ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 10, Issue – 5, October – 2025, Page No. : 65 – 70

Complications of Tissue Expander Placement in Reconstructive Surgery

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Citation this Article: Dr. Saurabh Sharma, Dr. Amit Sharma, "Complications of Tissue Expander Placement in Reconstructive Surgery", IJMSIR - October – 2025, Vol – 10, Issue - 5, P. No. 65 – 70.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Tissue expanders are widely used in reconstructive surgery, especially for burn patients, breast reconstruction after a mastectomy, or coverage of complex defects. Although they have important advantages in staged reconstruction, they are not without complications. Infection, extrusion, seroma formation, capsular contracture, pain, and implant failure are some of the complications of tissue expander placement as discussed in this paper. Knowledge regarding these risk factors is important for optimizing patient outcomes and creating preventative strategies against complications.

Keywords: Tissue expanders, capsular contracture, implant failure, infection, surgical complications

Introduction

Tissue expansion is a common technique used in reconstructive plastic surgery for the restoration of lost tissue or skin. That entails gradually stretching the skin and tissue beneath it with a tissue expander, usually a silicone balloon placed under the skin. The technique is used for breast reconstruction after mastectomy, and reconstruction of soft tissue defects from trauma, burns, or congenital defects. Gradually inflating the expander over time promotes growth in the surrounding tissue itself, creating the skin necessary for reconstruction or aesthetic restoration.

Tissue expanders, while widely used and proven effective, are not without risks. Although expander placement is advantageous, it is capable of producing a variety of complications that may affect the short-term surgical result or long-term success. These complications may range in severity from relatively minor complications such as transient pain/discomfort to more serious complications such as infection, tissue necrosis (death), and expander rupture. In addition, complications not only prolong recovery but also could potentially undermine aesthetic outcomes, requiring additional surgeries or interventions.

The objective of this paper is to summarize the most frequently encountered and significant complications occurring during expander placement in plastic surgery. We will explore these challenges to underscore the significance of preventative measures, early diagnosis, and effective management strategies in improving patient

outcomes and reducing risks. Furthermore, the review will delve into novel surgical techniques and expander technologies that have potential solutions to minimizing complications while maximizing the safety and effectiveness of tissue expansion procedures.

Common Complications

1. Infection

Infection, one of the most common complications seen when the tissue expanders are used, has reported values ranging from 5% to 20% (Kim et al., 2017)[1]. Infections are generally related to bacterial colonization introduced by the surgical procedure or expansion sessions and can vary from a mild, superficial infection to a deep infection that requires the removal of the expander. Early diagnosis and treatment are crucial to minimize complications that could jeopardize the reconstructive effort.

Factors that increase the risk of infection include immunosuppression, diabetes mellitus, prolonged hospital stays, and previous radiation therapy — all of which can hamper the body's ability to combat infections and heal adequately. Preventive approaches include limiting bacterial exposure and improving patient resistance to infection. Implementing stringent aseptic surgical techniques, including careful skin preparation and sterile handling of the expander, is paramount in minimizing the risk of contamination. Preop and post-op prophylactic antibiotics have also been used to prevent bacterial colonization. Also, limiting manual manipulation of the expander during expansion sessions, and the use of antibiotic-impregnated expanders, have both been associated with reduced infection rates.

Infections are managed according to their severity. Superficial infections are often treated successfully with oral antibiotics, whereas infection in deeper ones or involving biofilm generally requires intravenous antibiotics or surgery. In patients with widespread infection or infection that does not respond to medical management, removal of the expander may be necessary to prevent systemic sequelae. With strict measures and prompt treatment, the risk of infection can be greatly mitigated, enhancing both the safety and efficacy of tissue expander based reconstruction.

2. Pain and Discomfort

The expansion process can cause pain and discomfort for many patients as the surrounding tissues are gradually stretched to the expander. Some people find it hard to get used to and uncomfortable—though that discomfort can vary depending on how stretchy your tissues are, how quickly your tissues push on each other, and how sensitive you are. Pain control is a major component of the comfort of patients and adherence to the treatment plan. Pain control strategies include non-opioid analgesics, gradual dilation techniques, and muscle relaxants as needed (McCarthy et al., 2015)[2].

There are few strategies — each one in the right context — that can help mitigate the pain and the patient outcome. Making nerve blocks a sinus procedure can help some patients by prolonging pain relief by numbing the inflating area before expansion starts. Moreover, gradual and controlled expansion is important to relieve excess mechanical stress on the tissues by avoiding sudden stretching causing extreme discomfort. Topical analgesics can be used in combination with oral pain medications (eg, NSAIDs or acetaminophen) for pain management. In cases of acute discomfort, muscle relaxants can also be prescribed to help relieve muscle tension related to the expansion process.

3. Seroma Formation

Seromas, temporary post-operative fluid collections around the tissue expander, are a common complication associated with pain, delayed tissue healing, and risks of

infection. These fluid collections are a result of both inflammatory responses and surgical disruption of lymphatic channels. Seromas can be persistent if not addressed appropriately and may require intervention because the complication progresses (Nahabedian,2018)[3]. Excess dead space between tissue layers, significant bleeding intraoperatively, primary tissue displacement, and excessive electrocautery use (causing thermal injury and subsequently increased fluid generation) are some factors contributing to seroma formation. Principle of prevention include meticulous surgical technique so that minimal tissue trauma & trauma with it, proper drain placement to facilitate fluid removal after surgery along with optimum positioning so that tension on surgical site is not increased unnecessarily.

Seromas are managed based on size and persistence. Small seromas can resolve spontaneously; however, larger or symptomatic collections typically require aspiration in a sterile environment to prevent infection. The use of surgical drainage and the duration of its use afterwards will be a part of the management of high-risk cases where surgical drains may be required for an extended period to remove any accumulated fluid and prevent any recurrence. In patients with persistent seromas refractory to conventional management, sclerosing agents can be used to facilitate adhesion of the tissue layers and prevent further accumulation of fluid

4. Expander Extrusion

Expander extrusion is a significant complication where the overlying skin becomes too thin or compromised, resulting in exposure of the expander. It is more frequently encountered in patients with irradiated tissues or in aggressive expansion members, as both can weaken the mechanical strength of the skin. Once extruded, it usually requires expander removal, which jeopardizes the success of the reconstruction. Thus, risk factors should be reduced, and preventive methods should be applied to enhance patient outcomes (Cordeiro et al., 2019)[4].

Causes of expander extrusion include poor soft tissue coverage, overexpansion rates, radiated tissue, and bad technique. Prevention essentially means expansion needs to be done gradually, giving time for the surrounding tissue to adapt and strengthen the tissue in the region over time. The expander should not be overfilled, which can put too much pressure on the skin overlying the expander, resulting in thinning and, ultimately, breakdown (necrosis). Acellular dermal matrices (ADMs) have further been demonstrated to augment tissue layers, providing additional support in this patient population, particularly among those at elevated risk. The open approach helps to decrease the risk of expander extrusion and, with the use of ADMs and refined soft tissue coverage techniques, leads to successful and robust reconstructive results.

5. Capsular Contracture

Capsular contracture of tissue expanders is defined as the excessive fibrotic tissue that forms around the expander, resulting in tightness, discomfort, and aesthetic deformity. The face contains fine soft tissue and has a small ability to expand; contracture in this area can lead to one of the most significant functional and aesthetic problems. It is a multifactorial disease whose etiology utilizes bacterial contamination, chronic inflammation, and individual biological responses as key factors in its development (Spear et al., 2020)[5].

Management strategies range from conservative measures such as massage therapy, leukotriene inhibitors, and external compression. In advanced cases, surgical treatment may be needed in the form of capsulotomy (release of the capsule) or capsulectomy (complete removal of the capsule). Prevention strategies includes meticulous surgical technique, infection control, and

controlled expansion rates are essential to minimizing capsular contracture risk in tissue expanders.

6. Implant Failure and Deflation

They may tear or leak requiring replacement of the tissue expanders to preserve the integrity of the reconstruction process. Although implant failure may occur due to mechanical stress caused by external forces, inherent manufacturing defects, or excessive expansion pressures that exceed the structural limits of the expander. Rupture or leakage of the graft can result in failure of ACD reconstruction, increasing the complexity of the surgical result and subsequent procedures if not identified early (Ramos-Gallardo et al., 2021)[6].

Use of FDA approved expanders reduces the chances of defect due to manufacturing. Also, it reduces stress on the expander body, therefore reducing the risk of rupture. The expander's integrity is monitored by regular clinical and imaging evaluations and when issues arise, it allows for timely intervention to avoid progression of the problem. Following these preventive strategies can help to significantly reduce the risk of implant failure, achieving a positive and predictable reconstructive result.

7. Suture Line Hypertrophy

Suture line hypertrophy is described as the overgrowth response of scar tissue overlying the incision with an increase in deposition of collagen and other extracellular matrix elements resulting in a prominent scar over the incision site. This is part of the body's natural healing process, but it can lead to a raised, hard, or red scar that can be uncomfortable or bothersome cosmetically. There are multiple reasons for suture line hypertrophy and one of the option is excessive tension on the skin when the tissue expander stretches the skin too tightly or when the skin itself is stretching itself during an active healing phase stressed surgical site. Some people may also be genetically predisposed to develop hypertrophic scarring. Excess scarring can also result from prolonged inflammation, infection at the incision site, and improper wound care.

Common symptoms of suture line hypertrophy include raised, red, or thickened scars that are often darker than the normal skin surrounding it. Others may have itching, pain, or tenderness at the site — especially if the scar is under tension. Management strategies attempt to minimize the appearance of the hypertrophic scar and reduce associated discomfort. Silicone gel sheets or topical silicone gels are often applied to cushion the scars and prevent atrophy, and rheumatics can be administered to lessen inflammation and promote normal tissue growth. Gentle massage of the scar may help break down excess collagen and make the scar look better. In certain situations laser therapy is used to enhance collagen remodeling while improving scar texture. In extreme cases, surgical revision is necessary — trimming away the excess tissue and closing the wound in a way that minimizes additional hypertrophic scarring.

Staying out of the sun can help the scar to not darken and stand out. After healing, gentle stretching and massage can help reduce scar formation. Inspirited by the fact that the sooner silicone-based treatments are adopted, less likely you have to deal with hypertrophic scarring. There is a need to focus on prevention and management to hasten the healing process and provide superior cosmetic and functional outcomes.

8. Facial Neuropraxia

A less common injury that occurs only in rare cases during expansion is called facial neuropraxia, which is a reversible lesion of the facial nerve in the area. It's usually caused by pressure, stretching, or trauma to the nerve, which leads to temporary loss of function. Patients may develop weakness or paralysis of facial muscles, as seen in the sagging eyelid or inability to smile, as well as

numbness, tingling, and decreased sensation in the region involved. The main types of facial neuropraxia are due to direct pressure of the expander against the facial nerve, surgical manipulation near the nerve, and improper placement/expanded expander.

Facial neuropraxia is most commonly managed conservatively, as this condition usually spontaneously improves within weeks to months as the nerve repairs. Facial exercises and physiotherapy should be supportive measures, they can help speed up the recovery by improving nerve function. If their symptoms continue in more severe or lingering cases, another types of medical intervention or surgical treatment might be necessary. Surgical planning, expander positioning, and expansion protocols can be employed to mitigate the risk of facial neuropraxia.

Figure 1: Complication of expander placement. A. Extrusion B. Infection C. Hypertrophy

Prevention Strategies

Prevention and Management Strategies of complications start with thorough preoperative planning. The reduction in complication rates could be considered as the combined effect of adequate patient selection and extensive preoperative evaluation. Certain risk factors, including smoking, diabetes, and prior radiation exposure, should be vigilantly assessed to determine high-risk patients at increased risk for negative outcomes. By implementing stringent aseptic measures during surgery along with meticulous pocket dissection and appropriate drain placement, the risks of infection and seroma formation can be markedly reduced. Furthermore, incremental dilation with conservative volume increments minimizes mechanical stress on adjacent tissues, decreasing the risk of expander extrusion.

But because the patient usually goes home after surgery, it is important to repeatedly monitor the patient in the early postoperative period so that any complications can be detected if they occur. Studies by Pittman et al. (2016)[7] provide evidence for an improved reduction of complications like capsular contracture and expander extrusion with the introduction of adjuvant therapies, including acellular dermal matrices (ADMs). In addition, novel biomaterials, antimicrobial-coated expanders, and new 3D imaging technologies are being tested to improve outcomes and minimize complications. These approaches can greatly enhance the safety and effectiveness of expander placement.

Conclusion and Future Directions

Such risks need to be appreciated by surgeons who should adopt meticulous preoperative surgical techniques and treatment plans to reduce adverse outcomes. In future studies, optimizing expander design, developing antimicrobial coatings, surgical protocols, and enhancing patient selection criteria may help to minimize complication rates.

Newer technologies, like 3D-printed scaffolds and biologically integrated expanders, patient-specific treatment algorithms based on genetic and biomechanical information will be beneficial for patients.

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