Minimally Invasive Nipple Sparing Mastectomy: Exercise in Style or Proof of Concept

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Leonardo Barellini[1], Virginia Coli[1], Gianluca Marcaccini[2]

[1]UOC Oncologic and Reconstructive Surgery of the Breast, Spedali Riuniti, 56123 Livorno, Italy
[2]UOC Plastic Surgery, Azienda Ospedaliera Universitaria Senese, 53100 Siena, Italy

Introduction

Minimally invasive nipple-sparing mastectomy (M-NSM) with immediate implant breast reconstruction is increasingly being applied for the treatment of breast cancer that is not amenable for conservative surgery [1,2]. M-NSM involves several techniques with the most commonly used being the single port with gas inflation. By a small (3.5 cm), axillary incision, the surgical instruments are introduced via a single port device. Carbon dioxide (CO_2) is then inflated to provide enough room to dissect the gland from the posterior, and muscular planes, and then from the anterior mastectomy flap [3]. The reconstruction step is accomplished by the immediate insertion of a tissue expander or prosthesis through an axillary incision in the pre-pectoral or submuscular plan [3]. M-NSM is a challenging procedure. It is performed in a parenchymatous organ without a natural cavity unlike laparoscopy or thoracoscopy which it is inspired by. However, encouraging results regarding oncologic safety, improved complication rates, and better cosmetic outcomes underscore the potential of M-NSM as an alternative to conventional nipple-sparing mastectomy (C-NSM). This editorial seeks to highlight the advantages and challenges of this promising procedure by analyzing the indications, oncologic, and cosmetic outcomes, and focusing on the feasibility and complications that can occur according to a strict anatomical description.

Indications

M-NSM has been proposed in patients with diffuse ductal carcinoma in situ, early-stage breast cancer <3 cm in diameter, breast seize $\leq$ C cup without severe ptosis, prophylactic mastectomy, absence of involvement of the skin or nipple [3–5]. Patient selection based on breast size is of paramount importance. Breasts larger than C cup or with significant ptosis increase technical difficulties and prolong operative time. Moreover, small breasts require small prostheses that can be implanted through a 3.5 cm axillary incision without the need to enlarge it.

Feasibility

M-NSM requires precision for both prophylactic surgery and breast cancer treatment to achieve effective cancer prevention or oncologic completeness while preserving mastectomy flap viability. Dissection of the pre-mammary surgical plan in M-NSM, as in C-NSM, is the most difficult step of the procedure because the surgical plan lacks distinct anatomic landmarks, requiring surgical skill, prolonged operative time, and a steep learning curve [3]. The anatomy of the breast layers has been thoroughly studied, but opinions diverge [6]. According to most anatomists, they are composed of the skin, dermis, subcutaneous fat, anterior layer of the superficial fascia, premammary fat, gland, posterior layer of the superficial fascia, and pectoralis fascia. According to other authors, the superficial fascia is posterior to the gland and unique, whereas the anterior layer of the superficial fascia (breast fascia), is not homogeneously represented and has independent lamina wrapping anteriorly to the gland [6]. Cooper's ligaments cross the breast from the posterior layer of the superficial fascia and anchor it to the skin [2]. These anatomical structures are well represented mostly at a young age and before pregnancy and lactation, whereas in the elderly, the adipose replacement of the glandular component of the breast and the progressive loosening of the Cooper ligaments make them not constant. The video-assisted aid in M-NSM magnifies the surgical field, enabling accurate identification of the Cooper ligaments and the capsula mammae. This requires, particularly at the beginning of the experience, caution and time to get familiar with the endoscopic vision and the technical challenge of using the surgical instruments in a small operative field with difficult dissection angles. These are certainly the reasons why prolonged operative time has been described in the literature for M-NSM (mean, 248 min) compared to C-NSM (mean, 191 min) [1] However, the learning curve associated with M-NSM is manageable, and after adequate training, the surgical team can achieve consistent outcomes [3,5,6].

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Correspondence to: Leonardo Barellini, UOC Oncologic and Reconstructive Surgery of the Breast, Spedali Riuniti, 56123 Livorno, Italy (e-mail: barellinileonardo@gmail.com).
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There was no significant difference in blood loss between patients undergoing M-NSM and C-NSM [5]. Different endoscopic devices have been used to ensure safe dissection and hemostasis. Each has its advantages and disadvantages. For example, advanced energy devices are affordable for hemostasis, but can induce a thermal injury to the mastectomy flap. Other authors have proposed monopolar or bipolar scissors, forceps, or hooks, based on the personal experience of each surgeon [7].

Oncologic Safety

A recent meta-analysis demonstrated that locoregional recurrence and distant metastasis following M-NSM were comparable to those of C-NSM [5]. However, the average follow-up times were shorter in M-NSM (up to 52.1 months in comparative studies) than in C-NSM [5], and longer follow-up should be collected in order to draw definitive conclusions.

Complications

Among the complications after nipple-sparing mastectomy (NSM), flap ischemia, which can evolve into reconstruction failure, is one of the most important and can be ruled out by maintaining adequate viability of the skin envelope. This can be achieved by an in-depth study of the vascular anatomy of the breast, which has been investigated by many authors. Wuringer described a ligamentous septum originating from the pectoralis major fascia at the level of the 5th intercostal space and leading to branches in the thoracoacromial, lateral thoracic, and intercostal arteries. These vascular bundles run in a deep plan and are cut during mastectomy. In a recent study, Nahabedian *et al*. [8] demonstrated the importance of skin and nipple perfusion by the 5th intercostal perforator artery which was not observed in the Wuringer septum but was superficial at the lower pole of the breast. Other important vascular branches that need to be preserved are the superficial branches of the internal mammary artery perforators, as described by Nakajima [9]. These data demonstrate how the incision site plays an important role in skin and nipple areolar complex (NAC) necrosis. Deep vascular inflow to the breast is interrupted during NSM, and the viability of the skin and NAC relies on the superficial network, which a long skin incision can disrupt. Accordingly, an axillary incision, as performed in M-NSMs, distant from the breast skin envelope, can effectively reduce superficial vessels damage. Indeed, in a recent study, Lai *et al*. [10] demonstrated that the skin or NAC necrosis rate was 7.4% for single axillary incision, 14.4% for an upper outer radial incision and 22.4% for a per-areolar incision. Another advantage of M-NSMs is the assistance of the CO_2 gas, which at 8 mmHg, maintains sufficient skin envelope stretching. This allows the surgeon to identify the correct anatomical layer using the intrinsic weight of the breast gland and the traction applied by the laparoscopic graspers, and to rule out the potentially dangerous, traumatic effect of the retractors, as in C-NSM.

Nipple Sensation

Loss of nipple sensation is a disabling consequence of NSM. Some authors have reported better nipple sensation preservation rates after C-NSM, while some studies have reported better outcomes after M-NSM [5,7]. The NAC sensation is given by the intercostal nerves from T3–T6. In particular the anterior cutaneous branches of the intercostal nerve move laterally from the sternum and run superficially toward the medial part of the breast and the NAC, while the lateral cutaneous branches merge from the thorax at the middle axillary line and once they overtake the serratus anterior, they penetrate the breast gland at the level of the lateral margin of the pectoralis major muscle. Of all these branches, the most relevant for the sensation of the NAC is the IV° lateral branch, which enters the NAC after crossing the gland from deep to the surface. All nerve terminations collect at the nipple base [6,11]. This anatomical description of breast innervation can explain why, after an oncologically correct NSM that interrupts the anterior and lateral cutaneous branches of the intercostal nerves, nipple sensation is lost independently of the technique adopted [6].

Cosmetic Outcomes

Single port M-NSM has the advantage of an incision located outside the mastectomy flap, far from the NAC. The incision in this technique appears concealed in the axillary fold and is approximately 3.5 cm, much shorter than that in C-NSM. There are cases in which the incision length must be prolonged to implant the prosthesis or tissue expander, however, this does not significantly affect the cosmetic outcome. Indeed, several studies have shown that M-NSM improves the patient satisfaction regarding scar appearance, length and incision location [1–4,10].

Conclusions

M-NSM is a promising procedure, and although demanding, it has rapidly permeated the surgical community and has provided surgeons with important tools. Specifically, it allows for better cosmetic outcomes compared to C-NSM, fewer postoperative mastectomy flaps, and fewer NAC necrotic complications. The learning curve associated with M-NSM is manageable. After adequate training, the surgical team can achieve consistent outcomes. However, a prolonged operative time is required, and no significant improvement in nipple sensation is expected.

Availability of Data and Materials

Not applicable.

Author Contributions

LB, VC and GM contributed to the design of the manuscript. LB and GM contributed to the drafting of the manuscript. LB and VC supervised and reviewed the work. All authors have been involved in revising the manuscript critically for important intellectual content. All authors

gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

Leonardo Barellini is serving as one of the Editorial Board members of this journal. We declare that Leonardo Barellini had no involvement in the review of this article and has no access to information regarding its review. Other authors declare no conflict of interest.

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