History of Breast Reconstruction

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ABSTRACT

The treatment of breast cancer has evolved significantly from the original surgical technique described by Halsted. The reconstruction of the breast has also been a large interest among surgeons and patients. The history of breast reconstruction dates back to the 1800s with an attempt to transplant a lipoma to a mastectomy site. Several techniques ranging from the “walking flap” of Gilles to the free perforator flap using autogenous tissue for recreation of a breast “mound” have been established and refined. The use of tissue expanders for breast reconstruction has also been perfected over the last three decades. Breast reconstruction, which was once admonished in the early part of the 20th century, has now become a routine choice for women undergoing breast cancer surgery.

KEYWORDS: Reconstruction, breast, history, cancer, surgery

Breast cancer affects one of every nine women and accounts for at least one third of all new cancers yearly. Its incidence is highest among white women. Breast cancer rates increased 3.8% per year through the 1980s, but this increase has stabilized over the 1990s to the present.

Breast cancer is second only to lung cancer as the primary source of cancer deaths in women. In fact, the breast cancer death rate in women between the ages of 20 and 59 surpasses all other cancer-related deaths. As of last year, the breast cancer death rate remains the greatest in the African-American population.¹

HISTORY

Breast cancer has been described as far back as 1600 B.C. in the papyrus writings of the ancient Egyptians. Galen later theorized that breast cancer was due to a “coagulum of black bile” within the breast. Virchow proposed this so-called “tumor” arose from the epithelium and spread outward in all directions. The great surgeon Halsted continued to support the theory that breast cancer initiated as a “regional” phenomenon, before it spread

distantly. William Halsted performed the first radical mastectomy in 1889 as a very aggressive way to surgically control the contained disease.² The teachings of Halsted kept breast reconstruction from emerging as an option because he considered it a “violation of the local control of the disease.” Halsted admonished surgeons not to perform plastic operations at the mastectomy site.

Halsted believed: “The slightest inattention to detail and or attempts to hasten convalescence by such plastic operations as are feasible only when a restricted amount of skin is removed, may sacrifice his patient to disease.”

Others adopted the fear that reconstruction would hide a possible local recurrence or adversely modify the course of the disease. This has certainly not been the case. As time continued, new evidence emerged. The surgical treatment of breast disease shifted toward breast conservation, in contradiction to Halsted. This was adopted and continues today as the standard of care for early breast cancers.

Less aggressive approaches to the treatment of breast cancer have emerged over the last few decades. Pioneer studies in the Guy’s Hospital in London during

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the 1960s randomized patients who received radical mastectomies with those who received partial mastectomies and adjuvant radiation therapy.³ This set the standards for modern trials, which continued to support breast conservation therapy as a means of controlling early-stage disease.

Early Breast Reconstruction

As the understanding of breast cancer progressed, so did the interest in the reconstruction of the breast. The first attempt at a true breast reconstruction was in 1895. Vincent Czerny, a professor of surgery at Heidelberg, is generally credited with the first autogenous breast reconstruction. In 1895,⁴ he published a mastectomy case for benign disease that was “reconstructed” by transplantation of a fist-sized lipoma from the patient’s flank.

In 1906, the Italian surgeon Tanzini⁵ had difficulty closing large wounds after the radical mastectomy. He developed a pedicled flap of skin and underlying latissimus dorsi muscle, which he transferred to the mastectomy defect. He was noted in history to be the first to use a musculocutaneous flap in breast reconstruction. But his technique was soon forgotten, and only an occasional reconstruction was attempted for the next 60 years because of Halsted’s principles.

In 1905, Ombredanne from France performed a breast reconstruction using the pectoral muscle as a mound.⁶ He reported two cases using a rather ingenious local muscle flap for a mound. This method was very distinct from the many plastic surgery operations being performed at that time. Others were describing procedures to restore the skin defect after mastectomy, but “mound restoration” was considered a “luxury operation with limited indications.”

Some of the techniques for breast reconstruction used during the first half of the 20th century included bisecting the opposite breast and using half as a pedicle for breast reconstruction. Sir Harold Gilles used a tubed abdominal flap method, which he developed in 1919, to perform his first breast reconstruction in 1942.⁷ Several others followed with excellent reconstructions, but the limiting factor became the need for several staged operations over a minimum of 6 months.

These extensive procedures required multiple delays and transfers and often resulted in many significant scars. Frequently, the flaps would fail, and disappointing results kept these flaps from gaining any popularity. Neither the surgeon nor patient could recommend these early “reconstructions” to anybody.

In the decades that followed, the Germans continued to lead the way. Hohler and Bohmert⁸ performed two-stage reconstructions utilizing the thoracoepigastric flap followed by insertion of prosthesis for routine mastectomies.

Modern Techniques

IMPLANT RECONSTRUCTION

Cronin and Gerow fathered the modern era of breast reconstruction with the introduction of the silicone gel breast implant in 1963.⁹ The typical method of breast reconstruction was through a delayed insertion following mastectomy. The delayed technique dominated until a case of an immediate reconstruction was reported in 1971. Snyderman and Guthrie¹⁰ reported the use of a silicone breast implant placed under the remaining chest wall skin immediately following a mastectomy. This approach was adopted and prevailed over the remainder of the decade.¹¹

Improving on the basics of the silicone implant, techniques continued to develop. Radovan described the use of tissue expansion for breast reconstruction.¹² From this introduction, a patient with a more extensive skin deficit could now be a candidate for reconstruction of her breast. In 1982, Radovan¹² initially published his results with skin expanders for breast reconstruction. He described a technique to allow for gradual expansion of the skin to replace the tissue lost from mastectomies. This sparked the use and popularity of breast reconstruction using tissue expanders. Since then, several have detailed the use of different textures, sizes, shapes of tissue expanders.

Modern breast expanders have allowed tailoring the breast reconstruction to the patient’s needs to achieve symmetry with the contralateral breast. Tissue expanders have been designed that are usually textured and anatomically shaped and have either user-friendly integrated or remote ports. This has allowed relatively “foolproof” expansion by general practitioners or nursing staff. These newer-generation expanders generally do not require significant overexpansion because the lower pole is preferentially inflated by virtue of design.

In 1984, Becker¹³ described a dual-chamber expander that had a silicone gel outer lumen with an inflatable inner saline lumen. This pioneered a single-stage, predictable way of rapidly achieving a breast reconstruction. Becker’s technique eliminated the need for a second-stage operation in which the expanders were removed and replaced with permanent implants. Over the ensuing decade, breast reconstruction with tissue expanders was utilized with varying techniques and proved to be an effective way of achieving an aesthetic result.

Several surgeons challenged the long-term results of expander reconstruction. Clough and colleagues¹⁴ detailed the long-term cosmetic outcome of breast implant reconstruction. The authors reported a linear deterioration of the cosmetic result over time. The majority of implant reconstructions were “acceptable” initially but became less desirable as time progressed. This was felt to be related to the asymmetrical, unpredictable aging of

the implants. The skin expansion technique was clearly not as simple as it originally appeared. Elliot and Hartrampf¹⁵ listed several drawbacks of this technique including the need for numerous visits and the risk of deflation and need for replacement. Others¹⁶ criticized the expansion technique for taking longer, requiring more revisions, with results that appeared round and less natural-looking when compared with an autoflap. This forced a rekindled interest in autogenous breast reconstruction.

AUTOGENOUS RECONSTRUCTION

The first modern description of an autogenous reconstruction of the breast came toward the end of the 1970s. Schneider, Hill, and Brown¹⁷ and Muhlbauer and Olbrisch¹⁸ first reintroduced the latissimus dorsi musculocutaneous flap for breast reconstruction in 1977. Further refinements of this flap were performed by McCraw, Dibbell, and Carraway.¹⁹ By 1978, the goal of one-stage reconstruction for breast defects was proven possible. Its use was popularized by Bostwick, Schlefman, and others by the end of the decade.²⁰

It was commonly practiced that the latissimus dorsi flap was of inadequate volume by itself and had to be used covering an implant. By 1987, Hokin and Silfverskiold²¹ described 55 breast reconstructions using an extended latissimus dorsi musculocutaneous flap without implant. "Large flaps up to 30 × 8 centimeters were available with partial necrosis to 10%."²¹ Large skin paddle techniques, preexpansion of the skin overlying the latissimus, and endoscopic harvesting were developed. The latissimus provided the majority of patients with satisfactory results, but the problems with the donor site were not negligible. Latissimus donor sites left large scars and had a high risk of seroma.

Breast reconstruction was developed with goals to allow women to feel comfortable in clothing and eliminate the need for an often cumbersome external prosthesis. The extensive skin resection, a result of the mastectomy, often forced reconstructive surgeons to aim for a smaller reconstructed breast size. This often meant a need for a significant reduction of the contralateral breast to achieve symmetry. As time progressed, the goals of the reconstruction became more refined. Surgeons then strived for more precise contours, better volume matching, and even positioning. These goals were often limited by the mastectomy defects.

The mastectomy technique is likely the single most influential factor in the reconstructive outcome. The mastectomy technique has also evolved from a "tissue-eradicating" to a "tissue-sparing" philosophy. Skin-sparing mastectomy technique typically involves a periareolar incision with some type of lateral "keyhole" extension. Surgeons try to encompass the prior biopsy site within the incision. The use of this technique has resulted in a larger, good-quality anterior chest wall skin.

Reconstructive needs for skin replacement has been largely reduced. Breast scars can be avoided and native breast skin color and texture can be maintained.

Several studies in large centers have supported the efficacy of the skin-sparing mastectomy as a cancer operation. In a comparison between skin-sparing and conventional mastectomies, Kroll and colleagues²² showed similar recurrence rates in both groups. Several supportive studies have since shown similar results. The use of the skin-sparing technique has also led to reduced operating times, fewer revision surgeries, and greater patient satisfaction.

As change improved the mastectomy technique, change also improved breast reconstructive technique. In 1979, Robbins²³ reported using a vertically oriented skin-muscle flap of the rectus abdominis for breast reconstruction. This was modified a few years later by several others. This allowed larger volumes of tissue to be transferred to recreate a breast mound.

In 1982, Hartrampf, Schlefman, and Black²⁴ transferred a transversely oriented abdominal musculocutaneous island (TRAM) flap for breast reconstruction. Their report described a vertically oriented rectus abdominis muscle with a horizontally oriented cutaneous paddle. This allowed the use of the lower abdominal skin and subcutaneous tissue as the breast "mound" while also providing a more aesthetic donor site closure. Others followed with the use of this technique. Since then, the TRAM flap has undergone modifications in technique to improve its blood supply.

Schlefman and Dinner²⁵ studied anatomic dissections and showed that the primary source of circulation to the rectus abdominis muscle was actually from the deep inferior epigastric artery. This added to previous anatomic studies demonstrated by Milloy and colleagues in 1960.²⁶ The anatomic contribution between the superior and inferior epigastric arteries was defined. As a result of these and similar studies, most surgeons now center the design of the TRAM flap slightly higher on the abdomen, just below the umbilicus.

Based on their anatomic dissections in the late 1980s, Moon, Taylor, and others²⁷ suggest surgical delay of the TRAM flap in the attempt to improve flap viability. The improvement from delay becomes evident clinically after 1 week and is not further improved by extending the delay to 2 weeks. Surgical delay of a TRAM flap permits its use in those patients who are at higher risk of arterial and venous insufficiency.

By 1987, Hartrampf²⁸ had formulated a risk factor stratification to evaluate a patient for TRAM flap breast reconstruction. This looked at scores assigned to factors such as obesity, smoking, diabetes, previous abdominal surgeries, and other pertinent conditions. For high-risk patients, Hartrampf recommends the use of a double-pedicled TRAM flap. Paige and colleagues²⁹ looked at the overall morbidity in either uni- or

double-pedicled TRAM flaps and found no significant difference.

The pedicled TRAM flap has certainly become the "workhorse" for autologous breast reconstruction. Advantages of the TRAM flap are that it accomplishes reconstruction with autogenous tissue, leaves an acceptable donor scar, and serves as a simultaneous abdominoplasty. Disadvantages are a high tissue-to-blood supply ratio, protracted recovery with abdominal discomfort, potential for hernia from weakness from the abdominal wall, and limitations imposed by previous abdominal scars.

FREE TISSUE TRANSFER

Autologous tissue reconstruction after mastectomy has become an increasingly popular option. Microvascular free flaps also gained popularity, especially when performed as an immediate reconstruction. This allows freshly dissected recipient vessels to be used for microsurgical anastomoses. Free tissue transfer has been shown to be associated with lower incidences of partial flap necrosis and lower chance of significant fat necrosis.³⁰ For surgeons experienced in microsurgery, the flap loss rate can be as low as 2%, with similar morbidities and operative times as its pedicled counterpart. Truly the techniques for microsurgical free tissue transfer have improved over time.

In 1979, Holmstrom³¹ was the first to use the normally discarded tissue from an abdominoplasty as a free flap in breast reconstruction. Over the last two and a half decades, the free TRAM flap has become the standard for microvascular autogenous breast reconstruction. Excellent results have been published by several authors. There have been studies³² that have shown better, more reliable blood supply; less functional impairment of the abdominal wall donor site; use of a lower abdominal skin flap; and loss of the "pedicle bulge" when compared with the traditional pedicled TRAM flap technique.

If the free TRAM flap is not available, several other options for breast reconstruction have been developed for breast reconstruction. Unfortunately, they are not as easily adaptable as the free TRAM flap technique. Blondeel³³ and Allen³⁴ report the use of the superior gluteal artery perforator and the deep inferior epigastric perforator as good alternatives to the TRAM flap. These require a great deal of technique but have been demonstrated to have some advantages over the TRAM flap, such as lower donor site morbidity and potential for sensation. The lateral thigh flap and even the omentum flap were described as free tissue transfers for breast reconstruction.

Over the last decade, surgeons^{35,36} have studied the pros and cons of using various recipient vessels for breast reconstruction. The internal mammary vessels may be utilized as an alternate to the subscapular system.

This may be necessary in those who have undergone a previous axillary dissection and/or radiation, those in which a smaller, more medial breast shape is needed, and in those in which the axillary vessels are not suitable. The internal mammary vessel exposure does require the resection of a rib, a longer preparation time, and a larger medial incision.

NIPPLE AREOLA RECONSTRUCTION

Reconstruction of the nipple areola complex is the last step in the process of a postmastectomy surgical rehabilitation. In the past, reconstruction of the areola has involved skin grafts from various local and distant sites that were selected on the basis of pigmentation. These methods are now largely obsolete. The contralateral areola offers the best match of color and texture for reconstruction.³⁷ This is considered the first choice for donor tissue. Use of the contralateral nipple is reserved for patients willing to sacrifice 50% of the height of a prominent nipple on the normal breast. Thus, the vast majority of patients are not candidates for this so-termed "nipple-sharing" operation.

In the early 1980s, procedures for nipple reconstruction began to appear in the literature. Working independently, Barton³⁸ and Little³⁹ described their own modifications of DiPirro's Maltese cross technique. Various techniques of nipple reconstruction ensued, allowing use of transferred tissue and scar to form a nipple prominence. Among them are Little's skate flap and its modifications, Anton and Hartrampf's star flap and Bostwick's C-V flap, Cronin's S-flap, Smith and Nelson's mushroom flap, and several others.³⁹

Several studies looked at long-term projection of the various reconstructive techniques. Various authors promoted their own techniques as being superior, but each has to decide which works best for himself.

Becker⁴⁰ was the first to suggest tattooing the reconstructed nipple areola in 1986. Spear⁴¹ popularized it in the years to follow. Currently, medical tattooing appliances are ubiquitous and of high quality and offer several tones and hues of pigment to match the color of the native areola. Some pigment fading over time is to be expected, and a few touch-up procedures may be required. Pigment fading was the most common long-term complaint, voiced by up to 60%. A few required touch-ups and the majority were satisfied with their outcome.

SUMMARY

Breast reconstructive techniques have evolved a great deal over the past several decades. A woman who requires breast cancer surgery can comfortably realize that she can exist with a recreated breast that looks and feels like very natural. This can be achieved through implants or autologous reconstruction. There are options that

can be tailored to the individual's needs. The idea that a woman must live without a breast is a notion of the past.

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