OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE
Technology

Docking Methods for Robot-assisted Rhytidectomy and Platysmaplasty

Anastasiya S. Borisenko, MD, PhD
Valentin I. Sharobaro, MD, PhD
Alexey E. Avdeev, MD, PhD
Yousif M. Ahmed Alsheikh, MD

Background: In recent years, the development of robotic surgery has been rapidly evolving as well as the interest in their use due to the advantages they provide, such as precision in dissection, the ability to magnify the visualization of the operative field up to 20:1, and the ability to operate in hard-to-reach areas that otherwise cannot be achieved using the traditional methods. Research is being published constantly on the utilization of such robots within the fields of general surgery, oncology, and urology, with few cases in maxillofacial surgery.
Methods: There are no docking algorithms or methods for plastic surgery operations, especially those involving the head and neck area. In this article, we explore different docking methods with da Vinci Si, Xi, and 5 surgical systems for aesthetic facial and neck surgery.
Results: The results of the multiple different techniques used highlighted a few possible access points, whereas others were deemed impractical due to certain limitations such as the limited maneuverability of the robot's arms, the angles required for safe access, and the patient's body limiting the movement of the robot. Da Vinci 5 comes with significant advantages compared with its predecessors due to its novel and improved technologies, such as force feedback technology and artificial intelligence greatly enhancing the robot's usability.
Conclusions: Robotic surgery is a viable operative method that is beneficial for improving the outcomes when using the appropriate docking methods. *(Plast Reconstr Surg Glob Open 2025;13:e6733; doi: 10.1097/GOX.0000000000006733; Published online 24 April 2025.)*

INTRODUCTION

Robot-assisted surgery is a minimally invasive approach that minimizes trauma, improves precision during operations, and enhances surgical outcomes. It has been used in many fields, including general surgery, oncology, and urology; unfortunately, not within the field of plastic surgery. There have been no docking algorithms or methods for plastic surgery operations, especially those involving aesthetic surgery in the head and neck area.

Robotic systems consist of multiple arms equipped with instruments and a camera, which are controlled by a surgeon remotely using a console. These systems need to be docked correctly, which involves precise positioning of the robot and arms at the desired surgical site to ensure safety and ease of maneuverability.

From the Department of Plastic Surgery, I.M. Sechenov First Moscow State Medical University, Moscow, Russia.

Received for publication August 7, 2024; accepted March 11, 2025.

DOI: 10.1097/GOX.0000000000006733

Following multiple robotic simulation exercises at the Simulation Center of Botkin Hospital, Moscow, as well as tests on silicone body parts, the authors have explored all the possible docking variants that would apply to real-life patients to create algorithms that can be used by other surgeons to access these anatomical structures safely.

A comparison of the different da Vinci robots is necessary, such as da Vinci Si; da Vinci Xi; and the newest version, da Vinci 5, which has been examined by the authors at the Intuitive Headquarters in Sunnyvale, California, because differences in the trocar's size, instrument length, force feedback technology (sensitivity of the robot to the surrounding tissue), artificial intelligence, Firefly technology, and orientation and flexibility of the robot's arms will affect the docking methods used on hard-to-reach areas such as the head and neck (Table 1).

The authors of this article concluded that, due to the da Vinci 5 orientation, the ability to turn 360 degrees around the central point, and the smaller trocar size and instruments, the docking methods should be significantly easier to achieve with such characteristics. As for the da Vinci Xi version, it shares some characteristics with the da Vinci 5 version; however, the technology used in the da

Disclosure statements are at the end of this article, following the correspondence information.

Vinci 5 is far superior to that of da Vinci Xi, which would also result in changes to the docking algorithms.

These docking methods were then utilized in an abdominoplasty operation with cholecystectomy, which proved to be successful in providing a safe working space while simultaneously improving aesthetic results.

For the first time, we have set out to establish the basis for the docking algorithms for the da Vinci robot systems within the field of plastic surgery.

Takeaways

Question: Our study focuses on creating standardized docking algorithms for surgical robots, such as the da Vinci system, to ensure safe and effective aesthetic plastic surgery.

Findings: Our study demonstrated the feasibility of using da Vinci robots in aesthetic plastic surgery by developing and validating multiple docking methods. The research involved practical trials that identified successful and unsuccessful docking techniques.

Meaning: This study establishes new standards for using surgical robotic technology in aesthetic plastic surgery, offering validated methods for safe and effective procedures.

MATERIALS AND METHODS

The patient, a 67-year-old woman, was admitted to the Plastic Surgery Department at Sechenov University for a comprehensive evaluation and planned facial rejuvenation procedures. She complained of sagging facial skin, deep creases under her eyes and from the nose to the mouth corners, prominent jowls, and banding around the neck, which are often addressed with platysmaplasty. Additionally, she experienced drooping of the forehead and eyebrows, indicating the need for a brow lift, as well as puffiness under the eyes, indicative of the need for blepharoplasty. To address facial sagging, a rhytidectomy was planned to tighten the facial skin and reduce the appearance of wrinkles and jowls. Physical examination revealed a finely wrinkled skin type with poor elasticity. Further observations included a high hyoid bone and insufficient chin protrusion, whereas her submandibular gland was properly positioned without any ptosis (Fig. 1). A surgical plan was made to perform rhytidectomy, platysmaplasty, brow lift, and blepharoplasty using advanced robotic techniques with preplanned docking to achieve the optimal aesthetic outcomes. The patient was placed in a supine position on the operating table. A da Vinci Si surgical system was used in a closed operation using gas, utilizing 3 of the robot's arms, which included a camera and 2 instruments.

During the rhytidectomy, platysmaplasty, brow lifting, and blepharoplasty operation, the team of plastic surgeons established 5 different access points for the docking process by using 5 different incisions, including hairline incisions, supraauricular incisions, infraauricular incisions, supraclavicular incisions, and a submental incision (Fig. 2). The previously mentioned access points were then compared with one another to assess their effectiveness, ease of use, and safety on the area to be operated on.

Robotic brow lifting was previously done[1] using 5 different incision points in front of the hairline horizontally: "The dissection plane was under the temporoparietal fascia in the temple and under the periosteum in the forehead with periosteum division at the upper orbital rim via 5 ports as described by Ramirez." In our case, we have established 2 access points into the hairline from the right and left sides to minimize scarring and to ensure that the postoperative scars are not visible.

Docking Methods for Brow Lifting

Regarding the brow lifting part of the operation, the 2-access-point method was sufficient to access the forehead with the robotic instruments from both sides, providing a comfortable working space for the surgeon and for the robot's arms to be freely maneuvered.

Docking Methods for Rhytidectomy

For the rhytidectomy part of the operation, the most reliable docking method was by inserting the camera and 1 instrument through the infraauricular incisions while the second instrument was inserted using the supraauricular incision. The combination of these access points provided a comfortable working space, which allowed for the ease of maneuverability of the robot's arms. However, inserting the camera and an instrument using the supraauricular incision did not provide the same maneuverability as the aforementioned method, because the orbital region would limit the angle required to access and view the more medial parts of the face (Figs. 3, 4). The dissection is subcutaneous and follows similar steps to the traditional techniques based on the surgeon's preference and the patient's needs. The excess skin is then excised using traditional methods.

Docking Methods for Platysmaplasty

The docking method for platysmaplasty proved to be more complicated because many factors play a role in the ability to maneuver the arms, including the operation table; the length and width of the instruments; the patient's body mass index; and anatomy such as the breasts, shoulders, and the length of the neck relative to the shoulders, which in certain patients may block or limit

Table 1. Comparison of da Vinci Robots and Their Properties

Robot	Instrument Size, mm	Artificial Intelligence	Sensory Feedback Technology	Firefly Technology
da Vinci Si	8	None	None	None
da Vinci Xi	5 and 8	None	None	None
da Vinci 5	5 and 8	Available	Available	Available

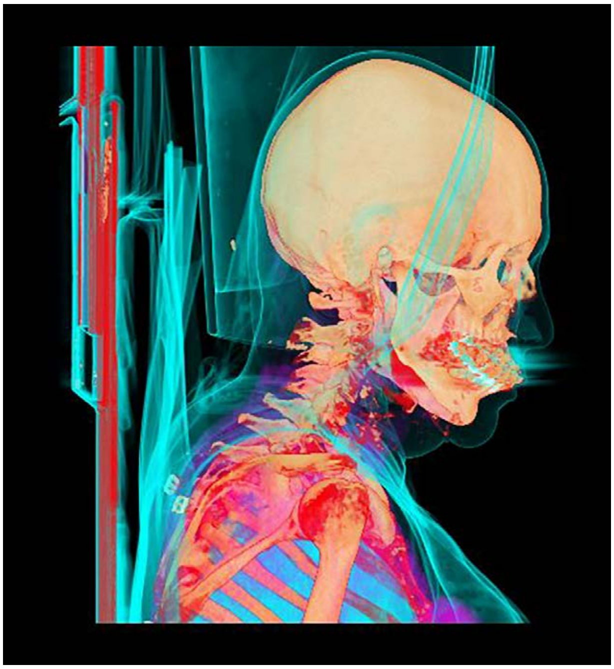

Fig. 1. The computed tomography scan of the 64-year-old patient reveals a high hyoid bone. All soft tissues are located supraplatysmal, and there is a noted ptosis of the submandibular gland. The patient exhibits fine wrinkled skin and age-related changes such as hyper elastosis, along with signs of photoaging and chronological aging. In both frontal and side views, pronounced marionette lines are evident. The proportions of all 3 facial segments are balanced, with sagging skin presenting an obtuse angle. The chin projection is adequate, and there is a presence of supraplatysmal fat.

the movement of the arms, making it more difficult and risky to operate.

(A) The first docking method used was by inserting the camera through the supraclavicular incision and the 2 instruments through the infraauricular incisions. This method required lowering the head of the patient to ensure the ease of movement of the arms. However, the patient's breast and shoulders were limiting the view and movement of the camera, making it difficult to operate, thus making it a more suitable choice for accessing the anterolateral parts of the platysma in slimmer patients who do not require any resection of the submandibular glands, as well as in older patients with fine, wrinkled skin and redundant skin that requires a wider dissection area.

(B) The second docking method used was by inserting the camera through the submental incision and the 2 instruments through the infraauricular incisions. This method limited the view and made it more difficult to operate, because viewing the platysma from the submental region required the patient's head to be lowered even further, causing the throat to protrude at a sharper angle, necessitating the instruments to be repositioned to a more acute angle, which could overstretch and damage the skin. There are important factors that need to be considered with such an access point, including the maneuverability of the operating table and the ability to move the headrest; other factors include the width of the shoulders, length of the neck, the size of the breast, the amount of excess skin, and skin quality, all of which are important to consider

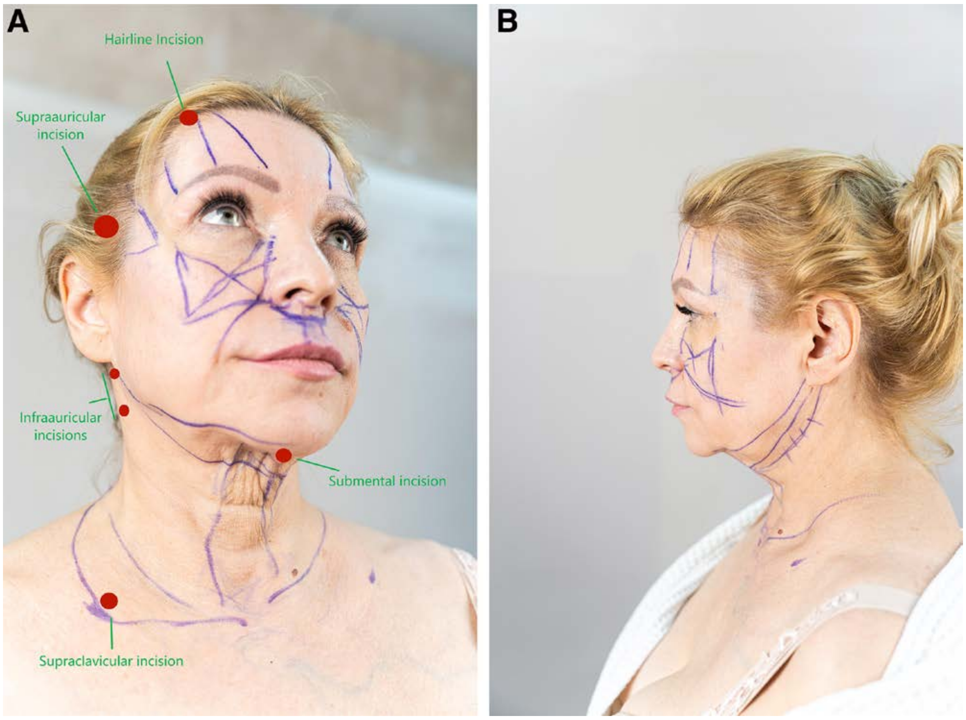

Fig. 2. Markings before the operation indicating the access points. A, Measurements and incisions. B, Measurements.

Fig. 3. Rhytidectomy access.

Fig. 4. Clear picture of the face lift access.

when using the submental access. We can use the submental access in combination with contralateral instrumental access when the focus is on the medial part of the neck. As for the lateral parts of the neck, ipsilateral instrumental access is preferable.

(C.1) The third and most promising docking method was by inserting the camera and 1 instrument through the infraauricular incisions with the second instrument inserted through the supraclavicular incision from the side of the camera. This variant provided the safest and most easily accessible working space on the platysma (Fig. 5).

(C.2) A second variant of this docking method involved inserting the camera through an infraauricular incision, with both instruments inserted on the other side through the infraauricular and supraclavicular incisions. This method required the patient's head to be turned toward the camera side.

(C.3) Finally, a third variant to this method would be by inserting the camera through the infraauricular incision, with both instruments inserted through both supraclavicular incisions (Figs. 6–8).

RESULTS

The following docking methods proved to be the most reliable in providing the safest and most comfortable access for the surgeon and the robot.

Fig. 5. Platysmaplasty access C.1.

Fig. 6. Platysmaplasty access C.3 with gas.

Fig. 7. Platysmaplasty access C.3 with gas during dissection.

Recommended access points of brow lift: 1 instrument and a camera on the side of the forehead to be operated on via the mid-hairline incision point, and 1 instrument via the opposite incision. This docking method is recommended for all patients.

Recommended access points for rhytidectomy: 1 instrument via the supraauricular incision, a camera, and 1 instrument via the infraauricular incisions. This docking method is recommended for younger patients for the lifting of the middle zone.

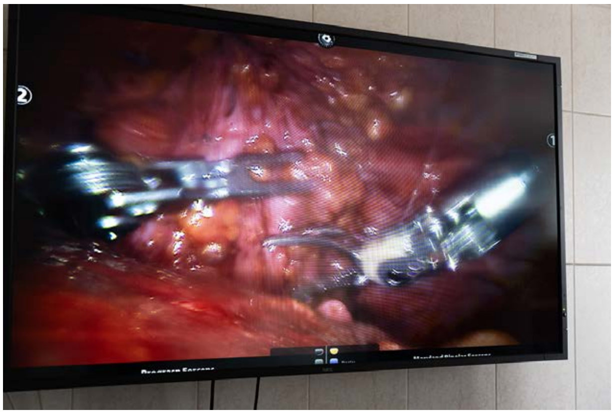

Fig. 8. Dissection under gas.

Fig. 9. Anteroposterior view of the results 6 months after the operation.

Recommended access points for platysmaplasty: 1 instrument and a camera via the infraauricular incisions, and 1 instrument via the supraclavicular incision on the side of the camera. A second variant involves inserting the camera via the infraauricular incision, with 2 instruments via both sides of the supraclavicular incisions. Both methods are effective, and the choice will be based on the surgeon's preference. This docking method is recommended for patients with deformative skin type and good elasticity, 45–55 years of age, who have an anatomically high hyoid bone with no ptosis of the submandibular gland and good skin turgor.

Fig. 10. Three-quarter view of the results 6 months after the operation.

As for the supraclavicular docking method with the camera via the supraclavicular incision and 2 instruments via the infraauricular incisions, it is recommended for slimmer, finely wrinkled skin-type patients who do or do not require any resection of the submandibular glands but have excess skin redundancy that requires a bigger area of dissection. These docking methods are applicable to all versions of da Vinci robots. However, da Vinci 5 comes with significant advantages compared with its predecessors due to its improved orientation, in addition to its ability to rotate 360 degrees and its new state-of-the-art technologies that would allow for safer usage of the robot (Figs. 9–11).

DISCUSSIONS

Over the past 20 years, robotic operations have become routine procedures in many surgical fields, with the exception of plastic surgery.[2] The outcomes of a series of robotic operations are limited by an insufficient number of observations,[3] especially between the years 2004 and 2016, when only a few articles in the global literature discussed the use of robotic technology in abdominal and oncological operations,[4,5] as well as urological operations,[4,6] but not in aesthetic plastic surgery.

In 2014, an intriguing article was published on the practice of robot-assisted cosmetic surgery on cadaveric material.[7] In 2016, the first prospective randomized controlled trial was published, demonstrating a comparative assessment of the outcomes of cholecystectomy using

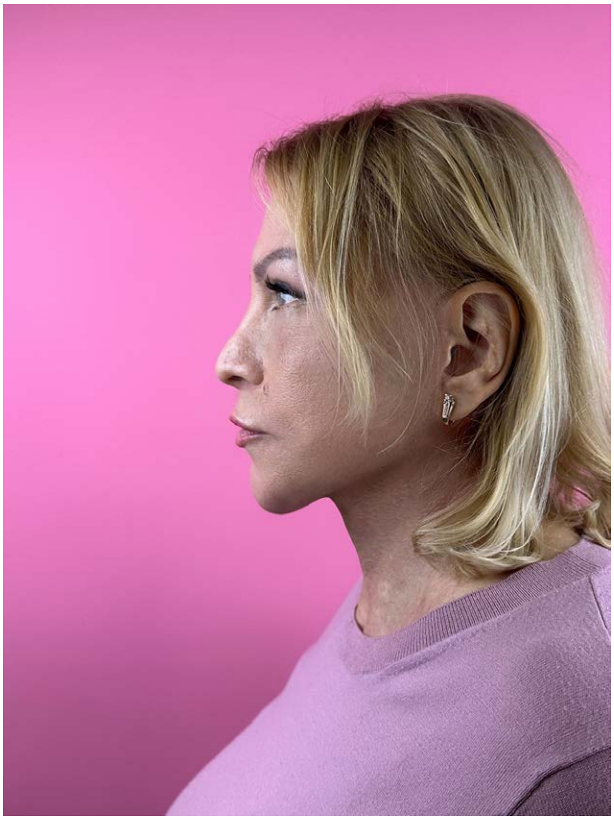

Fig. 11. Lateral view 6 months after the operation.

robotic and laparoscopic techniques in which the robotic technique has led to higher patient satisfaction due to improved cosmetic results and body image perception.[8]

In the same year, Ryabkin et al[1] utilized robotic tools while performing a forehead lift at the tissue dissection stage and noted the absence of specialized instruments for aesthetic surgery. However, by 2017, Nehme et al[9] highlighted in their review article the advantages of using robots in reconstructive plastic surgery during combined operations. They emphasized the enhanced aesthetic outcomes and high satisfaction between both patients and surgeons.[9] To date, we have found publications on robotic mini-abdominoplasty[10] and neck rejuvenation with open dissection using a robot on a limited number of patients,[4,11,12] and in heterogeneous groups by body mass index, which prevents an objective justification for the choice of the surgical method used.

The docking methods we set to establish in this article will make sure that other surgeons can reliably replicate the results of our findings, leading to a shorter docking phase while preserving the safety of these access points. Compared with traditional methods, the robotic method can ensure better outcomes by clearly visualizing the operative field under camera vision, that way we can ensure a more precise dissection while maintaining good hemostasis. The minimally invasive nature of this method will also ensure less trauma to the skin; smaller incision scars, which is an important factor for patients concerned about scarring; and overall fewer postoperative complications.

For us, the benefits of robot-assisted operations in plastic surgery are evident: precision in dissection, the ability to magnify the visualization of the operative field up to 20:1, the ability to operate in hard-to-reach areas without extensive incisions, and a shorter rehabilitation period are all obvious benefits of such technology. As for the da Vinci 5 system, the 10,000× computing power combined with artificial intelligence for machine learning; force feedback technology for safer navigation of the arms and their maneuverability during surgery; and the Firefly fluorescence imaging technology, which is an integrated fluorescence capability that uses near-infrared technology to help surgeons navigate and identify the key landmarks in real time as well as the orientation of the robot, are all factors that will have a huge impact on the safety and effectiveness of the operations.

Several authors highlight the advantages of using robotic technology for performing combined operations aimed at removing neoplasms with aesthetic corrections of nearby body areas.[6,13–15] For example, procedures aimed at removing neoplasms in the maxillofacial area combined with aesthetic rejuvenating procedures on the neck. An unconventional surgical plan with minimally invasive access in inconspicuous areas of the body, such as behind the ear, in the axillary fold, and intraoral access, was justified everywhere.[12,14–16] The focus was on achieving better functional and aesthetic outcomes for patients.

Along with the undeniable advantages of using robots, there are also disadvantages:

1. High cost of consumable materials.
2. The necessity to master a specialized technique for operating the robot, which requires a lengthy training period.
3. When working with robotic instruments, there is a lack of tactile sensations and feedback upon contacting tissues in the operative field.[1,5,17,18]

Thus, selecting the “ideal” patient for such operations remains a pertinent issue.

When indications for surgery are present, the use of robotic technology is justified in cases where the cost of consumables is warranted, and the minimization of trauma perfectly aligns with high evaluations of the aesthetic outcome, fully meeting the expectations of both the surgeon and the patient. Further progress in robotic systems, such as da Vinci 5 will open new possibilities to get better results in aesthetic facial and neck surgery.

CONCLUSIONS

The authors of this study aim to establish the world’s first docking algorithms for robot-assisted operations in the field of aesthetic plastic surgery. To this day, there have not been any standardized docking algorithms and methods for such operations, leaving a gap that needs to be researched and explored further to help innovate and develop the field of robotic plastic surgery.

With the ever-growing acceptance of robot-assisted surgery, the authors of this article believe that da Vinci 5 has the potential to unlock new horizons with the benefits it could add to the field of aesthetic plastic surgery by using its state-of-the-art capabilities. This is just the beginning of a series of docking algorithms intended to set the basis for robot-assisted plastic surgery.

Anastasiya S. Borisenko, MD, PhD
Department of Plastic Surgery
I.M. Sechenov First Moscow State Medical University
Trubetskaya str., 8-2
Moscow 119992, Russia
E-mail: dr_borisenko@mail.ru
Instagram: @dr.anastasia.borisenko

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

PATIENT CONSENT

The patient provided written consent for the use of her image.

REFERENCES

1. Ryabkin AV, Borovikov AM, Manturova NE, et al. Robotic-assisted upper face rejuvenation. *Plast Reconstr Surg Glob Open.* 2016;4:e747.
2. Aitzetmüller MM, Klietz M-L, Dermietzel AF, et al. Robotic-assisted microsurgery and its future in plastic surgery. *J Clin Med.* 2022;11:3378.
3. Moglia A, Georgiou K, Georgiou E, et al. A systematic review on artificial intelligence in robot-assisted surgery. *Int J Surg.* 2021;95:106151.
4. Gutt CN, Oniu T, Mehrabi A, et al. Robot-assisted abdominal surgery. *Br J Surg.* 2004;91:1390–1397.
5. Kang S-W, Lee SH, Ryu HR, et al. Initial experience with robot-assisted modified radical neck dissection for the management of thyroid carcinoma with lateral neck node metastasis. *Surgery.* 2010;148:1214–1221.
6. Sung GT, Gill IS. Robotic laparoscopic surgery: a comparison of the da Vinci and Zeus systems. *Urology.* 2001;58:893–898.
7. Taghizadeh F, Reiley C, Mohr C, et al. Evaluation of robotic-assisted platysmaplasty procedures in a cadaveric model using the da Vinci surgical system. *J Robot Surg.* 2014;8:63–71.
8. Kudsi OY, Castellanos A, Kaza S, et al. Cosmesis, patient satisfaction, and quality of life after da Vinci Single-Site cholecystectomy and multiport laparoscopic cholecystectomy: short-term results from a prospective, multicenter, randomized, controlled trial. *Surg Endosc.* 2017;31:3242–3250.
9. Nehme J, Neville JJ, Bahsoun AN. The use of robotics in plastic and reconstructive surgery: a systematic review. *JPRAS Open.* 2017;13:1–10.
10. Correa MAF. Minimally invasive robotic abdominoplasty. *Adv Plast Reconstr Surg.* 2017;1:82–90. Available at https://scholar.archive.org/work/imxhnodkz5a7vaf7m5xuydaciy/access/wayback/https://applispublishers.com/wp-content/uploads/2017/05/APRS-01-000118.pdf.
11. Mohamed SE, Saeed A, Moulthrop T, et al. Retroauricular robotic thyroidectomy with concomitant neck-lift surgery. *Ann Surg Oncol.* 2015;22:172.
12. Park YM, Lee WJ, Yun IS, et al. Free flap reconstruction after robot-assisted neck dissection via a modified face-lift or retroauricular approach. *Ann Surg Oncol.* 2013;20:891–898.
13. Kandil E, Saeed A, Mohamed SE, et al. Modified robotic-assisted thyroidectomy: an initial experience with the retroauricular approach. *Laryngoscope.* 2015;125:767–771.
14. Hurtuk AM, Marcinow A, Agrawal A, et al. Quality-of-life outcomes in transoral robotic surgery. *Otolaryngol Head Neck Surg.* 2012;146:68–73.
15. Koh YW, Chung WY, Hong HJ, et al. Robot-assisted selective neck dissection via modified face-lift approach for early oral tongue cancer: a video demonstration. *Ann Surg Oncol.* 2012;19:1334–1335.
16. Selber JC, Robb G, Serletti JM, et al. Transoral robotic free flap reconstruction of oropharyngeal defects: a preclinical investigation. *Plast Reconstr Surg.* 2010;125:896–900.
17. Turchetti G, Palla I, Pierotti F, et al. Economic evaluation of da Vinci-assisted robotic surgery: a systematic review. *Surg Endosc.* 2012;26:598–606.
18. Pugin F, Bucher P, Morel P. History of robotic surgery: from AESOP® and ZEUS® to da Vinci®. *J Visc Surg.* 2011;148:e3–e8.