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Review Article

Current strategies for the reconstruction of the nipple-areola complex: a review

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ABSTRACT

The reconstruction of the nipple-areola complex after a mastectomy is essential for the bio-psycho-social recovery of the patient, it is generally performed 4 to 6 months after surgery and there are multiple surgical reconstruction techniques depending on the experience of the surgeon and of the individual characteristics of the patients. The most widely used for its safety and for having shown the best results is the local flap technique combined with the use of autologous, alloplastic and allograft grafts. However, currently there is still no technique that shows long-term lasting results. For this reason, in this article we describe the five categories of reconstruction techniques for the nipple-areola complex that currently exist, their advantages and disadvantages, as well as the lines of research in tissue engineering in which the world is working to find a therapeutic strategy that can reproduce a nipple-areola complex with the characteristics of the biologic.

Keywords: Nipple-areola complex, Mastectomy, Local flap, Autologous graft, 3D tattoos, Tissue engineering

INTRODUCTION

Nipple-areola complex (NAC) reconstruction represents the final stage of a mastectomy for breast cancer and is generally performed four to six months after breast reconstruction.[Error! Reference source not found.] The different alternatives in breast reconstruction in which the NAC is involved are essential for an adequate comprehensive recovery of the patient, especially in the psychological aspect, since it can mainly avoid a disorder of body dysmorphia, low self-esteem and feelings. of insecurity. Currently, despite the existence of multiple reconstruction strategies, there is still no gold standard technique that shows significantly better and lasting long-term results.[2] Reconstruction techniques of the NAC include the use of local flaps, grafts, injectable fillers, tissue substitutes through tissue engineering, or a combination of these in order to minimize projection loss, achieve the appropriate color combination, maintain the shape, size, texture and symmetry as similar to the patient's breasts. [3] In the last 80

years, more than 60 NAC reconstruction techniques have been described, the first technique was described in 1944 with a NAC transplant during a reduction mammoplasty procedure, the following technique was described in 1946 by the surgeon Berson who tried to recreate nipple prominence with a local flap for a breast cancer patient. Skin grafting is one of the most widely used techniques today. It was originally started to be implemented in 1949 with Adams et al. and was later modified by Brent et al. This technique consisted of extracting a circular skin graft and placing it around the neo-nipple. Currently, depending on the original color of the areola, the donor site is selected from a different site: if it is light pink, the graft can be taken from the oral mucosa. If they are darker, donor sites include the groin, buttocks, or upper thigh, because skin removed from these areas tends to be hyperpigmented.[4,5] In 1972 Millard et al first introduced nipple sharing, this technique is popular when a central lumpectomy has been performed or the contralateral nipple has been preserved with a projection of more than 1 cm so that it can contribute 50% or more of the volume of the complex areola-nipple to be reconstructed.[6] The bank or reimplantation of the areola-nipple complex ('Nipple saving') was another technique that was first introduced by Millard in 1971, this technique consisted of extracting the NAC from the breast and reimplanting it in the groin area, the buttocks or abdomen. Some-time later, the preserved NAC was replaced in the reconstructed sinus. However, this technique was discontinued after the report of several cases where cancer cells had spread to the inguinal lymph nodes. In 1980, the surgeons Lemperle and Spitalny proposed a modification of the technique, where cryopreservation and tissue review by a pathologist were used to rule out the presence of cancer cells. The results were not satisfactory; therefore, this technique was no longer used.[5]

DIFFERENCE BETWEEN A GRAFT OR A FLAP

The local flap procedure consists of the reconstruction of the NAC with autologous tissue in which the patient's own healthy tissue from a donor area of the body is used to be implanted in another region. This flap can be formed by dermis, epidermis, subcutaneous tissue, muscle and/or cartilage. Its main characteristic is that it is vascularized, it has its own vascular pedicle that is made up of a vein and an artery. They are an attractive option especially in those cases in which it is necessary to provide volume in the recipient area and in wounds that have adequate quality and laxity of the adjacent tissue. The graft, although it is also an autologous tissue, is made up of epidermis and dermis, it is very fine, so it does not add volume. The graft receives the vascularization of the recipient area.[7] Local flaps represent the most commonly described technique for nipple reconstruction. In general, they can be classified into three categories based on their vascularity: centrally based flaps, pedicled flaps, and removable flaps. Removable flaps were the first to be described by Hallock in 1993. Subsequently, in 1946, central-based flaps were introduced, including the reconstruction of Berson's "pseudo-nipple". Two decades later, in 1972, subdermal pedicled flaps were included, representing the most common category of local flaps to date. They can be based on a single pedicle, including the Snyder V-Y advancement flap described in 1972, or a triple pedicle such as the triple flap design described by Krogsgaard.[8] Intradermal tattooing for areolar reconstruction was first introduced by Bunchman et al. It was later popularized by Hilton Becker in 1986 and by Scott Spear in subsequent years. Today this technique is low cost, highly available and has perfected the technique so that the result is high quality and matches the native color and appearance of the areola (Figure 1).[9]

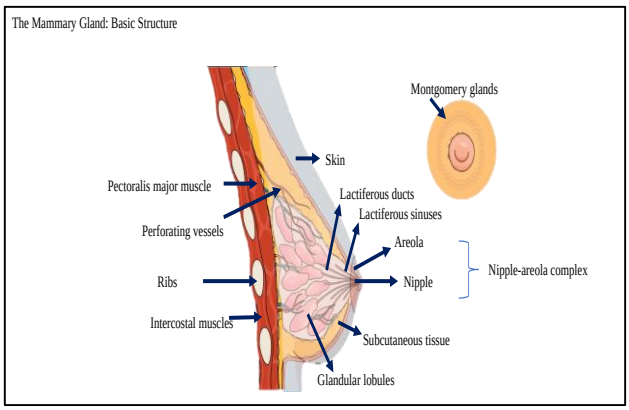

Figure 1: The internal and external structure of the nipple-areola complex.

SURGERIES IN WHICH THE RECONSTRUCTION OF THE NAC IS USED

Surgeries that frequently require areola and nipple reconstruction are simple or total mastectomy, skin-sparing mastectomy, radical mastectomy, and double mastectomy, although the reconstruction of these structures is also necessary in both men and women with burns, trauma, congenital athelia, correction of inverted nipples, NAC necrosis after mastopexy, reduction mammoplasty and in the surgical treatment of gynecomastia with nipple necrosis.[6,10-12] In 2003, nipple-areola-sparing mastectomy was shown to be an oncologically safe procedure in patients with tumors distant from the nipple.[13] Currently, the eligibility criteria for this NAC-sparing therapy have increased where patients with tumors 2.5 centimeters or more away from the nipple by digital mammography or ultrasound are considered eligible for this procedure.**Error! Reference source not found.**

CURRENT RECONSTRUCTION TECHNIQUES

The classification into 5 categories of possible NAC with different approaches consists of: 1) nipple sharing, 2) local flaps, 3) grafts, 4) tattooing, and 5) no reconstruction. Shared nipple use requires a contralateral nipple with a projection generally > 8 mm and 1.5 cm in diameter so that

it can contribute 50% or more of the volume of the nipple-areola complex to be reconstructed. Allows for symmetry with respect to color and texture, is generally used after central lumpectomy, and in patients with small nipples provides an excellent result compared to local flap techniques.[14] In the past this method was popular, however it is now used less frequently due to concerns by surgeons and patients about invasion of the normal contralateral nipple, potential donor site morbidity, decreased sensation erogenous and graft failure.[15] The use of local flaps is the most studied technique for the reconstruction of the nipple-areola complex, it generally produces satisfactory results and subdermal pedicled flaps represent the most used category.[16] In recent decades, this technique has achieved multiple advances in maintaining nipple projection, reducing the retraction force of the surrounding tissue, flap contraction, and preserving the blood supply to prevent nipple necrosis. Despite these advances, limitations remain, especially in implant-based breast reconstruction. Several studies comparing different flap techniques found that nipple projection stabilized at 12 months and that contraction during this period ranged from 40-70%. These limitations have been associated with multiple factors, including external retraction forces, scar contraction, fat necrosis, infection, and delayed wound healing.[17] Local flaps with augmentation grafts represent a secondary measure to improve structural support and increase projection of the reconstructed nipple-areola complex. In this technique, autologous or heterologous materials are used. Autologous tissues include: dermis, adipose tissue, cartilage (of the ribs or external ear), and gingival mucosa of the oral cavity. While heterologous materials are classified as synthetic or allogeneic. Synthetic materials include: silicone gel, hyaluronic acid, calcium hydroxyapatite, artificial bone substance, polytetrafluoroethylene, and allogeneic materials include acellular dermal matrix (AlloDermTM, GCDerm, SureDerm) and biologic collagen cast.[8]

Those patients who refuse additional surgeries or cannot safely undergo them may be candidates for 3D tattoos, which, unlike traditional tattoos, include shading and detail, creating an optical illusion to compensate for the lack of the nipple-areola complex. Indications for performing this technique are: the patient's preference to avoid future surgery, extremely thin and tight breast skin after implant-based reconstruction (because of the risk of exposure of the underlying implant), patients who are not candidates for other techniques due to surgical scars or medical comorbidities such as diabetes, severe obesity, heavy smoking, and immunosuppression from chemotherapy. It is contraindicated in pregnant or lactating women as the pigment can enter the bloodstream and affect the fetus or newborn.[18] The main disadvantage of tattoo-only reconstruction is the lack of actual nipple projection, as a three-dimensional effect can be obtained from the clever shading of the tattoo, however, from a side view this effect is lost. In addition, it is common to see some degree of depigmentation months or years later, and secondary tattooing is often required to correct color mismatch between natural and reconstructed areolas.[9] Another alternative is external prostheses, which are not a reconstructive option, but represent an economic alternative and a non-traumatic solution.[19]

TISSUE ENGINEERING AND REGENERATIVE MEDICINE

Tissue engineering is a multidisciplinary science that aims to regenerate or improve the functioning of a tissue or organ, to achieve this, it needs scaffolding, signals and growth factors, and stem cells, in an appropriate environment that allows growth and regeneration. of the tissue or organ. The scaffold is a biomaterial that must be biocompatible with the human body, chemically stable, mechanically resistant and non-toxic. Its function is to provide structural support for cell interactions and tissue formation.[20] Conventional tissue engineering and regenerative medicine techniques involve seeding a scaffold with patients' own cells and using growth factors to promote survival. Currently, the 3D printing technique has given a series of advantages to the production of scaffolds, however, the clinical application of these techniques is limited by their cost and ability to produce sufficient volumes of functional tissue.[21]

In a study published in 2021, Samadi et al proposed using processed costal cartilage from an animal model placed within biocompatible 3D-printed external scaffolds to generate tissue cylinders that mimic the shape, size, and biomechanical properties of native human nipple tissue while inhibiting shrinkage and loss of projection. After 3 months in vivo, significantly greater preservation of scaffolded teat contour, projection, and volume was demonstrated and the presence of healthy, viable cartilage.[22] Currently, there are different lines of research in which autologous tissue is seeded on 3D-printed biomaterial scaffolds, to subsequently implant it sub-dermally. However, these techniques are still in experimental phases in animals.[17]

DISCUSSION

The choice of the reconstructive technique depends on the experience of the surgeon and the characteristics and needs of the patient. The factors that guide the surgeon in choosing the appropriate technique are: the type and thickness of the skin, the quality of the patient's healing, the method adopted for breast reconstruction and the patient's adjuvant treatments. Different authors have suggested that the reconstruction of the ideal NAC should achieve the best aesthetic result; however, no surgical strategy to date is exempt from having secondary complications due to the lack of soft tissue structural support within or at the base of the flap, fat necrosis, scar contraction, delayed wound healing, infection, skin and subcutaneous tissue with therapeutic radiation sequelae such as inelastic/fibrous skin.[8] Currently, local flaps are the safest described technique and their combination with autologous and alloplastic grafts and augmentation with

allografts such as cartilage, fat, calcium hydroxyapatite, acellular dermal matrix, polymethylmethacrylate and collagen scaffolds have shown less loss of nipple projection. although it may expose the patient to a greater risk of flap necrosis. It is important to mention that the graft is the most frequently described technique for the specific reconstruction of the areola, but in recent years tattooing has become more popular due to its low cost, easy access, safety, and the short time in which it can be performed. carry out.[19]

CONCLUSION

Although there are different therapeutic alternatives for the reconstruction of the nipple-areola complex, there is no gold standard treatment available, recent research points towards tissue engineering as a potential therapeutic strategy, so it is essential to contribute with further studies and trials. clinicians in order to issue better recommendations based on scientific evidence.

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