Robotic-assisted harvest of latissimus dorsi muscle flap for breast reconstruction. Review of the literature.

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ABSTRACT

Robotic-assisted surgery continues to gain ground over conventional surgical methods, due to reported better results regarding the aesthetic outcome and the decreased percentage of complications. Latissimus dorsi flap harvesting for breast reconstruction has been used for many years but serious complications have been reported. To overcome this, recently, minimally invasive methods such as robotic assisted surgery has been suggested with conflicting outcomes. Therefore, literature review was conducted regarding robotic assisted harvesting of the latissimus dorsi flap for breast reconstruction. A narrative review of the contemporary literature was performed in PubMed database for the use of robotic assisted surgery of latissimus dorsi muscle flap harvesting for breast reconstruction. Appropriate search terms were used, and specific inclusion and exclusion criteria were applied. Five studies met the inclusion criteria. A total of 32 cases of robotically assisted harvesting of pedicled latissimus dorsi muscle flap for implant-based breast reconstruction have been identified. All flaps were successfully harvested without converting in traditional open procedure. There were no significant postoperative complications, expect from few cases of postoperative seromas, which were conservaticely managed. Additionally, all patients expressed full satisfaction with their cosmetic outcome. Robotic assisted harvesting technique of the latissimus dorsi flap for breast reconstruction is safe and comparable to the conventional methods. Reduced hospital stays, and superior aesthetic outcome are the main advantages while total cost and the difficulty of reaching the learning curve plateau are the main concerns regarding this modern and minimally invasive surgical approach.

KEYWORDS: Robotic; Latissimus Dorsi; Breast; Reconstruction; Harvesting.

INTRODUCTION

Minimally invasive surgical techniques are increasingly adopted worldwide due to less complication rates resulting from reported reduced length of the necessary incisions and the superior aesthetic outcome. Integration of robotic assisted surgery by many surgical specialties such as General surgery, Urology, Gynecology, Cardiac surgery and ENT constitutes a great step to this trend[1–5].

Plastic and Reconstructive Surgery incorporates surgical techniques and other therapeutical methods usually applied on the outer surface of the human body i.e. the skin. However, there are many surgical procedures in which inner structures, such as muscles, are necessary to be reached, harvested and transposed to adjacent or distant defects. Granted that Plastic Surgery has a special concern for the minimization and the quality of the scars, application of minimally invasive surgical techniques, where possible, is of particular interest. Endoscopic and robotic assisted techniques have already started being applied in muscle harvesting, microsurgery, transoral surgery and lymphatic surgery[5–8]. Latissimus dorsi muscle flap (LDMF) harvesting for breast reconstruction has been used for many years, but serious complications have been reported [9]. To overcome this, minimally invasive methods such as robotic assisted surgery have been recently suggested.

Therefore, literature review was conducted, on studies archived in PubMed, examining the profile of robotic assisted harvesting of LDMF for breast reconstruction.

METHODS

Study design

All studies and case reports addressing cases of patients who underwent robotic-assisted harvesting of LDMF for breast reconstruction. Reviews and animal or cadaveric studies were excluded from analysis. Only studies in English language were included. Moreover, studies or cases describing the use of robotic-assisted harvesting of LDMF in exclusively repairing other reconstruction defects were excluded. Two of the authors (AP and ES) independently and meticulously searched literature and excluded duplicates. Any disagreements were resolved by a third author (NN) and a final decision was made accordingly.

Search Strategy and Data collection

This review was conducted by searching medical literature in MEDLINE dated back up to 10 years. The search was conducted in May 2019. The following key words were used for the search: ‘robotic’, ‘robot’, ‘latissimus dorsi’, and ‘breast reconstruction’. A minimum number of key words were utilized in order to assess an eligible number that could be easily searched while simultaneously minimizing the potential loss of articles. Articles that fulfilled or were deemed to fulfil the inclusion criteria were retrieved.

Our search strategy included the Medical Subject Heading (MeSH) terms:

- “Robot AND Latissimus Dorsi AND Breast reconstruction”
- “Robotic AND Latissimus Dorsi AND Breast reconstruction”

All the retrieved article titles and abstracts were screened for relevant manuscripts. A full text review of the selected relevant articles was made in order to detect the studies included in this review. Relevant full text review manuscripts or systematic review manuscripts were used to retrieve articles of any publishing date from their reference list and include them to this review. Data on patients’ characteristics included age, type of mastectomy, history of external breast irradiation, and time of breast reconstructive surgery. Moreover, intraoperative and postoperative were also evaluated such as intraoperative blood loss, total operative time of harvesting procedure and postoperative complications, if available.

RESULTS

A total of 5 studies, which presented 32 cases of robotic-assisted harvesting of pedicled latissimus dorsi muscle flap for implant-based breast reconstruction have been published[10–14]. **Table** highlights the characteristics of included patients, the type of surgical approach and the perioperative short-term outcomes.

In the study conducted by Selber et al., 5 patients who underwent robotic-assisted harvesting of LDMF for breast reconstruction[14]. Among them, 3 cases were for immediate, implanted-based reconstruction with nipple-areola complex-sparing mastectomies, and, 2 patients had a history of radiated breasts, where expanders were replaced form pedicled flaps[14]. Clemens et al. described a total of 17 cases who had a successful robotic-assisted harvesting of LDMF[10]. Among them, 12 patients received radiation as adjuvant therapy after their mastectomy and before their breast reconstruction[10]. Additionally, in 2015, Chung et al. reported a cases series of 7 patients, where muscle flaps were successfully harvested for breast reconstruction, through transaxillary gasless robotic-assisted approach[11]. More specifically, 3 patients underwent delayed reconstruction following tissue expander insertion or breast-conserving surgery and 4 cases had immediate breast reconstruction after nipple-sparing mastectomy[11]. Moreover, Lai et al. have published two different studies in 2018, describing 3 case reports[12, 13]. The first case reported a 28-year old woman who underwent simultaneously robotic-assisted quandrectomy for left breast invasive carcinoma and immediate partial breast reconstruction with robotic-assisted LDMF[12].

The second and third case described a 46-year old diagnosed with carcinoma in situ and a 48-year old female with multicentric infiltrating ductal carcinoma, respectively[13]. Both of them underwent a robotic nipple-sparing mastectomy with immediate robotic-assisted harvesting of LDMF.

All LDMF were successfully harvested without converting to traditional open approach and without technical difficulty. The operative time for robotic-assisted harvesting of LDMF ranged from 50 minutes to 267 minutes. The two studies conducted by Lai et al. described the overall blood loss during operation[12, 13]. More specifically, these 3 patients had 40, 50 and 45ml blood loss during robotic-assisted harvesting of LDMF, respectively.

In terms of perioperative complications, Selber et al. described a case of a transient and contralateral nerve palsy which was completely recovered two weeks postoperatively[14]. In the same study, all patients seemed to occur a moderate back pain/discomfort[14]. On the other hand, regarding postoperative complication, in the study conducted by Clemens et al. 8.3% and 14.1% of patients who underwent robotic-assisted harvesting of LDMF had seroma and surgical site infection, respectively[10]. Twelve patients presented with no postoperative seromas or hematomas, while Lai et al. reported a total of 3 cases where a postoperative seroma in the back occurred and was managed by repeated aspirations[10, 12, 13]. Three studies reported a total of ten cases who were satisfied with the postoperative surgical scar and their aesthetic outcome[11–13].

Only one study was found comparing the outcomes of robotic-assisted LDMF to those of the traditional open technique (TOT): Clemens et al in a retrospective analysis compared the outcomes of robotic-assisted LDMF to those of the traditional open technique (TOT) for an average follow-up period of 14.6 ±7.3 months[10]. Latissimus dorsi breast reconstruction following radiation was performed in 12 patients using robotic-assisted LDMF and in 64 patients using TOT[10]. Surgical complication rates (i.e. seroma, infection, delayed wound healing, and capsular contracture) were less in robotic-assisted LDMF than in TOT (16.7% versus 37.5%) but without statistical significance (p=0.31)[14]. Furthermore, the average length of hospital stay for robotic-assisted patients was 2.7 days (range 2-3), substantially shorter than that of TOT patients (3.4 days, range 3 - 6)[10].

DISCUSSION

Robotic-assisted harvesting technique has enhanced precision, motion scaling, high resolution, three-dimensional optics, tremor elimination, freedom of motion around various anatomical areas and more comfortable operating posture[15]. As a result of these advantages, robotic surgery has gained a role in the harvest of the LDMF and other reconstructive procedures of plastic surgery, in comparison to endoscopic techniques of LDMF[16–18]. Some of the suggested indication for robotic-assisted harvesting of LDMF are reconstruction of the defects mostly in the scalp or the limbs and reconstruction of the volume using a latissimus dorsi flap in association with fat injections in immediate or delayed breast reconstruction as well as in cases of nipple-sparing mastectomy[19].

In the present review, although a small number of cases has been already published, the use of the robotic system for raising the latissimus dorsi flap in breast reconstruction surgery seems a very promising procedure. All flaps were successfully harvested without converting into the TOT and with minimum postoperative complications. All of these complications were managed conservatively. All patients had an excellent postoperative cosmetic result. Thus, robotic-assisted harvesting of LDMF is a safe and reproductible procedure, even in radiated breast delayed-immediate implant reconstruction[11].

Among advantages of robotic-assisted harvesting of LDMF, aesthetic outcome seems to be the most important and the main reason that patients decided to proceed with this specific approach. Chung et al. reported an excellent aesthetic outcome in terms of scar healing and breast symmetry[11]. In addition, although the small number of included cases, there was no conversion from robotic to traditional open harvesting procedure. Another significant advantage is that robotic-assisted harvesting of LDMF can be a technique of choice for patients with history of breast external irradiation with low rate of complications.

The main drawbacks of the robotic-assisted LDMF reported in this review were the learning curve, the lack of tactile biofeedback and the cost[15, 20]. Finally, irrespective of the procedure applied, patients with disinsertion of the latissimus dorsi, often self-report shoulder instability, even in the absence of strength or mobility deficits which often occur[12]. Furthermore, cost is an issue generally raised when robotic surgery is applied, as the robotic system is both expensive to purchase as well as to use it. However, if less complication rates and shorter hospital stay are also considered then the robot-associated costs might be balanced. In addition, in cases where acellular dermal matrices are necessary for the enforcement of the lower pole of the breast then usage of robotic system for harvesting the latissimus dorsi and replacing these matrices is much cheaper[5]. As with most minimal invasive techniques, learning curve is a crucial obstacle to adopting or not the specific approach. The problem is that there is no formal robotic training in plastic surgery compared to other specialities, such as Urologists and General Surgeons, and as a result there is no available data in the literature about the demanding learning curve of robotic-assisted harvesting of LDMF[5].

To our knowledge this is the first narrative review of patients who underwent the specific robotic-assisted procedure for breast reconstruction after mastectomy for breast cancer, describing the advantages and disadvantages of this surgical technique. Of note, the results of our systematic review should be interpreted in the context of its limitations. First of all, the current study is not a systematic review of the literature, on the contrary is a narrative review addressing a small number of patients with significant heterogeneity. Thus, objective results about further advantages or disadvantages of the specific surgical approach cannot be reported. There are no randomized trials (RCTs) published in the current literature comparing robotic- assisted harvesting of LDMF with TOT, and as a result the evaluation of robotic- assisted harvesting of LDMF as a superior surgical approach is impossible. Another important limitation of the current study is the fact that these studies conducted at single centers.

In conclusion, robotic-assisted harvesting of LDMF for BR, has been reported through small, retrospective cohorts and only once in a retrospective comparative study, comparing it with TOT. Thus, level of evidence is not adequate to support definitive conclusions. However, encouraging reported outcomes, mainly regarding cosmetic results and wound-associated complications, justify that the technique merits further investigations. Once the critical aspect of structured, objective training has been addressed, prospective, comparative studies are needed to quantitatively assess advantages and disadvantages of the technique.

Declarations

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Conflicts of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

Availability of data and material Data are available by correspondence author

Code availability Not applicable

Authors' contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Spyridon Vourtsis, Anna Paspala, Panagis Lykoudis and Eleftherios Spartalis. Literature search and Data analysis of the manuscript were performed by Gerasimos Tsourouflis and Anna Paspala was drafted and critically revised the work. Dimitrios Dimitroulis, Emmanuil Pikoulis and Nikolaos Nikiteas read and approved the final manuscript.

REFERENCES

1. Terashima M, Tokunaga M, Tanizawa Y, Bando E, Kawamura T, Miki Y, Makuuchi R, Honda S, Tatsubayashi T, Takagi W, Omori H, Hirata F (2015) Robotic surgery for gastric cancer. Gastric Cancer 18:449–457 . https://doi.org/10.1007/s10120-015-0501-4
2. Goonewardene SS, Gillatt D, Persad R (2018) A systematic review of PFE pre-prostatectomy. J Robot Surg 12:397–400 . https://doi.org/10.1007/s11701-018-0803-8
3. Fader AN, Seamon LG, Escobar PF, Frasure HE, Havrilesky LA, Zanotti KM, Secord AA, Boggess JF, Cohn DE, Fowler JM, Skafianos G, Rossi E, Gehrig PA

(2012) Minimally invasive surgery versus laparotomy in women with high grade endometrial cancer: A multi-site study performed at high volume cancer centers. Gynecol Oncol 126:180–185 . https://doi.org/10.1016/j.ygyno.2012.04.028

4. Anderson CA, Kypson AP, Chitwood WR (2008) Robotic mitral surgery: Current and future roles. Curr Opin Cardiol 23:117–120 . https://doi.org/10.1097/HCO.0b013e3282f41b38

5. Selber JC (2017) Can i Make Robotic Surgery Make Sense in My Practice? Plast Reconstr Surg 139:781e-792e . https://doi.org/10.1097/PRS.0000000000003151

6. Agochukwu N, Bonaroti A, Beck S, Liau J (2017) Laparoscopic Harvest of the Rectus Abdominis for Perineal Reconstruction. Plast Reconstr Surg - Glob Open 5:1–5 . https://doi.org/10.1097/GOX.0000000000001581

7. Duvvuri U, Bonawitz SC, Kim S (2013) Robotic-assisted oropharyngeal reconstruction. J Robot Surg 7:9–14 . https://doi.org/10.1007/s11701-011-0326-z

8. Lee HJ, Lee YH, Chong GO, Hong DG, Lee YS (2017) Robotic-assisted transperitoneal infrarenal para-aortic lymphadenectomy for gynecological malignancies: Comparison with a laparoscopic approach. Anticancer Res 37:7087–7093 . https://doi.org/10.21873/anticanres.12182

9. Xu S, Tang P, Chen X, Yang X, Pan Q, Gui Y, Chen L (2016) Novel technique for laparoscopic harvesting of latissimus dorsi flap with prosthesis implantation for breast reconstruction A preliminary study with 2 case reports. Med (United States) 95:3–6 . https://doi.org/10.1097/MD.0000000000005428

10. Clemens MW, Kronowitz S, Selber JC (2014) Robotic-assisted latissimus dorsi harvest in delayed-immediate breast reconstruction. Semin Plast Surg 28:20–25 . https://doi.org/10.1055/s-0034-1368163

11. Chung JH, You HJ, Kim HS, Lee B Il, Park SH, Yoon ES (2015) A novel

technique for robot assisted latissimus dorsi flap harvest. J Plast Reconstr Aesthetic Surg 68:966–972 . https://doi.org/10.1016/j.bjps.2015.03.021

12. Lai HW, Lin SL, Chen ST, Lin YL, Chen DR, Pai SS, Kuo SJ (2018) Robotic nipple sparing mastectomy and immediate breast reconstruction with robotic latissimus dorsi flap harvest – Technique and preliminary results. J Plast Reconstr Aesthetic Surg 71:e59–e61 . https://doi.org/10.1016/j.bjps.2018.07.006

13. Lai HW, Chen ST, Lin SL, Lin YL, Wu HK, Pai SH, Chen DR, Kuo SJ (2018) Technique for single axillary incision robotic assisted quadrantectomy and immediate partial breast reconstruction with robotic latissimus dorsi flap harvest for breast cancer. Med (United States) 97: . https://doi.org/10.1097/MD.0000000000011373

14. Selber JC, Baumann DP, Holsinger FC (2012) Robotic latissimus dorsi muscle harvest: A case series. Plast Reconstr Surg 129:1305–1312 . https://doi.org/10.1097/PRS.0b013e31824ecc0b

15. Struk S, Qassemyar Q, Leymarie N, Honart JF, Alkhashnam H, De Fremicourt K, Conversano A, Schaff JB, Rimareix F, Kolb F, Sarfati B (2018) The ongoing emergence of robotics in plastic and reconstructive surgery. Ann Chir Plast Esthet 63:105–112 . https://doi.org/10.1016/j.anplas.2018.01.002

16. Leff DR, Vashisht R, Yongue G, Keshtgar M, Yang GZ, Darzi A (2011) Endoscopic breast surgery: Where are we now and what might the future hold for video-assisted breast surgery? Breast Cancer Res Treat 125:607–625 . https://doi.org/10.1007/s10549-010-1258-4

17. Ibrahim AE, Sarhane KA, Pederson JC, Selber JC (2014) Robotic harvest of the rectus abdominis muscle: Principles and clinical applications. Semin Plast Surg 28:26–31 . https://doi.org/10.1055/s-0034-1368164

18. Ichihara S, Bodin F, Pedersen JC, Porto de Melo P, Garcia JC, Facca S, Liverneaux PA (2016) Robotically assisted harvest of the latissimus dorsi muscle: A cadaver feasibility study and clinical test case. Hand Surg Rehabil 35:81–84 . https://doi.org/10.1016/j.hansur.2016.01.002

19. Lind J, Walker G, Verheyden CN (2011) Restoration of normal eyelid function after resection of orbitotemporal neurofibroma. Plast Reconstr Surg 128:74–109 . https://doi.org/10.1097/PRS.0b013e31821ef148

20. Leonardis JM, Diefenbach BJ, Lyons DA, Olinger TA, Giladi AM, Momoh AO, Lipps DB (2019) The influence of reconstruction choice and inclusion of radiation therapy on functional shoulder biomechanics in women undergoing mastectomy for breast cancer. Breast Cancer Res Treat 173:447–453 . https://doi.org/10.1007/s10549-018-5003-8