

Awake Breast Surgery: A Systematic Review

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Abstract. *Background/Aim:* Awake surgery has become a valid alternative to general anesthesia in many surgery fields. This technique played a very important role during the COVID-19 period. The growing use of this technique has many advantages. We performed a systematic review to study the potentialities of awake breast surgery. *Materials and Methods:* We searched Pubmed, Embase, and Cochrane library database and retrieved a total of 109 records. Forty-nine of them were excluded as unsuitable. Finally, we selected a total of 12 records concerning different types of studies for topic appropriateness. Three reviewers reviewed independently each record. *Results:* Five articles analyzing the sustainability of awake surgery during the COVID-19 period were selected. In addition, one article analyzing the impact on the immune system and six articles and eight case reports analyzing anesthetic techniques were also selected. The studies analyzing awake breast surgery during the

COVID-19 period showed advantages in terms of sustainability and length of hospitalization. The study analyzing the immune response after awake breast surgery showed lesser lymphocyte response than the general anesthesia group. The studies analyzing anesthetic techniques in awake breast surgery showed that the nerve blocks allow good level of safety and postoperative pain control. *Conclusion:* The awake breast surgery and fast track implementation shortened hospital stays and reduced costs, without influencing the surgical results. Furthermore, awake breast surgery reduced surgical stress compared to general anesthesia. Among the various anesthetic techniques, nerve blocks are the most advantageous in terms of safety and efficacy compared to epidural anesthesia.

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Historically, surgery mainly required support with general anesthesia. The practice of surgical interventions on awake patients under local anesthesia, with or without mild sedation, has gained popularity in recent years. Awake surgery is currently proposed for surgical procedures in which the patient was previously expected to be intubated. Surgery with local anesthesia on an awake patient is a valid alternative for different types of surgery such as hand surgery, neurosurgery, spinal surgery, and cardiac surgery. In all these, awake surgery appears to be advantageous in terms of costs, associated symptoms, and recovery after surgery, without increasing the surgical burden on the patient or on the result of the operation (1-4).

In neurosurgery, awake strategy can be used in intraoperative brain mapping. In these cases, many techniques such as local



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anesthesia and conscious sedation are utilized to perform surgical procedures. The potential to reduce postoperative morbidity represents the main advantage of these techniques, allowing identification of the different language areas in proximity to the lesion and application of direct electrical stimulations in areas adjacent to the tumor to preserve their function. To obtain such results, the patient must be awake in order to be able to speak during the tests (5).

Recently, awake surgery was introduced in the spinal surgery field with the purpose of minimizing the significant rates of morbidity and mortality. This safe surgical approach provides many advantages, such as short stays in the hospital and well-controlled pain. It is also characterized by better outcomes compared with general anesthesia, minimizing the associated cardiopulmonary side effects. Furthermore, it is also associated with less postoperative nausea and drug use (4).

In cardiac surgery, while loco-regional anesthesia was previously used only as a supplement to general anesthesia, it can nowadays be used instead of it. Combining these two types of anesthesia is advantageous in many aspects: shortened ventilation time, improved pulmonary and cardiac functions, reduced incidence of renal failure and myocardial infarction, reduced response to stress and relative immune system impairment, reduced rates of atrial fibrillation, and reduced psychological morbidity. Further benefits include lower costs in terms of procedural costs and reduced overall hospital and intensive care unit length of stay (6).

Recent technological advances have facilitated a fully robotic endoscopic cardiac surgery, enabling procedures such as endoscopic mitral valve repair, atrial septal defect closure, and totally endoscopic coronary artery bypass surgery (3).

Awake hand surgery offers advantages in surgical procedures where the active motion is crucial for controlling and improving the outcomes. Soft tissue manipulations, tendon repairs and tendon transfers are the main surgical procedures where the awake technique shows advantages. The awake approach also confers significant benefits to patients, caregivers and healthcare systems through efficiency and cost savings (1).

In this context, the objective of this systematic review is to analyze the various advantageous aspects of awake breast surgery, and how important it is to evaluate this anesthetic technique as a possible alternative to general anesthesia.

Materials and Methods

We followed the PRISMA guidelines. A systematic literature search was conducted for articles on awake breast surgery, which were published up to November 2022, using the databases of PubMed, Embase and Cochrane library. Searches were performed using the free keywords: ("Awake breast surgery" OR "Awake surgery" OR "Surgery without patient intubation"). Additional keywords (awake, surgery, immunological impact, awake surgery during COVID-19

period) and further combinations of these and related terms were used to achieve higher sensitivity. The references of all selected publications were analyzed.

Three of the authors (GC, MP, MM) independently reviewed study titles and abstracts to identify all potentially eligible studies using a predefined data extraction form. The following data were extracted: first author's surname, year of publication, study location, ethnicity, study design, exposure assessment.

First, we included studies comparing awake breast surgeries to breast surgeries performed under general anesthesia. The search was limited to articles published in English. All studies investigating awake breast surgery and its advantages in terms of sustainability, immunological impact, awake breast surgery during COVID-19 period, and the anesthesiological techniques were included. No time limit was stipulated.

Three authors (GC, MP, and MM) independently analyzed the records for eligibility, and extracted data from the articles. Disagreements on study eligibility were resolved through discussion with yet another review author (GV). Additional data were requested from the authors whenever necessary (Figure 1).

Results

From the literature research, we selected a total of 5 articles analyzing the sustainability of awake breast surgery and the implication of this technique during the COVID-19 period: One article analyzing the aspect of surgical stress and the impact on the immune system in awake breast surgery; six articles and eight case reports analyzing anesthetic techniques in awake breast surgery.

Buonomo *et al.* analyzed the sustainability of awake breast surgery in a total of 56 patients. Of these, 39 (70%) were eligible for day surgery (discharging the patient in the same day of the procedure) and the rest for the conventional surgery. The patients included in the ordinary surgical procedure group were those who did not satisfy the day surgery criteria (30%). During their study, no major complications were reported, and there were no statistically significant differences in patient characteristics between the two groups ($p>0.05$) (7). The cost of ordinary surgery to the National Health System (NHS) was 48,135 €, whereas that of day surgery was 53,118 €. Awake surgery permits to perform breast-conserving surgery in day surgery admission regimen leading to a cost saving. The cost of day surgery breast-conserving surgery (DS-BCS) for each patient was 1,362 €. Different to standard regimen BCS (BCS-ORD) cost (DRG) for each patient was 2,831.47 €. The difference of the two different health costs (DRG) was 1,469.47 €. The advantage of changing from standard admission regimen to day surgery regimen was summed at a net income of 99,591.43 € and a total annual loss of 21,431.67 €.

We analyzed four additional articles regarding awake breast surgery as a strategy during the COVID-19 period. Vanni *et al.* described an increased percentage of patients undergoing awake surgery, implementing the Enhanced

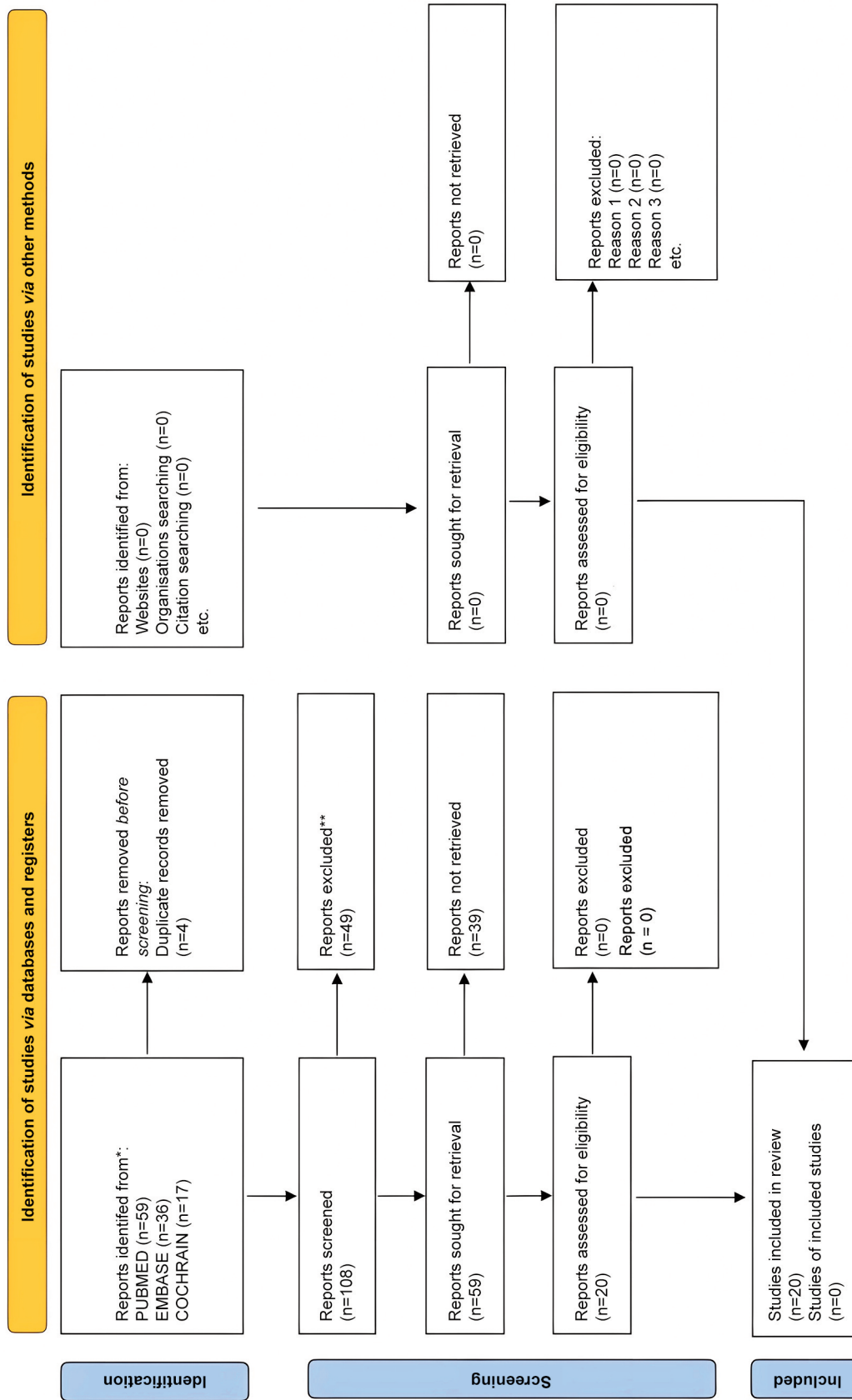


Figure 1. Flowchart of awake breast surgery: systematic review, according to Prisma 2020 guidelines (64).

Recovery After Surgery (ERAS) protocol for as many patients as possible. They retrospectively enrolled 37 and 39 patients who underwent breast surgery before and during the SARS COV-2 pandemic, respectively. Then, they examined, by changing the surgical strategy and incentivizing the use of the ERAS protocol, the effect on surgical time, time in the operating room and length of hospitalization. The percentage of patients undergoing awake surgery differed between the two groups from 36% to 73%. In both groups the most frequently performed awake surgical procedure was breast cancer surgery (BCS) + sentinel lymph node biopsy (SLNB). Axillary lymph node dissection (ALND) was never performed with an awake technique. Surgical time (ST) and operative room time (ORT) were analyzed in the COVID-19 group and the pre-COVID-19 group: ST and ORT were 85.81 ± 31.17 ; 139.13 ± 43.84 , respectively, in the COVID-19 group and 86.02 ± 32.02 and 159 ± 43.02 in the pre-COVID-19 group. Hospitalization days varied between the two groups from 1.92 ± 1.31 to 1.35 ± 0.68 . Regarding surgical complications, no statistically significant differences were demonstrated between the groups. In the pre-COVID-19 group, one seroma and one postoperative mild anemia were found as complications. In the COVID-19 group, one seroma was found as a complication. There was a reduction of 0.57 days between the COVID-19 group and the pre-COVID-19 group. There was a statistically significant difference in ORT (20.79 min) and in length of stay (0.57 hospital bed day) between the two groups (8). There was no difference in ST between the two groups. Further, there was a higher number of potential surgical treatments in the COVID-19 group, during the same time frame.

Vanni *et al.* retrospectively enrolled 498 patients. All patients underwent BCS. A total of 253 patients, until 10 March 2020, were assigned to the pre-COVID-19 group and 245 patients were assigned to the COVID-19 group. In the COVID-19 group, 141 patients were subjected to awake BCS. In the pre-COVID-19 group, 84 cases were subjected to awake BCS. The increased rates of this procedure were found to be statistically significant ($p < 0.001$). In the COVID-19 group, 14 patients were converted from an awake anesthesia regimen to a non-awake anesthesia regimen. In the pre-COVID-19 group, 26 patients were converted from an awake anesthesia regimen to a non-awake regimen. No statistically significant difference in the numbers of regimen conversion was found between the two groups. There were no statistically significant differences in patient characteristics (age, BMI) and the size of lesions between the groups. In the COVID-19 group the surgical procedure duration was 70 ± 8.4 min vs. 68.3 ± 8.5 min in pre-COVID-19 group, with no statistically significant difference. In the COVID-19 group, patients stay in the operatory room was 134.1 ± 27.6 min while in the pre-COVID-19 group patients stay in the operatory room was 146.3 ± 24.7 min, and the

difference was statistically significant (p -value < 0.001). In the COVID-19 group, the hospital stay was 1.31 ± 0.5 vs. 1.31 ± 0.6 in the Pre-COVID-19 group. There was no statistically significant difference between the two groups in this aspect. In the COVID-19 group there was a higher number of breast conservative surgeries (11 cases vs. 3), proving a statistically significant difference (9).

M. Khattab *et al.* analyzed 149 patients who underwent spine surgery with spinal anesthesia. The operative time of the procedures was between 45 to 300 min. The patients were conscious and able to hold a conversation during surgery. In three cases, after three hours of spinal anesthesia, patients were converted to general anesthesia. Immediately after surgery, patients were able to eat and demonstrated excellent postoperative pain relief. No readmissions 30- or 90-days after surgery were observed. Of 149 cases, 25 were not satisfied with the spinal anesthesia, while 124 were satisfied with this technique (4).

Andrews *et al.* developed recommendations to explain and help clinicians to adopt local anesthesia for rhinology procedures and shorten waiting times and hospital stay during the COVID-19 period (10).

We analyzed one article regarding the immune response following awake breast surgery. Vanni *et al.* enrolled 56 patients with breast cancer who underwent BCS through either general or local anesthesia and analyzed the postoperative lymphocyte response. Significant differences regarding the proportion of natural killer cells, total leukocyte and lymphocyte count were found. Lower median values of total lymphocytes were observed on postoperative days 1 ($p = 0.001$), 2 (0.02) and 3 (0.01) in the awake surgery group compared to the general-anesthesia group; furthermore, higher total lymphocyte count was found in the control group on postoperative day 2 (11).

We analyzed six articles and eight case reports dealing with anesthesiological techniques in awake breast surgery.

In the prospective observational study of Santanastaso *et al.* (12), 50 patients who underwent quadrantectomy procedures, with or without axillary dissection, with thoracic paravertebral block as regional anesthesia technique, were enrolled. The numeric rating scale (NRS) score was determined at time 0 and 2, 6, 12, and 24 h after surgery: NRS at time 0 was > 3 in three cases, one case after 2 h, and one case after 6 h. During the surgical procedure, opioid use was not necessary for any patient. Only two episodes of postoperative nausea were observed after surgery, which were resolved without antiemetic drugs. Five patients obtained a NRS score > 3 and therefore required a supplementary dose of analgesics. Twenty-five patients were discharged on post-operative day (POD) 1, 2 patients were discharged on POD 2 and 23 patients on the same day of the surgery. All patients reported satisfaction level of 5 (very satisfied) with the anesthesiological treatment. No patients

reported chronic pain at 6 months after surgery. A limitation of this study was the absence of comparison with other regional anesthesiologic techniques (12).

Santanastaso *et al.* study (13) enrolled 51 patients eligible for radical mastectomy; 11 cases also required lymphadenectomy and 7 patients received a tissue expander. In 14 patients, thoracic paravertebral block (TPVB) was used as the sole anesthesiologic procedure while in 37 patients TPVB was accompanied by general anesthesia. During surgery, opioid drugs were not necessary for any patient. Seven patients, in which lymphadenectomy and tissue expander positioning were necessary, requested supplementary administration of analgesic drug during the 24 h following surgery; four patients after 2 h, two patients after 6 h, and only one after 12 h. There was a single case of postoperative nausea resolved without drugs. The NRS score was >3 in seven patients: four after 2 h after surgery, two after 6 h and one after 12 h. Patients' satisfaction of the anesthesiological procedure was level 5 (very satisfied). There were no patients who manifested chronic pain 6 months after surgery (13).

Shimizu *et al.* described the combined use of tumescent anesthesia and intercostal nerve block for breast augmentation (14). This combination was applied to 35 patients who underwent breast augmentation from January 2008 to April 2012. Blood loss was less than 10 ml in all patients. A total of 31 patients reported no pain after surgery and four patients described mild pain. All cases showed no postoperative bleeding, no local anesthetic toxicity, and no pneumothorax (14).

In Vanni *et al.* study, enrolled 103 patients for a randomized trial that compared erector spinae plane block (ESP) block with pectoral nerve block I (PECS1) plus serratus plane block in breast conserving surgery (15). The highest static visual analogue scale (VAS) value was 4 in the serratus plane block (SPB) group and 6 in ESP group. The absence of a statistically significant difference was confirmed, notwithstanding a higher static vas score in the ESP group at 0 h and 2 h. The SPB group showed a pain peak at 2 h and 6 h. Higher Dynamic VAS values were 6 and 5, respectively, in the ESP and SPB groups. No statistically significant difference was found in dynamic VAS scores between the two groups or in patient-controlled analgesia (PCA) infusion pump analysis (15).

De la Parra *et al.* reported on 16 patients who underwent breast reconstruction with deep inferior epigastric perforator (DIEP) flap. In this study, the patients were divided into two groups: general anesthesia group (group 1) and epidural block with no sedation group (group 2); nine patients were included in the former and seven patients in the latter. Only one patient from Group 1 reached mobilization from bed on POD 1, compared to 4 patients from Group 2. The mobilization of the other patients occurred on POD 2. There

were no significant differences between the two groups regarding VAS on POD 1-5. All procedures were completed without vascular insufficiency or thrombosis (16).

Wenk *et al.* retrospectively analyzed 39 patients who underwent breast cancer surgery with cervical epidural alone. In 26 patients, cervical epidural catheter was enough to carry out the surgery. In one case, the identification of the epidural space was not possible. An insufficient sensory block was reported in four patients and a partially insufficient sensory block in seven patients. In one patient, the procedure was delayed as the dura was accidentally punctured (17).

Discussion

Economic aspect/Fast track during COVID-19. Buonomo *et al.* showed that breast-conserving surgery, performed on an awake patient, brings added value to the patients themselves and to the NHS or Sistema Sanitario Nazionale (SSN). The study's benchmark was the comparison between the costs incurred by a DS-BCS treatment and those incurred by an ORD-BCS treatment. Based on the assumption that the DS regimen also guarantees a high degree of safety and quality of treatment, it not only reduces the costs and the shortening of waiting time for the patient, but also increases the efficiency and productivity of the healthcare system, *i.e.*, the number of patients undergoing treatment (7, 18). Demonstrating this, Buonomo *et al.* managed to maximize the utility of the hospital health service during the pandemic with awake breast surgery and, at the same time, minimize the risk of COVID-19. The main complications of the DS regimen are urinary retention, nausea, vomiting, and hyperalgesia. In case of such complications, patients were not discharged in postoperative day 0 and discharged according to clinical condition. The main contributors to these complications have been identified as general anesthesia and opioid-based post-operative analgesia. To limit these complications, several locoregional anesthesia protocols are in place to reduce the use of opioids in the post-operative period. It has also been shown that the use of ropivacaine during surgery allows intraoperative pain management, opening up the possibility of surgery without intubation (7, 19-21). Therefore, from the point of view of productivity and cost savings for hospitals, the day surgery approach of awake surgery is a valid alternative to the conventional approach.

Awake breast surgery played a very important role during COVID-19. Indeed, oncological treatment could not be subjected to delays or cancellations. Therefore, the problem of limited bed availability and the risk of exposing frail patients to possible infection through hospitalization had to be faced. Hence, an attempt was made to find a surgical treatment that would ensure the shortest possible hospital stay in order to minimize exposure, while occupying as few beds as possible

and leaving them available for COVID-19 patients (8, 9). The chosen strategy was to increase the percentage of patients undergoing awake surgery, and to encourage the ERAS protocol for as many patients as possible (9). Vanni *et al.* examined the effect of changing the surgical strategy and promoting the use of the ERAS protocol on surgical time, time in the operating room and length of hospitalization (8, 9, 15). This study showed the great potential of awake breast surgery in the surgical treatment of breast cancer, both in terms of hospital resource management and patient benefit. Under this strategy, the patient is certainly exposed to less psychological stress and, consequently, also to less physical stress than conventional surgical strategies (5). During the COVID-19 pandemic, many resources had to be redistributed to account for the increased hospitalization rates. Breast surgery was not the only surgical field that experienced this reorganization to support the COVID-19 period requirements. Other examples for this reorganization are the spinal and the rhinological surgery. Spinal surgery is mainly an elective surgery and thus suffered a significant slowdown. Awake surgery was also a valid alternative, allowing a reduction in costs, hospital stay and use of resources (4). It was allowed with a high surgical safety level. Similarly, rhinological surgery has also undergone a significant slowdown during the pandemic, particularly non-oncological surgery, such as that of chronic rhino-sinusitis. The surgical procedure delay was also associated with a worse surgical outcome. Thus, awake rhinological surgery represents a valid alternative, reducing expenditure, shortening hospitalization, minimizing expense for future treatments, and reducing the use of operating theaters, which aren't required in the setting of an awake procedure (10).

According to this experience, it would therefore be useful to evaluate new strategies that may guarantee on one hand greater sustainability (7) regarding hospital management of surgical treatment, and on the other hand exposure to less physical and psychological stress while still ensuring optimal surgical management and low risk of complications (9, 15, 22).

Impact on the immune system. Vanni *et al.* studied the patient's immune system following BCS in terms of surgical stress under local *vs.* general anesthesia (5). Any type of surgical procedure may have an impact on the immune system (23-26). The main conclusions of this study were the presence of correlation between local anesthesia and immune response and the association between awake surgery and a reduced impact on the immune system in comparison to general anesthesia (5). According to several studies, the effect of drugs administered during general anesthesia may interfere with the immune system (27). Volatile anesthetics also add a proinflammatory stimulus to the surgical stress response (28-30). Surgical stress and general anesthesia are possibly responsible for the reduction in circulating lymphocytes and other immune system cells, and their

cytotoxic activity. The use of drugs such as propofol, opioids and morphine are associated with immune suppression (27, 31-33). Lymphocytes and natural killer (NK) cells are the first immunological line against tumors (23, 34, 35). Opioids affect the immune system through mu-opioid receptors, decreasing NK cells and cytokine production (36, 37). The influence of general anesthesia and surgical resection on the immune system could be also relevant in the process of tumor dissemination.

There are three main factors underlying the process of metastasis and recurrence: the first is based on the release of pro-inflammatory cytokines and pro-oncogenic and angiogenic factors on the surviving cancer cells; the second is based on the acquisition of the capacity for vascular and lymphatic invasion through the activation of oncogenes; the third is based on dissemination after removal of the primary tumor (38-41).

It is documented that opioids act directly on tumor growth through the activation of some transcription factors (42, 43) and by activation of vascular endothelial growth factor (VEGF) receptors (44, 45). Surgical resection triggers an inflammatory response and tissue hypoxia, which can drive progression to metastatic disease (46-48). Interactions between catecholamines and cortisol with the immune system and the antitumor activity also influence these processes (49). It is therefore evident that anesthesia, at least in theory, is crucial not only for performing the surgical treatment but also for influencing tumorigenesis, through the use of drugs with sympatholytic, anti-inflammatory, and immunomodulatory effects (50). The reduction of peripheral blood lymphocytes can theoretically increase the probability of tumor progression and metastasis (51, 52). However, the possibility that a few hours of general anesthesia could have a significant impact on the progression of the disease is dubious (51). Nonetheless, it is possible that, depending on the different types of tumors, surgical stress and therefore immune suppression have an impact. Yet, further studies are needed to demonstrate the importance of surgical stress on the progression of tumor disease (53).

Anesthesiology techniques. There are several studies demonstrating the possibility of performing breast surgery on awake patients. Thoracic paravertebral block is a technique that allows breast surgery to be performed while the patient is awake without increasing operating room times. Santonastaso *et al.* demonstrated that it is possible to perform quadrantectomy with or without lymphadenectomy, (12) or lumpectomy (54), using this technique, eliminating the use of opioids during the postoperative period and consequently decreasing post operative nausea and vomiting (PONV) and other opioid side-effects. The NRS score values indicate how the use of this technique does not produce a significant impact on postoperative pain. This feature also

allows for rapid discharge, with 46% of patients discharged on the same day. Patients reported a high level of satisfaction, probably on account of avoiding general anesthesia and consequently fewer adverse symptoms. (12). In another study, Santonastaso *et al.* showed that thoracic paravertebral block, either in combination with general anesthesia or as a sole anesthesiological technique, is a possibility for radical mastectomy (13). This study demonstrated the prospect of radical mastectomy without the use of postoperative opioids. The NRS score values show that the use of this technique does not have a significant impact on postoperative pain. Patients reported a high level of satisfaction probably owing to the avoidance of general anesthesia, which leads to fewer adverse symptoms such as nausea. Approximately 40% of women who undergo mastectomies or quadrantectomies, with or without axillary dissection, suffer from chronic pain after surgery, with early post-operation pain being one of the most important complications (13, 55). The paravertebral thoracic block is therefore a concrete possibility for awake breast surgery. This possibility is clearer for quadrantectomy operations, with or without lymphadenectomy. This is also evident for mastectomy but the evidence is weaker (13, 55). In particular, evidence regarding the advantage in terms of length of stay according to the different surgical techniques in the case of awake mastectomy is not clear.

Another possibility is intercostal nerve block and tumescent anesthesia. This technique can be used for breast augmentation, as described by Y. Shimizu *et al.* The tumescent technique consists of epinephrine and lidocaine mixed with saline. Its use with intercostal nerve block offers three main advantages: first, the awake patients can directly express their degree of satisfaction with the result obtained with the positioning and size of the protheses; second, reduced blood loss due to the use of tumescent solution, which prevents bleeding; third, patients can be released immediately after the surgery (14). The advantages of utilizing this anesthetic technique in terms of hospitalization time, postoperative pain, and the possible disadvantage on the execution of the surgery, are not clear.

Wide local anesthesia no tourniquet (WALANT) is an anesthetic technique, which is currently used in orthopedic surgery of the lower and upper limbs. It is used particularly in hand surgery, such as in the surgical treatment of carpal tunnel and tendon transfer surgery, but also in fracture fixation of the hand and distal radius, ankle fractures and fixation, and lower and upper extremity trauma surgery. This technique is based on the injection of local anesthesia consisting of adrenaline and lidocaine into the surgical incision site. Sufficient time after administration of the tumescent anesthetic must pass for vasocontraction to take place. This type of anesthetic technique offers many advantages in terms of surgical time, surgical stress,

economic sustainability, and patient compliance, allowing the patient to stay awake during surgery and decreasing anxiety (56). Currently, this technique is used in orthopedic surgery, but it cannot be excluded that this method may also be suitable in breast surgery.

Another anesthesiological possibility is the serratus anterior plane (SAP) block. The SAP block allows analgesia in the lateral part of the chest and in the axilla. Thus, in order to perform breast surgery with this technique it is also necessary to add a second block such as PECS 1 or the transverse thoracic plane block. Pedrosa *et al.* presented a case report using this technique for breast lumpectomy with axillary dissection (57). Vanni *et al.* compared ESP Block with SAP block plus pectoral nerve block in breast conserving surgery. This study showed ESP block as a true possibility when PECS 1 or SPB or other regional anesthetic techniques are contraindicated. In particular, ESP block was demonstrated to be a safe and faster alternative to SPB + PECS1 (15). A case report by Bagaphou *et al.* (58) described the use of PECS block associated with ESP block for radical mastectomy in two patients. In both cases, patients were awake, and opioid use was significantly reduced. The combination of PECS and parasternal block with sedation is therefore an alternative to general anesthesia (58). Another case report by Santonastaso *et al.* described the use of the spinal erector plane block with the anterior serratus plane block together with a mild sedation (without the use of opioids) for the execution of a radical mastectomy and biopsy of the sentinel lymph node (59-60). Sepolvere *et al.* described the use of a bilateral ESP block as a single analgesic technique with mild sedation and no opioids use for bilateral modified radical mastectomy. No complications were recorded, and the patient maintained stable vital parameters without increasing the operating time (61).

Wenk *et al.* demonstrated the possibility of using cervical spinal anesthesia in breast surgery on an awake patient. In this study, however, it is clear that this type of anesthesia can be associated with complications such as nausea or vomiting, but more importantly lack of identification of the epidural cervical space and insufficient sensitivity block (17). The risk of significant neurological complications in case of incorrectly performed procedures makes this technique less attractive than the others (17).

De La Parra *et al.* examined the clinical advantages of awake surgery in breast reconstructive surgery with DIEP using the double epidural (thoracic and lumbar) technique for this particular reconstructive procedure. This technique allows a more rapid postoperative recovery than general anesthesia. The absence of abdominal muscle relaxants complicates this technique, and in order to minimize the deeper thoracic motion during the anastomosis procedure period, the sedation is deep. Despite these two factors, this study demonstrated that it is possible to use this type of

Table I. Analysis of different anesthetic techniques.

| | Cases | Cases of necessary conversion in G.A. | Cases of NRS score >3 at 2, 6, 12, 24 h | Cases of efficacy of anesthetic technique |
|---|-------|---------------------------------------|---|---|
| DIEP flap for breast reconstruction using epidural anesthesia with the patient awake | 7 | 0 | – | 0 |
| Feasibility of cervical epidural anesthesia for breast cancer surgery | 39 | 4 | – | 26 |
| Thoracic paravertebral block and awake surgery: a prospective observational study | 50 | 1 | 5 | 49 |
| Single shot ultrasound-guided thoracic paravertebral block for opioid-free radical mastectomy | 14 | 0 | 7 | 14 |
| Erector spinae plane block <i>versus</i> serratus plane block in breast conserving surgery | 103 | 0 | – | 103 |
| Combined usage of intercostal nerve block and tumescent anesthesia: an effective anesthesia technique for breast augmentation | 35 | 0 | – | 35 |

anesthesiological technique for this particular reconstructive surgery. Locoregional anesthesia is therefore an appropriate/legitimate/decent/feasible alternative to general anesthesia, and an advantageous one, especially for the faster postoperative recovery compared to surgery under general anesthesia (16, 62, 63) (Table I).

Awake breast surgery represents a reality among the anesthesiologic techniques. This technique demonstrates advantages from different points of view compared to breast surgery under general anesthesia. It is advantageous in terms of economic sustainability, waiting times, postoperative morbidity, length of hospitalization and surgical stress. The real effect of reduced immunological impact on the disease and tumor progression after surgery is still not well understood. Among the different techniques proposed in awake breast surgery, nerve blocks are the safest and most effective, compared to anesthesia with cervical epidural catheterization.

In conclusion, awake breast surgery can be considered not only as a possibility but also as a favorable approach to breast surgery in general. Nonetheless, it is essential to consider the possible need to resort to general anesthesia in each individual case.

Conflicts of Interest

The Authors declare that they have no potential conflicts of interest in relation to this study.

Authors' Contributions

GV, MP and GC: conceptualization, methodology, formal analysis, and design of the study, MM, methodology. GV, GC, MP, MM, CB, TF, EG, FS, LA, AN reviewed the literature, manuscripts selection and exclusions. MD and OCB supervision. All the Authors approved the final version of the manuscript.

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