kinases.

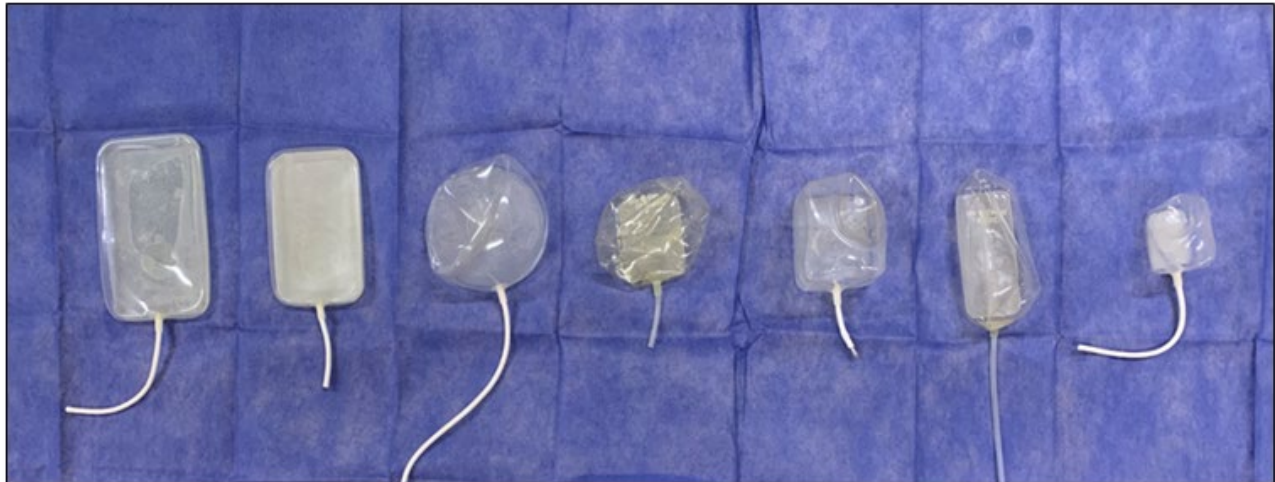
Understanding the tissue expansion process offers a practical guide based on scientific research.

#### MATERIALS AND METHODS

The force required to maintain tissue elongation decreases over time [5]. Applying a constant force for a certain period reduces tissue resistance, increasing the amount of expanded

tissue and requiring less force (stress force) to continue the process. Gradual force application is crucial to avoid altering tissue elasticity patterns and causing quality alterations (striae, tissue thinning) or rupture, which could expose the expander. The biological effects of tissue expansion are observed at the epidermis, dermis, muscle, fat, capsule, and blood vessel levels (**Table 2**). Mechanical stretching and biological growth occur during tissue expansion, reaching histological normality up to two years post-expander removal [6,7].





**Figure 2.** Types of expanders.

*Photographic archive Hospital "Dr. Manuel Gea González General Hospital".*

Differential expanders produce more expansion in specific parts. Customized expanders are tailored for specific defects [8]. Rectangular expanders gain 38% of the calculated expander surface area, round expanders gain 25%, and crescent expanders gain 32% [9].

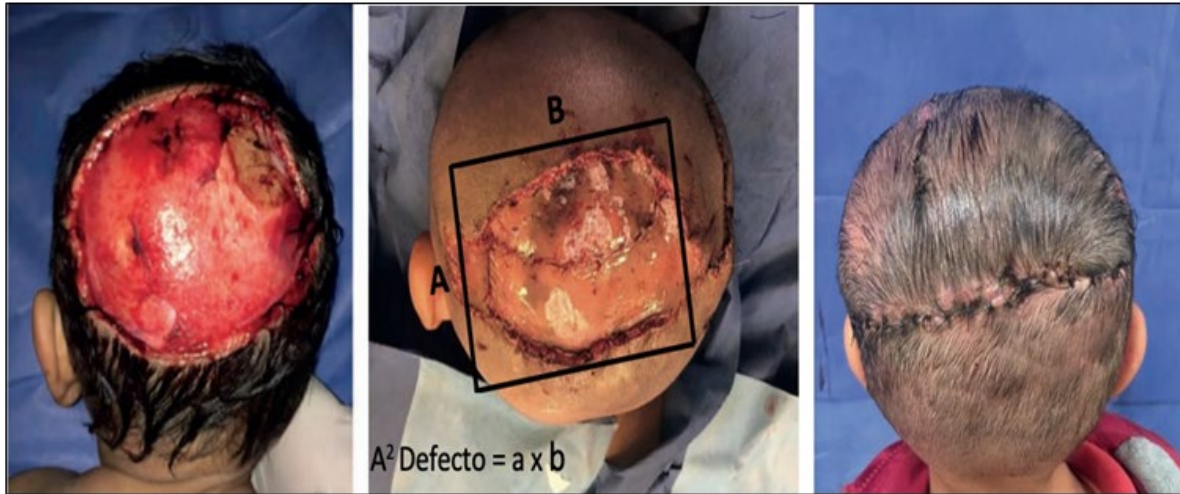
**PLANNING THE EXPANSION**

This is a complex process involving a multidisciplinary team and family support. Emotional stability is crucial due to

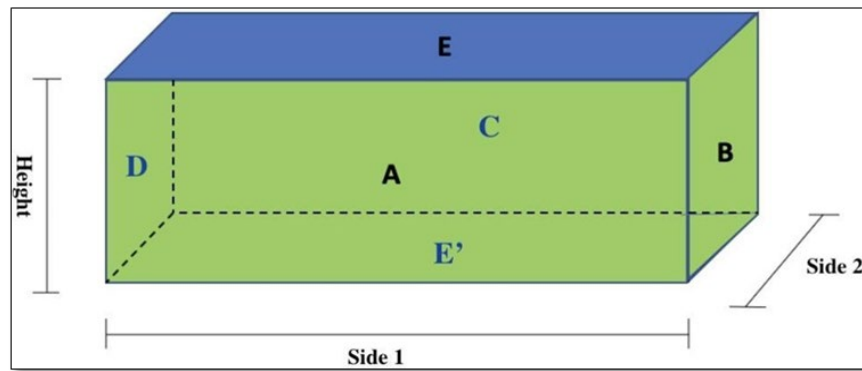
temporary aesthetic disfigurement. There are absolute and relative contraindications for expander use (Table 3). Size, shape, and volume selection must consider defect size, donor site, and expected flap advancement [10]. Several theories exist for choosing an expander; one suggests the expander's base should match the defect size. However, the expander's base should ideally be 2.5-3 times the defect width [11,12] (Figures 3 & 4). To estimate the tissue needed, use: defect area + expander area + 20%.

**Table 3.** Contraindications for the use of tissue expanders.

Pre-expanded Free Perforator Flaps	
Indications	Contraindications
<ul style="list-style-type: none"> <li>Coverage of extensive scars on the face, neck, or anterior chest.</li> </ul>	<ul style="list-style-type: none"> <li>Poor-quality recipient vessels.</li> </ul>
<ul style="list-style-type: none"> <li>Release of scars with contractures.</li> </ul>	<ul style="list-style-type: none"> <li>Recipient vessels near a radiation therapy zone.</li> </ul>
<ul style="list-style-type: none"> <li>Coverage after resection of giant congenital nevi.</li> </ul>	<ul style="list-style-type: none"> <li>Significant comorbidities that preclude lengthy or complex procedures.</li> </ul>
<ul style="list-style-type: none"> <li>Penile reconstruction.</li> </ul>	<ul style="list-style-type: none"> <li>Use of drugs, smoking, or immunosuppression.</li> </ul>
<ul style="list-style-type: none"> <li>Esophageal reconstruction.</li> </ul>	<ul style="list-style-type: none"> <li>Suspected patient non-compliance with expansion sessions.</li> </ul>
	<ul style="list-style-type: none"> <li>Microsurgical team with little or no experience.</li> </ul>



**Figure 3.** Calculation of the size of the expander.  
 Photographic archive Hospital "Dr. Manuel Gea González General Hospital".



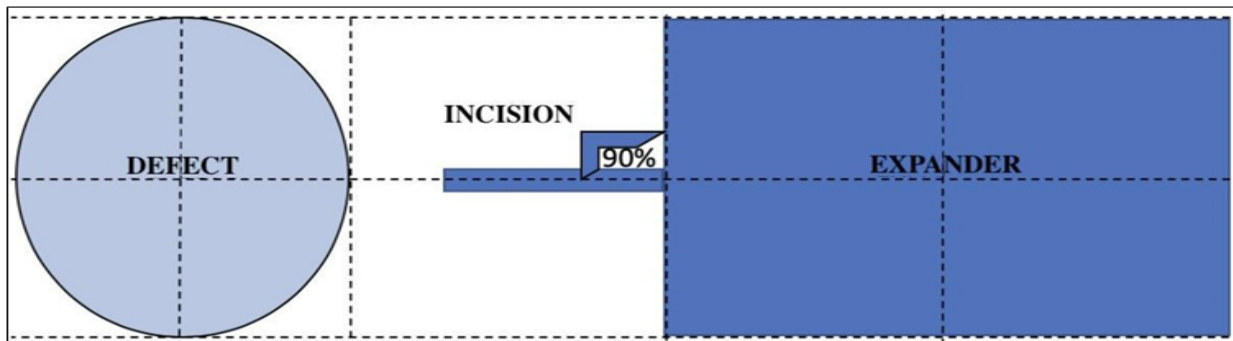
**Figure 4.** Area expanded with the expander. EXPANDED AREA: (A + B + C + D) – E BASE AREA OF THE EXPANDER (E AND E'): Side 1 x Side 2.

**AREA "A" AND "C": SIDE 1 X HEIGHT AREA "B" AND "D": SIDE 2 X HEIGHT**

**Surgical Technique**

The incision should be perpendicular to the expansion direction to avoid tension and possible dehiscence during expansion. It can be made in previous scars or at the defect

edge [10] (Figure 5). The pocket's size should match the expander's size to avoid deformation or displacement. Hemostasis and meticulous dissection preserve overlying vascularization. Closed drains combat dead space [13-15]. The expander is partially filled (10-20% capacity) for proper positioning. Expansion typically starts 2 to 3 weeks post-placement [3].

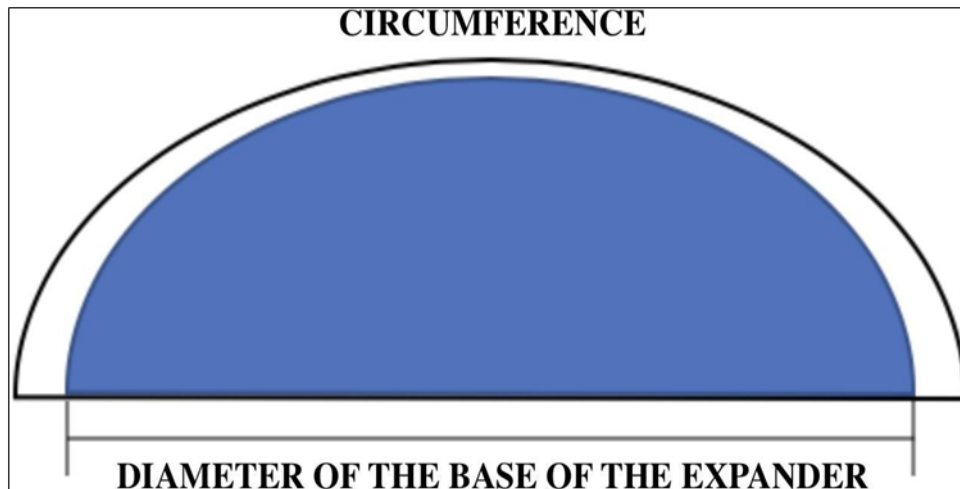


**Figure 5.** Incision.

Expansion is performed on an outpatient basis, usually without anesthesia. The area is examined for inflammation and sensitivity. The expander and valve are palpated for folds and accessibility [16]. After cleaning and preparation, the valve is located with a magnetic device, and the dome is pierced with a syringe. Gentle aspiration confirms system continuity. Expansion is done with 0.9% saline, avoiding air

introduction [17]. Each session's volume is recorded. Expansion lasts 6 to 12 weeks, after which the expander is removed and the final reconstruction is performed [18] (**Figure 6**). The formed capsule is dissected perpendicular to the advancement direction to increase flap mobilization.

Complete capsule removal is generally unnecessary and potentially harmful [19,12].



**Figure 6.** Expanded tissue area.

#### APPLICATIONS BY ANATOMICAL REGION

**Scalp:** Approximately 50% of the scalp can be reconstructed without significant thinning of the remaining hair.

Location: Subcutaneous or subgaleal plane.

Duration: Expansion can occur 2-3 times per week [20].

Considerations: Incisions are camouflaged in the hairline, eyebrow line, midline, or tension lines.

**Head and Neck:** Flaps are designed considering vessel branches. Special care must be taken with aesthetic units and flap tension.

Location: Subcutaneous plane, superficial to SMAS. In the neck, the expander can be placed superficial or deep to the platysma [18].

Considerations: Avoid facial nerve branches and Stenon duct [21].

**Ears:** Used for microtia corrections and auricular wound coverage.

Location: Respect the superficial temporal fascia in the supra- and preauricular region [22].

Considerations: Typically involves three stages: 1. Expander placement, 2. Expander removal, 3. Auricular remnants and scar remodeling.

**Chest and Breast:** Thoracic and abdominal defects are better managed with multiple expanders.

Location: Submuscular plane (pectoralis major), with inferolateral pole covered by serratus anterior fascia [23].

Considerations: Respect the nipple-areola complex (NAC). In radiated tissues, complications include infection and extrusion [24].

**Abdomen:** Advantages include low neurovascular damage risk and better expansion potential.

Location: Plane between internal and external obliques.  
Duration: 4 weeks to 3 months.

Considerations: Avoid pressures exceeding 30-40 cmH<sub>2</sub>O to prevent complications like abdominal compartment syndrome [25].

**Extremities:** Expansion is associated with higher complication rates, requiring careful technique selection.

Location: Supramuscular plane.

Considerations: Avoid superficial vessels or sensory nerves. The expander should not cross or interfere with joint mobility.

#### COMPLICATIONS

The success rate of tissue expansion ranges from 84-97%. However, complications can occur, related to the expander, the patient, or the surgical technique (**Table 4**). Factors

associated with these complications include improper expander selection, inadequate patient evaluation, and technical errors during the expansion process. Common complications are hematoma, infection, exposure, and

extrusion. To mitigate these risks, careful planning, meticulous surgical technique, and diligent postoperative care are imperative.

**Table 4.** Complications at each stage of Tissue Expansion.

Complications of Tissue Expansion	
<b>Complications of expander insertion</b>	<ul style="list-style-type: none"> <li>• Skin perforation above the expander pocket</li> </ul>
	<ul style="list-style-type: none"> <li>• Placement of the port near or under the expander</li> </ul>
	<ul style="list-style-type: none"> <li>• Expander or port perforation</li> </ul>
	<ul style="list-style-type: none"> <li>• Trauma to vascular, nervous, or muscular tissues</li> </ul>
<b>Early post-insertion complications</b>	<ul style="list-style-type: none"> <li>• Hematoma</li> </ul>
	<ul style="list-style-type: none"> <li>• Seroma</li> </ul>
	<ul style="list-style-type: none"> <li>• Infection</li> </ul>
	<ul style="list-style-type: none"> <li>• Wound dehiscence</li> </ul>
	<ul style="list-style-type: none"> <li>• Expander migration</li> </ul>
	<ul style="list-style-type: none"> <li>• Wound necrosis</li> </ul>
	<ul style="list-style-type: none"> <li>• Dermal necrosis</li> </ul>
<b>Complications during the expansion period</b>	<ul style="list-style-type: none"> <li>• Expander perforation</li> </ul>
	<ul style="list-style-type: none"> <li>• Seroma</li> </ul>
	<ul style="list-style-type: none"> <li>• Infection</li> </ul>
	<ul style="list-style-type: none"> <li>• Expander exposure</li> </ul>
	<ul style="list-style-type: none"> <li>• Expander migration</li> </ul>
	<ul style="list-style-type: none"> <li>• Expander rotation or collapse</li> </ul>
<b>Complications during expander removal</b>	<ul style="list-style-type: none"> <li>• Hematoma</li> </ul>
	<ul style="list-style-type: none"> <li>• Capsular seroma</li> </ul>
	<ul style="list-style-type: none"> <li>• Pathological scarring</li> </ul>
	<ul style="list-style-type: none"> <li>• Distal flap necrosis</li> </ul>
	<ul style="list-style-type: none"> <li>• Skin deformity and contracture</li> </ul>
	<ul style="list-style-type: none"> <li>• Skin retraction</li> </ul>
	<ul style="list-style-type: none"> <li>• Dermal atrophy</li> </ul>
	<ul style="list-style-type: none"> <li>• Altered sensitivity</li> </ul>
<ul style="list-style-type: none"> <li>• Rotation folds</li> </ul>	

Unfavorable Results and Complications: Tissue expansion is a multi-stage process that necessitates careful patient selection, meticulous planning, precise execution with attention to detail, sterile techniques, and three-dimensional skin movement throughout the treatment course. Due to

these complexities, certain complications and unfavorable outcomes may arise during the process. Complications can occur during the insertion of the expander, after its placement, during the tissue expansion period, and at the

time of its removal. Therefore, special attention is required throughout this procedure [10].

### TISSUE EXPANSION AND CURRENT ADVANCES

In recent years, tissue expansion has seen several improvements, including new expansion systems, optimization of the expansion process, and reduction of radiation effects through fat grafting and neof ormation of fat tissue post-expansion.

The CO2 expander system, already FDA-approved, allows patients to control their expansion safely and conveniently without punctures and remotely, with minimal clinic visits. This system is primarily used for breast reconstruction [2].

Regarding tissue expansion and fat, experimental and clinical studies have demonstrated that tissue expansion has positive effects on fat tissue. Rigotti et al. showed that creating internal tensile force through an expander induces the proliferation of newly formed adipose tissue, both by the tensile force generated by the expander and by pro-adipogenic factors contained in the edema generated during the expansion process [29]. He et al. demonstrated that dissection of fat tissue prior to the placement of the negative pressure expander increases contact between adipocytes and induces the proliferation of adipose-derived stem cells. These stem cells undergo adipogenesis in the adipogenic environment created by external volume expansion, leading to better adipose regeneration.

Using expansion to prepare perforator flaps is a novel technique to shape the tissue according to specific needs. Reconstruction with pre-expanded flaps is one of the highest rungs of the reconstructive ladder. Expanded flaps are preferred over non-expanded perforator flaps for four main reasons: larger flap size, thinner flap, smaller donor site scar and deformity, and a more reliable flap.

### CONCLUSION

Tissue expansion is a valuable tool within the reconstructive arsenal. It requires proper patient selection, meticulous planning, and precise execution at each stage, generating gratifying outcomes by enabling the reconstruction of complex lesions and defects resulting from trauma and congenital anomalies. Currently, tissue expansion has been combined with various innovative strategies to achieve better results. The success of tissue expansion depends on comprehensive patient management, care provided throughout the process, and the support of the patient's family network to optimize results.

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