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ROBOTIC SURGERY & TELESURGERY»**

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ATHENS**

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**“Robotic-assisted harvest of latissimus dorsi muscle
flap for breast reconstruction. Review of literature”**

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**“ΕΛΑΧΙΣΤΑ ΕΠΕΜΒΑΤΙΚΗ ΧΕΙΡΟΥΡΓΙΚΗ, ΡΟΜΠΟΤΙΚΗ
ΧΕΙΡΟΥΡΓΙΚΗ ΚΑΙ ΤΗΛΕΧΕΙΡΟΥΡΓΙΚΗ”**

**ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ
ΑΘΗΝΩΝ**

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Περίληψη

Εισαγωγή/Σκοπός: Οι ρομποτικά υποβοηθούμενες χειρουργικές επεμβάσεις συνεχίζουν να κερδίζουν έδαφος, σε σχέση με τις συμβατικές χειρουργικές μεθόδους λόγω των αναφερομένων καλύτερων αποτελεσμάτων σχετικά με το αισθητικό αποτέλεσμα και το μειωμένο ποσοστό επιπλοκών. Αν και η παρασκευή του κρημνού του πλατύ ραχιαίου μυός, για την αποκατάσταση του μαστού, χρησιμοποιείται εδώ και πολλά χρόνια, μια πληθώρα σοβαρών επιπλοκών έχουν αναφερθεί. Πρόσφατα, ελάχιστα επεμβατικές χειρουργικές προσεγγίσεις όπως η ρομποτικά υποβοηθούμενη τεχνική, έχουν προταθεί, με αντικρουόμενα αποτελέσματα, για την αντιμετώπιση των τεχνικών δυσκολιών. Σε διερεύνηση των ανωτέρω, διεξήχθη ανασκόπηση της βιβλιογραφίας σχετικά με την ρομποτικά υποβοηθούμενη παρασκευή του κρημνού του πλατύ ραχιαίου μυός για την αποκατάσταση του μαστού.

Υλικό & Μέθοδος: Διεξήχθη ανασκόπηση της σύγχρονης βιβλιογραφίας, στη βάση δεδομένων του PubMed, για τη χρήση της ρομποτικά υποβοηθούμενης χειρουργικής επέμβασης παρασκευής του κρημνού του πλατύ ραχιαίου μυός, για την αποκατάσταση του μαστού. Κατάλληλοι όροι αναζήτησης χρησιμοποιήθηκαν και εφαρμόστηκαν ειδικά κριτήρια ένταξης και αποκλεισμού.

Αποτελέσματα: Πέντε μελέτες πληρούσαν τα κριτήρια. Ανευρέθησαν τριάντα δύο περιπτώσεις, συνολικά, ρομποτικά υποβοηθούμενης παρασκευής του μισχωτού κρημνού του πλατύ ραχιαίου μυός, για την αποκατάσταση μαστού με ενθέματα. Όλοι οι κρημνοί παρασκευάστηκαν επιτυχώς χωρίς να χρειαστεί μετατροπή στην παραδοσιακή ανοικτή μέθοδο. Δεν υπήρξαν ιδιαίτερες μετεγχειρητικές επιπλοκές εκτός από λίγες περιπτώσεις μετεγχειρητικού υγρώματος, οι οποίες αντιμετωπίστηκαν επιτυχώς. Επιπρόσθετα, όλοι οι ασθενείς ήταν ικανοποιημένοι με το μετεγχειρητικό αισθητικό αποτέλεσμα τους.

Συμπέρασμα: Η ρομποτικά υποβοηθούμενη παρασκευή του κρημνού του πλατύ ραχιαίου μυός για την αποκατάσταση του μαστού είναι ασφαλής και συγκρίσιμη με τις συμβατικές μεθόδους. Η μικρότερη διαμονή στο νοσοκομείο και το ανώτερο αισθητικό αποτέλεσμα αποτελούν τα κύρια πλεονεκτήματα ενώ το συνολικό κόστος και η δυσκολία της επίτευξης ικανοποιητικού χειρουργικού επιπέδου δια της καμπύλης εκμάθησης είναι τα κύρια μειονεκτήματα σχετικά με αυτή τη μοντέρνα και ελάχιστη επεμβατική χειρουργική προσέγγιση.

Λέξεις Κλειδιά: Ρομποτική, Πλατύς Ραχιαίος, Μαστός, Αποκατάσταση, Παρασκευή.

ABSTRACT

Introduction: 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. Although latissimus dorsi flap harvesting for breast reconstruction has been already used for several years, a plethora of serious complications have been reported. Recently, minimally invasive surgical approaches, such as robotic assisted technique, has been suggested with conflicting outcomes in order to overcome technical difficulties. Therefore, literature review was conducted regarding robotic assisted harvesting of the latissimus dorsi flap for breast reconstruction.

Material & Methods: 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.

Results: 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, except from few cases of postoperative seromas, which were conservatively managed. Additionally, all patients were satisfied with their postoperative cosmetic outcome.

Conclusion: 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.

Ευχαριστίες

Ευχαριστώ θερμά όλους τους καθηγητές, διδάσκοντες και προσωπικό του Π.Μ.Σ. “Ελάχιστα επεμβατική χειρουργική, ρομποτική χειρουργική και τηλεχειρουργική” για την ευκαιρία να γνωρίσω την ρομποτική χειρουργική, διευρύνοντας τους ορίζοντες μου και αποκτώντας μια ιδιαίτερα σημαντική γνώση για την εξέλιξη της σταδιοδρομίας μου.

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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 outcomes 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 and breast reconstruction with pedicled flaps were needed [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 quadrantectomy 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 reproducible 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.

CONCLUSION

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.

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APPENDIX A

Online Search Terms (Medline)

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

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

APPENDIX B

Table: Included studies related to use of Robotic-assisted harvesting of latissimus dorsi muscle flap for breast reconstruction

Authors	Year	Study design	Intervention	Conclusions
Selber et al	2012	Case Series	Pedicled flaps for BR	Very good results. Less scar the main advantage. Cost is a drawback but could be balanced.
Clemens et al	2014	Case Series Retrospective review. Comparison of robotic vs. conventional technique	Pedicled latissimus dorsi flap for BR (12 after breast radiation)	Less time in conventional technique. Less hospital stay, complications & scar in robotic technique.
Chung et al	2015	Case Series	Transaxillary gasless robotic assisted latissimus dorsi muscle harvest for BR.	Overall & cosmetic satisfaction. Time of robotic system usage decreases with experience.
Lai et al	2018	Case report	Robotic assisted quadrantectomy & immediate partial BR with RLDFH	Cosmetic result quite good. Satisfied patient. Less scar. More time than conventional method.
Lai et al	2018	Case report	Robotic NSM & immediate BR with RLDFH	RLDFH is most beneficial for small- to-medium-breast-sized women with early breast cancer indicated for NSM & desiring autologous BR.

BR= Breast Reconstruction; RLDFH= Robotic latissimus dorsi flap harvest; NSM= Nipple sparing mastectomy.