Cutaneous complications associated with breast augmentation: A review

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Abstract

Breast augmentation is one of the most popular and safe cosmetic procedures performed by plastic surgeons worldwide. Although breast implants are available in a number of different materials, silicone-filled implants remain the most common type. However, prior to the development of breast implants, various materials were injected into the soft tissues of the breasts to increase breast volume, which caused cutaneous complications and disfigurement. This review details the history of breast augmentation, the current methods used in augmentation surgery, and associated cutaneous complications.

Introduction

Breast augmentation is the most popular cosmetic surgery performed worldwide, and nearly 300,000 women in 2016 underwent augmentation surgery in the United States alone (American Society of Plastic Surgeons, 2015). As early as the late 1800s, people experimented with injecting various substances, ranging from glass balls and rubber to liquid silicone and oil, in an attempt to enhance breast volume, often with disastrous effects that required mastectomy (Adams and Mallucci, 2012).

Since the development of the first silicone implant by Cronin and Gerow in 1961 (Maxwell and Gabriel, 2009), implant safety, durability, and feel have improved. However, reports are ongoing (mainly from Asia and South America) of inappropriate chemicals that continue to be injected into the breasts (Chasan, 2007; Hage et al., 2001; Narins and Beer, 2006).

More recently, fat grafting as a form of primary augmentation has been re-explored. It allows for patients’ own lipoaspirate to be used to enlarge and contour the breasts (Coleman, 1995, 2004). Initially described by Czerny (1895), fat grafting only became more established in recent years by plastic surgeons, as more evidence suggests its safety with regard to both detection and recurrence of breast cancer (Groen et al., 2016).

The current authors focus on cutaneous complications associated with all described forms of breast augmentation surgery.

Injectable augmentation

The practice of using injectable material for breast augmentation is now rarely used in developed nations due to the high complication rates. However, some agents are still used in developing nations, and cutaneous complications can manifest years later.

Peters and Fornasier summarized the four main historical eras of injectable materials used for breast augmentation in their 2009 paper (Table 1).

Paraffin and other early examples

The first published report of paraffin injection was by Gersuny in 1899 (Gersuny, 1900), who injected paraffin into a patient’s scrotum after a previous bilateral orchiectomy so that the patient could pass the army’s mandatory physical examination. Once the case report was published, Gersuny and others focused on breast enhancement. The process entailed heating paraffin in specially designed hot water chambers surrounding the syringe and enabling the paraffin to form a liquid to ease injection of large volumes into the breast.

Initially, cosmesis was decent, and complications to the breast did not materialize until at least 5 to 10 years after the initial injection, including pulmonary embolism, migration, ulceration, fistulae,
Table 1

| Chemical                          | Era          |
|----------------------------------|--------------|
| Paraffin                         | 1859–1914    |
| A plethora of materials          | 1913–1943    |
| Liquid silicone                   | 1944–1991    |
| Hydrophilic polyacrylamide hydrogel | 1988–present |

infection, and necrosis, which frequently lead to breast amputation. After the disastrous results of paraffin, clinicians turned to a multitude of products, from ivory and glass balls to resins and glues, until the 1940s.

Silicone liquid

By the end of World War II, Japanese prostitutes were using industrial-grade liquid silicone extensively to augment their breasts in an attempt to attract U.S. servicemen, who preferred women with larger breasts (Peters and Fornasier, 2009). The silicone was initially used in pure form, but other substances such as vegetable oil were later added to increase local tissue response and reduce migration, especially when applied in large volumes (eg, to the buttocks or breasts; Mello et al., 2013). The Sakurai formula, as described in Japan, is the best known mixture to combine liquid silicone with olive oil (Chasan, 2007; Narins and Beer, 2006).

Local complications after industrial liquid silicone injections range from changes in color and consistency of the skin to intense inflammation with necrosis and ulceration. Fistulas and abscesses to the skin surface can also occur and lead to the elimination of the injected material and scar deformity (and Behar et al., 1993; Freitas et al., 2008; Rohrich and Potter, 2004).

The average time from the injection of silicone to the development of complications is 9 years (Christensen et al., 2005; Vinnik, 1978; Wilkie, 1977). Peters and Fornasier split the presentations of complications into two main types. With the first type, the patient usually presents with multiple and/or painful lumps (siliconomas) in the breasts that can occur as early as 2 years postinjection to 10 to 15 years later (Lai et al., 2005; Rohrich and Potter, 2004; Vinnik, 1978). Fine-needle aspiration cytology testing of these siliconomas shows vacuolated histiocytes, which is a sparse inflammatory component, and multinucleated giant cells (Dodd et al., 1993). The smaller, simple granulomas can be treated with localized resection only.

For the second type, patients present with more severe cutaneous side effects of skin inflammation and impending breakdown from siliconomas. As the silicone invades the dermis and epidermis of the overlying skin, the breast may show varying stages of skin cutaneous problems, from fine telangiectasia to necrosis. Many patients also have a history of receiving multiple injections of cortisone in an attempt to decrease/delay the inflammatory reaction, which can further complicate the clinical picture. Once fistulae have developed, treatment is much more difficult, and extensive surgery is usually necessary to fully excise these areas.

Hydrophilic polyacrylamide hydrogel

Hydrophilic polyacrylamide hydrogel (HPAMG) is a substance that most accredited clinicians have probably not come across or used directly. HPAMG was developed in Ukraine in the late 1980s, and this injectable gel is still heavily used in China and Iran as a safe material for facial and breast augmentation (Wei, 2016). Until recently, HPAMG appeared to be ideal soft-tissue filler material due to its supposed relatively good physiological compatibility and steady physicochemical state (Guo and Zhou, 2004). HPAMG is injected blindly into the breast, and it is not uncommon for the material to infiltrate into the breast parenchyma rather than the retro-mammary plane.

Due to its failure to develop a true fibrous capsule and its encapsulation by thin fibrous tissue only (Christensen et al., 2003), HPAMG can commonly track back up the injection site and cause severe cutaneous complications. Typically patients are injected with 150 to 200 mL of HPAMG for the augmentation. Complications can develop from several months to 3 years after injection and range from chemical migration to tissue necrosis and infection. Intraglandular injection will displace the breast lobules and, if injected in large amounts, may result in glandular atrophy and skin necrosis. Intraperatorial injections will split and dissect the muscle fibers, giving a pseudo-linguine sign on magnetic resonance imaging (MRI; Berg, 2006). The most commonly reported problems are skin induration (58.9%; Kasi et al., 2016) and chest pain (Wei, 2016).

As with most gels that are injected into the breast, surgical removal of all substance is difficult due to migration and local tissue reactions. Inoculated pools of the gels can interfere with breast cancer screening tools, and may cause long-term carcinogenic tissue changes. MRI is the most useful technique to help show the distribution of the injected augmentation materials, and delineate the tissue planes. Also, by varying the MRI sequence combinations, silicone, paraffin, autologous fat, and polyacrylamide gels can be differentiated by their differing signal intensities (Ebrahim et al., 2014).

Most case reports that have dealt with the severe complications of liquid augmentation suggest a skin-sparing mastectomy with or without muscle and delayed reconstruction as the safest form of treatment. In cases where skin necrosis and/or fistulae are significant, amputation of the breast is necessary with free-tissue reconstruction (Aoki et al., 1997).

Implants

There have been great advances in the development and safety of breast implants since Cronin and Gerow produced the first silicone breast prosthesis in 1961. However, silicone implants have a finite life span because they age and eventually fail (Rohrich et al., 1998). Rohrich et al. reported implant failure rates of 4% to 71% depending on the definition of implant failure, the population base, and the diagnostic method used. More recent industry reports have the incidence of rupture much lower at 1% to 4% (Spear et al., 2007), mainly due to the improvement in silicone gel and shell technology.

Implant rupture results in the release or migration of silicone into the surrounding tissues and can cause significant complications that are similar to those of liquid silicone as described (Adams and Mallucci, 2012; American Society of Plastic Surgeons, 2015). Once identified, ruptures are managed by explantation of the implants and a capsulectomy. Reaugmentation can be performed concomitantly if the patient wishes to remain augmented and the surrounding tissue quality is still sound. There are several case reports of siliconeoma migration as far down as the vulva and lower legs (Jeng et al., 2005). To limit distal silicone migration after rupture, most new-generation implants have a more cohesive gel. If the siliconomas become too hard, painful, and large, they can be managed with a simple excision. However, much like liquid silicon, when there is more extensive cutaneous involvement that causes ulceration, necrosis, and fistula formation, treatment is much more complex and patients usually require a mastectomy.

Other rare cutaneous complications with implants

Sensory alteration to the breast, especially the nipple-areolar complex, can be a major concern to some women undergoing augmentation. Studies that investigated sensory and lactation changes
indicated that the risk was low (Lund et al., 2016; Nommsen-Rivers et al., 2010; Stuebe et al., 2014; von Sperling et al., 2011), and long-term sensory injury risk was 0.1% (range, 0.0%-0.3%; Lund et al., 2016). A 10-year cohort study of 4927 women who underwent augmentation with Allergan implants found that nipple paresthesia/hypersensitivity for inframammary fold (IMF) incisions was only 0.2% (95% confidence interval, 0.1%-0.3%), and there were no reported changes for women who had periareolar incisions (Lund et al., 2016). Other studies have also echoed these findings of a slightly higher risk with an IMF incision (Mofid et al., 2006; Slezak and Dellon, 1993).

Larger implants and smaller breasts have shown an increased association of postoperative sensory alterations (Stuebe et al., 2014). However, the sensory changes in the small minority of patients who experienced them seemed to completely resolve over time without medical intervention. There was no difference in incidence of lactation issues after augmentation compared with the reported rate in postpartum women who do not have breast implants (Lund et al., 2016; Nommsen-Rivers et al., 2010; Stuebe et al., 2014; von Sperling et al., 2011).

Striae

Striae distensae (SD), which are commonly known as stretch marks, occur when tension is applied too rapidly for the skin’s ability to expand. SD is characterized by atrophic, linear, and parallel lesions that usually run perpendicular to the Langer’s lines, which represent the direction of minimum extensibility (Osman et al., 2008; Zheng et al., 1985). Cohort studies place the risk of SD postaugmentation mammoplasty with implants between 4.6% and 7.06% (Basile et al., 2012; Valente et al., 2014).

A classification for the degree of SD after augmentation has also been proposed to aid in risk assessment (Fig. 1). A study of 538 patients by Valente et al. in 2015 associated the following factors to increased SD risk: Young age (&lt; 35 years), larger implant volumes (&gt; 300 mL), smoking status, and normal or low body mass index, but the use of oral contraceptive medications was found to be a protective factor (Valente et al., 2014). However, Basile et al. found in his cohort of nulliparous women that the use of oral contraceptive medications, high body mass index, and history of stretch marks were related to a higher incidence (Basile et al., 2012). Both studies concluded that young age was a factor and has been hypothesized to be related to skin stretching caused by microfibril damage to fibrilins, which in younger women may be more fragile and thus more susceptible to rupture (Elsaie et al., 2009; Maia et al., 2009). (See Figs. 2–4.)

Mondor’s disease

Mondor’s disease or thrombophlebitis of the thoracoepigastric system of veins is a benign and usually self-limiting disease that has been reported after breast augmentation. Mondor’s disease commonly appears below the inframammary incision site as (occasionally painful) cordlike structures that are especially apparent when the arms are raised (Khan, 2009). Presentation is typically 2 to 3 weeks after augmentation and disappearance occurs 6 to 8 weeks postsurgery (Khan, 2008).

The cause of the disease is thought to be the division of the vertical superficial venous system when the incision occurs across the IMF, which leads to venous stasis and thrombus formation. Due to the majority of cases being transient and painless, a true incidence rate after augmentation is difficult to obtain, but the range in Khan’s study was between 1.07% and 4.55% (Khan, 2008, 2009).

Cutaneous complications associated with lipofilling

Although initially reported in 1895 by Czerny, liposuction and the method of autologous fat grafting were not used to the breast for augmentation until 1987 (Bircoll, 1987; Bircoll and Novack, 1987). As more evidence is published on the oncologic safety of fat grafting to the breast, more plastic surgeons are now routinely using the method in breast reconstruction surgery (Al Sulaymi et al., 2016; Gurunluoglu et al., 2013).

A vacuum-based, external, soft-tissue expander known as BRAVA (Brava, LLC; Miami, FL), has been successfully described to assist in the autologous fat grafting process (Coleman and Saboeiro, 2015; Khouri et al., 2012). Previously used as a nonsurgical breast enlargement system, the BRAVA is now particularly helpful in assisting
lipofilling augmentation in women who have very small breasts and/or very tight skin envelopes. The device enables a larger volume to be injected on the day of surgery and improves graft survival compared with more traditional lipofilling methods (Al Sufyani et al., 2016). The BRAVA technique achieves this by allowing the space to which fat can be added to enlarge through its vacuum, and it promotes angiogenesis to the existing tissue, which makes graft take more reliable (Al Sufyani et al., 2016; Gurunluoglu et al., 2013). However, a limitation is that patients are required to wear the device for approximately 10 to 12 hours per day for 4 weeks, both before and after the procedure.

Implant-related complications such as silicone leak/migration, rotation, seroma, or capsular contracture are avoided with fat grafting, which makes this method a low-risk and natural option for augmentation. However, the role of fat grafting in breast augmentation is limited because large volume changes through implants cannot be attained.

The total complication rate for fat grafting is between 8% and 15%, and lower than those reported after other reconstructive breast procedures such as implants and tissue flaps (Groen, 2016; Largo et al., 2014). Cutaneous complications associated with lipofilling can occur at both the breast and donor site, and range from erythema and cellulitis (0.8%) to cysts (6.9%) and abscess formation (6.9%). All reported cutaneous complications are minor, can be treated readily with either medical or surgical management, and can resolve over time.

**Breast implant–associated anaplastic large cell lymphoma**

Breast implant–associated anaplastic large cell lymphoma (biALCL) is a rare T-cell lymphoma in patients who underwent augmentation. To date, all patients with biALCL have had prolonged exposure to just textured implants (Brody et al., 2015; Miranda et al., 2014). biALCL is a rare condition for women undergoing augmentation, and many factors appear to be involved in its genesis rather than just exposure to implants. Typically, patients with biALCL present with only a seroma or mass (Loch-Wilkinson et al., 2017); however, reports exist of cutaneous manifestations, including subcutaneous nodules (Kim et al., 2011; Shahriari et al., 2017), erythematous skin eruptions or ulceration (Laurent et al., 2016), and indurated papules (Alcalá et al., 2016; Brody et al., 2015).

With the proper application of anti-infective strategies in the operating setting, biALCL risk can be significantly reduced (Shahriari et al., 2017). Patients diagnosed with biALCL have a favorable oncologic outcome after appropriate surgical management of the removal of the implant and total capsulectomy.

**Conclusions**

Although breast augmentation remains one of the most popular and safe procedures performed by plastic surgeons worldwide, cutaneous and soft-tissue complications are not uncommon. Clinicians need to be aware of all possible forms of augmentation, along with associated complications, so that a timely diagnosis can be made with appropriate management.

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![Fig. 3. Extensive Mondor disease of the left thoracoabdominal wall (Khan, 2009)](image)

![Fig. 4. Proposed striae classification by Basile et al. (2012)](image)
