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Robot-Assisted Nipple-Sparing Mastectomy and Immediate Reconstruction with Prepectoral Tiloop-Enveloped Implant: A Case Report

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Abstract

Background: Robot-assisted nipple-sparing mastectomy is a step forward within the framework of endoscopic mammary surgery. Although its use is still limited to a few centres, the technique has been proved safe and reproducible.

Purpose and Methods: This paper describes the first experience our centre had with robot-assisted nipple-sparing mastectomy, which was performed for prophylactic purposes using the Da Vinci Si robotic Surgical System.

Result: This preliminary experience was very positive as to the accuracy of surgical manoeuvres thanks to the high quality of the 3D image; the demolition and reconstruction operations (carried out using a prepectoral implant covered with a Tiloop Bra synthetic mesh) were performed through a single axillary incision of just a few centimeters.

Conclusion: The technical difficulties are undeniable, but the learning curves described in the literature are promising.

Keywords: Robotic assisted Nipple Sparing Mastectomy (R-NSM); Endoscopic breast surgery; Breast cancer; Nipple Sparing Mastectomy (NSM); Immediate Prosthetic Breast Reconstruction (IPBR); Synthetic mesh

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Introduction

Currently, a third of patients suffering from breast cancer are appropriate candidates for mastectomy. Inter alia, there is the emerging problem of prophylactic surgery. A growing number of women chooses mastectomy to reduce risk [1,2]. Conservative mastectomy, especially Nipple-Sparing Mastectomy (NSM), which enables the preservation of the skin and the nipple-areola complex, thereby maximizing the aesthetic result and patient satisfaction [3,4], is the gold standard for patients who are appropriate candidates for mastectomy (be it prophylactic of therapeutic).

Various accesses for the performance of NSM have been described, each with its advantages and limitations. The best access from an aesthetic standpoint, which is the inframammary fold, does not enable the optimal exposure of the whole parenchyma and requires a further axillary incision in cases where the removal of lymph nodes is necessary. The other incisions described in the literature enable a better exposure of the mammary gland, but each one of them has aesthetic disadvantages (deviation of the nipple-areola complex–NAC) or complications (NAC necrosis) [5-8].

In 2002, Kitamura et al. [9] proposed a new technique called endoscopic NSM, which enabled, by use of a monoport, the complete removal of the gland and the axillary lymph nodes and the performance of reconstruction surgery, all through a single centimeters-long incision on the midaxillary line, devoid of the problems described above concerning mammary incisions resulting into hidden scars and thus with a minimized aesthetic and psychological impact. The endoscopic technique proved well-tolerated, oncologically safe and linked to an increased patient satisfaction [10,11]. However, due to the limitations of the optical window, the instruments have a limited range of movement [12] and are to work almost in parallel [10,11,13-16]; moreover, the manual control of a two-dimensional endoscopic in-line camera leads to an optical window that is not suitable for the curvature of the mastectomy flap [12]. Due to its technical difficulties, the endoscopic nipple-sparing mastectomy did not spread on a large scale and was abandoned in various centers [10].

In October 2015, Toesca et al. were the first to describe robot-assisted NSM and immediate breast reconstruction with implant [17,18], proposing a technique able to avoid the problems of endoscopic NSM. Indeed, the robot ensures optimal vision thanks to three-dimensionality and a higher degree of magnification and illumination compared to traditional optical endoscopy; moreover, the 7 degrees of joint movement of robotic instruments enable one to work with angles that are better suited to the curvature of the mastectomy flap.

Toesca published the first 3 cases of robot-assisted nipple-sparing mastectomy performed on living patients through a 2.5 cm axillary extramammary incision using the Da Vinci S system (Intuitive Surgical, Sunnyvale, CA).

In 2016, Sarfati et al. published a feasibility and safety study of robot-assisted nipple sparing mastectomy on cadaveric models, describing a technique similar to that proposed by [19], albeit with a few differences as to the position of the patient's arm and the type of access. The same group followed up on this study by publishing the first application of said technique on a living patient, using the Da Vinci Xi system (Intuitive Surgical, Sunnyvale, CA) [20].

The subsequent publications of series of cases of robot-assisted nipple-sparing mastectomy performed on living patients showed the feasibility, reproducibility and safety of the technique [21-23].

This publication reports our experience with robot-assisted nipple-sparing mastectomy performed in accordance with the methodology described by Toesca et al.

Case Presentation

A 42-year-old woman came back to us due to her being dissatisfied with the aesthetic result of a right-side nipple sparing mastectomy (followed by an immediate reconstruction by use of a 140 cc Mentor recto-pectoral anatomical implant) performed 16 months earlier by our team owing to the presence of an intermediate-grade *in situ* ductal carcinoma. The sentinel lymph node had come out negative for metastases, and the Patient had not undergone any adjuvant therapies. The radiological follow-up had come back negative for recurrences or new tumors. Upon examination, the NAC was asymmetrical both as to shape and position. On the right, a Baker level 3 capsular contracture and implant animation were detected; an upper hemi-periareolar access with lateral extension had been used in order to perform the mastectomy. The access had been chosen based on the presence of a previous upper periareolar scar through which an upper-central quadrantectomy whose margins had been affected by the neoplasm had been performed 2 months prior to the mastectomy. The left breast showed a grade 1 ptosis. Upon examination, no palpable mammary or bilateral axillary nodularities were detected. The volume of the breasts corresponded to a B-cup. During the interview, the Patient expressed the will to remove the left breast with the two-fold aim of both reducing the possibility of developing Contralateral Breast Cancer (CBC) and obtaining a better cosmetic result. The Patient had no family history of breast or ovary cancer. Once the Patient had been thoroughly informed about the relatively low risk of developing CBC over the course of her life, the possible complications of a mastectomy and the state of the art of

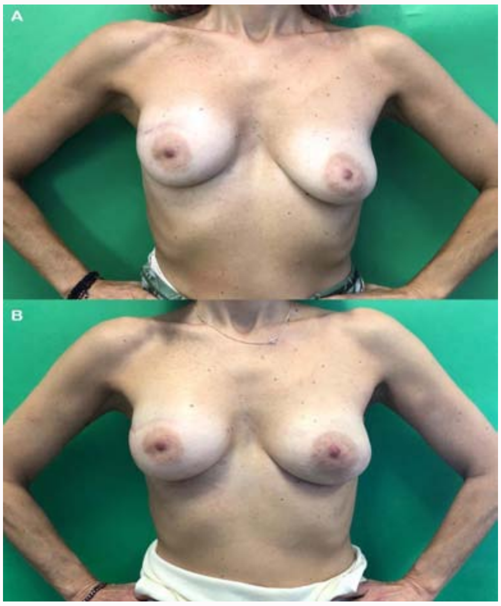

Figure 1: Pre and post-operative view of the patient.

robot-assisted mastectomy techniques, the revision of the right breast implant and a robot-assisted contralateral prophylactic mastectomy were opted for.

The preoperative evaluation did not show significant alterations. The Patient was 160 cm tall and weighed 50 kg (BMI: 19.53 kg/m^2). The woman was a light smoker (5 cigarettes a day) but showed no further relevant comorbidities. The Patient was classified as ASA 1.

The robot-assisted mastectomy technique we used, as well as the patient's position and the materials, are the ones described by Toesca et al. [12,17,18], using the Da Vinci Si Surgical System® (Intuitive Surgical, Sunnyvale, CA).

The patient was placed in a supine position, with the left shoulder on the edge of the operating table and the arm flexed posteriorly. The arm was fixed with a wrist brace at the height of the ipsilateral iliac crest, the elbow forming an angle of about 90°. The right arm was positioned along the body.

The non-robot-assisted first stage begins with an extramammary skin incision of about 2.5 cm in correspondence of the midaxillary line. The next step is a peri-incisional subcutaneous dissection of about 3 cm, which creates enough room for the access system (Access Transformer OCTOTM; Seoul, Korea) to be inserted. A small portion of the mastectomy was performed under direct vision through this incision (dissection on both superficial and deep planes). The non-robot-assisted first stage ends with the checking of haemostasis as well as the insertion, assembly and orientation of the access system. Then, the gas is insufflated through the specific channel and pneumatic tightness is checked.

The cart of the robot was positioned contralaterally to the breast to be removed (in this case, the robot was to the patient's right). Electrified scissors were chosen for the right working arm (Intuitive Surgical®, Sunnyvale, CA), whereas the left one was equipped with a Cadiere Bipolar Forceps (Intuitive Surgical®, Sunnyvale, CA). Upon completion of the docking, the instruments were converging and at a slight upward angle, whereas the arms lay on straight lines meeting approximately in correspondence of the NAC, their elbow joints as

Table 1: Summary Table of RNSM.

Author	Technique	Robot system	Number of procedures	Converted procedures	Major complications	Incision length	Maximum implant volume	Surgical time	Preparatory activities
Toesca A	Single-port with OCTOport [8]	Da Vinci Si [8]	5 [5]	2 [5]	0	2.5 cm - 3 cm [8]	Not reported	90 min-5 h [5]	Not described
		Da Vinci Xi[5]	25 [5]						
Sarfati B	Triple-port [10,11]	Da Vinci Xi [10-12]	63 [12]	1 [12]	3 infections (of which 1 resulted into the loss of the implant) [12]	5 cm [12]	225 ml - 440 ml [12]	~85 min [12]	Study on cadaveric models [10]
Lai H.W	Single-port with Glove Port [13]	Da Vinci Si [13]	39 [13]	0	0	3 cm - 5 cm [13]	500 ml [13]	56 min-250 min [13]	Endoscopic NSM (50 procedures) [13]
Park H.S	Gasless [15]	Da Vinci Xi [15]	1 [15]	0	0	6 cm [15]	Expander [15]	139 min [15]	Not described

open as possible in order to avoid conflicts.

During the robot-assisted phase, the first operator controls the console, whereas the second positions themselves at the operating table, on the same side as the arms. The second operator is to check the thickness of the skin flap and prevent parts of the robot from hitting the patient's body. The first operator uses the grasper to produce traction and countertraction and the electrified scissors to dissect. The magnified 3D vision enables the oncoplastic plane to be easily identified and haemostasis to be carefully supervised. The mastectomy starts in the lateral quadrants and continues examination of the retroareolar tissue was not necessary. Once the superficial dissection had been completed, we proceeded to loosen the gland from the deep planes, once again lateromedially.

Once the mastectomy had been completed, we proceeded to extract the robotic instruments, move the robot and disassemble and extract the Port as well as the breast, which was labelled and forwarded to the laboratory to be subjected to final histological examinations.

The palpation of the mastectomy cavity enabled the detection of an amount (around 10% of the total weight of the breast) of residual mammary tissue in the medial quadrants, which was removed under direct vision by use of retractors. Once haemostasis had been checked again, we proceeded to place a 170 cc prepectoral anatomical implant (Mentor Medical System B.V., Leiden and The Netherlands) with a Tiloop-Bra envelope (PF Medical, Germany). The choice of the implant was made based on the comparison with the contralateral periprosthetic cavity upon revision by use of capsulotomies.

Given the low levels of intraoperative bleeding, an elastic compression medication was not deemed necessary; however, the Patient wore a support bra in the period immediately after the operation.

The surgical procedure lasted a total of 295 min (Table 1), of which 15 for the first non-robot-assisted stage, 25 for the preparation of the robot-assisted stage (including the insertion of the port and the docking of the robot), 187 for the robot-assisted stage and 68 for the second non-robot-assisted stage (including the reconstruction of the left breast and the revision of the right implant).

Post-operative recovery was regular. Post-operative pain never exceeded level 4 of the NRS scale. Drainage was removed on the second day, whereas the patient was dismissed on the third day after the operation.

No complications were observed six months from the procedure. The histological examination of the breast did not detect any pathological alterations. Symmetry, in the opinion of both the surgical team and the very patient, improved significantly compared to the preoperative stage (Figure 1).

Discussion

This publication describes the first "robot-assisted nipple-sparing mastectomy" followed by an immediate reconstruction by use of a prepectoral implant covered by a synthetic mesh (Tiloop-bra).

Three nipple-sparing robot-assisted techniques have been described to date (Table 1):

- Toesca's single-port technique [17]: the 2.5-3 cm single axillary incision, though elegant and resulting into a practically invisible scar, forces the instruments to work almost in parallel, with a high degree of conflict between the robotic arms. The most significant disadvantage of the technique described by Toesca lies in the impossibility of placing large implants, thereby limiting its application to small- and medium-sized breasts exclusively [12,17]. We chose this technique for our first case of RANSM (Robot-Assisted Nipple-Sparing Mastectomy) because we had had the opportunity of assisting to RANSMs performed by Toesca first-hand;

- Sarfati' triple-port technique [19,20]: this technique, which was described and used on a living patient only after being carefully studied on cadavers, enables reconstructions with higher-volume implants compared to Toesca's technique (maximum implanted volume 440 ml), as the incision can be as long as 5 cm. The greater distance between the access points of the instruments allows for better working angles and a lower degree of conflict between the robotic arms; moreover, costs are reduced as a result of the monoport not being used [21].

- Lai's single-port technique [22]: this technique maintains the advantages of the single-port technique and enables the placing of the largest implants (maximum implanted volume: 500 cc [22]), as the scar can go from 2.5 cm to 5 cm according to the size of the breast.

- The gasless technique, described by Park's team in a single case-report [24], consists in the performing of a nipple-sparing mastectomy by use of the robotic machine, albeit with no ports or insufflation pressure. The working space is produced with long retractors.

We consider prepectoral implant-based reconstruction as the gold standard in patients who satisfy the requirements for its application. First and foremost, it enables the reconstruction of medium- and large-sized breasts in a single session, thereby sparing the patient the wait for the final reconstruction. The aesthetic outcome is significantly better both on the short and the long term: ptosis is natural, there is no risk of implant animation and capsular contracture rates are drastically reduced. Moreover, the sparing of the pectoral muscle considerably reduces post-op pain and allows for a covering structure should pre-pectoral reconstruction fail.

Although conservative mastectomies are oncologically safe techniques with local recurrence rates similar to traditional mastectomies [25-30], the most debated issue with respect to the robot-assisted approach is its oncological safety, since the flap cannot be checked by use of palpation as the dissection is performed on the superficial planes. However, the better vision they allow for (which is magnified, three-dimensional and perfectly illuminated), in particular in combination with subcutaneous hydrodissection, enables an optimal visual identification of the oncoplastic plane, thereby reducing the importance of flap palpation. Moreover, flap palpation can be performed at the end of the robot-assisted stage, and any residual parenchymal islands can be removed via open technique with the help of long retractors. To date, RANSM follow-ups are too short for the technique to be confirmed as oncologically equivalent to traditional nipple-sparing.

An important issue linked to RANSM is that of surgical time: in this case, the duration of the demolition stage was 5 times longer than our standard for traditional nipple-sparing mastectomy. Toesca's team highlighted how surgical time was reduced by more than 65% from the first to the third procedure they performed [17]. An accurate study on the learning curve conducted by Lai et al. highlighted how surgical time depends not only on the number of performed procedures, but also on the weight of the removed breast. Moreover, Lai's team suggests that robot-assisted mastectomy is more easily performed by those who are experienced in performing endoscopic nipple-sparing mastectomies [22]. In the future, the learning curve could become steeper, since its application will be based upon the accurate descriptions of the teams who have already validated and perfected the technique [12].

Data on the cost of this procedure is not available at the moment. However, costs are amortised in a hospital structure where the robot is used for various surgical specialties. The only extra costs arise from surgical instruments and time. The Toesca team is conducting a study on costs [12].

Conclusion

RANSM is a further step forward with respect to conservation in the field of mastectomies, since it allows for the intervention to be performed through an extramammary incision, thereby minimizing the cosmetic and psychological aspect of the complete removal of the mammary gland. Different techniques have been described for the performing of the RANSM, but none has proved significantly advantageous compared to the others. All RANSM methods share the feature of technical difficulty, which decreases as the surgeon performs more procedures. The cost of this procedure is another issue; however, it could be amortised in those structures where the robotic machine is used for other types of surgery too.

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