Incorporating Robotics into a Plastic Surgery Practice

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Benefits of Robotic Plastic Surgery

Robotic-assisted surgery may still be fairly new to the field of plastic and reconstructive surgery, but some of its benefits may already be apparent to both new and established practices, including the improvement of patient outcomes, recruitment of new patients and referring physicians, attention of media or the parental institution, and broadening the surgeon's skills to prepare for the future.

It would certainly be enticing to any physician to have the opportunity to improve their patient outcomes. For example, robotic-assisted rectus abdominis harvest leads to decreased scar burden, pain, hospital stay, and return to work [1]. Not only could this benefit a physician's existing practice, but this prospect also means that a practice offering robotic surgery could increase its patient recruitment and new patient interest. Even if the interested patients turn out not to be candidates for the surgery, the availability of diverse procedures may make the physician's practice more desirable in a field of dense competition.

Similarly, the availability of technologically advanced procedures could be enticing to a new pool of referring physicians, particularly those who may be using robotic-assisted surgery in their own specialties. For example, if a colorectal surgeon is able to use robotic surgery to perform an abdominoperineal resection (APR) and therefore avoid a laparotomy scar, then it would be ideal if the reconstructive surgeon could also use a minimally invasive approach to perform reconstruction, for example, with a robotic-assisted pedicled rectus abdominis muscle flap. Even those

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referring physicians who do not perform robotic surgery may become more interested in a plastic practice that seems open to innovation and advanced procedures.

In addition to recruiting business from new patients and referring physicians, robotic surgery could bring attention to the plastic surgery practice in a broader sense. Media interest is often focused on innovation in medicine. Not only can surgeons attract outside interest to their own practice, but if they are affiliated with a hospital or academic center, then also to the parent institution. In those cases, there may be new opportunities for academic or financial promotion. If the hospital is supportive of innovation, then they may provide further support of the physician's technological pursuits in return, creating a synergistic and mutually beneficial relationship.

Finally, learning the robotic technique is an opportunity for any plastic surgeon to broaden his/her own perspective and learn new techniques. Plastic surgeons, in particular, should be malleable in an age of change and keep up with the demands of younger generations who may begin to seek their care. No practice should become stagnant, and new technology can push the surgeon to learn new skills and ways of thinking. Even if the robot is not practical for a particular surgeon's practice, understanding its indications is beneficial to any patient-physician discussion, and possibly even referral to another colleague if indicated. There is something honorable about offering the best care for a patient, even if it means losing a financial opportunity. Most importantly, learning new techniques and embracing technology mean that the plastic surgeon is more prepared for the ever-changing field of medicine. It may be possible to ignore these changes in the short term, but not in the long run as the surrounding world shifts its views.

Feasibility of a Robotic Practice (US Perspective)

Once a surgeon has decided that robotic surgery is an interest to pursue, it is important to consider whether it is practical to incorporate it into a plastic surgery practice. There are many factors to consider:

1. *Indication*

   Currently, the Da Vinci robot has seen applications to the field of plastic surgery through transoral head and neck surgery, muscle flap harvest (latissimus dorsi or rectus abdominis), and microsurgery/lymphatic surgery [2]. Emerging research includes robotic-assisted mastectomy and reconstruction [3, 4]. The future is limitless. However, prior to embarking on a commitment to such a large venture, the physician should have a clear idea of what kind of procedures will be in demand in the practice. This may be related to the surgeon's referral sources or patient population. For example, if one works with many otolaryngologists, then there may be a need for transoral robotic flap reconstruction. Alternatively, if the plastic surgeon has a large breast cancer population, then it may be useful to have the robotic-assisted latissimus dorsi flap as part of his repertoire.

Supermicrosurgery is one indication that may be an ideal concept for the robotic practice. The benefits are obvious with elimination of tremor and the motion scaling for operations on extremely small structures [5]. Lymphovenous anastomosis (LVA) is currently the most common supermicrosurgical procedure, and robotic LVA is in the process of making its way to the market (Fig. 10.1). However, the optics and instrumentation of the Da Vinci robot still require some development and optimization before it can be useful in a supermicrosurgical application. Other systems marketed overseas have expeditiously targeted this market with some success, but if the surgeon is planning on a US-based practice, then this would not be realistically accomplished at this time.

2. *Availability*

Depending on the location and type of hospital system in which the physician is working, access to a robot may be a limiting factor. The robot is of a price tag of $1–2 million US dollars [6], and therefore no physician newly entering the field would have the resources to acquire one individually. Therefore, most interested physicians would need to use one that is readily available in their hospital. While urban hospitals tend to have a higher quantity of these systems already in their institution, this does not necessarily mean that they are available for sharing. Large academic institutions have many urologists, gynecologists, and general surgeons fighting for time with the machines, and therefore may be restricted to a new physician requesting it. On the other hand, smaller community hospitals, if they happen to have a machine, may have one that is not fully utilized and may be happy to make better use of their investment with additional participants. This is highly variable at each institution and is up to the plastic surgeon to research the details. This can become even more complex if the new surgeon requires additional training prior to beginning practice, as he would then need to find a location where a robotic simulator is available.

Finally, it is not only the machine or equipment that is necessary, but also trained robotic operating room staff. Unless the hospital already has the staff readily available from their work with other departments (and are willing to share), the surgeon may need to train his own staff, or at the very least request

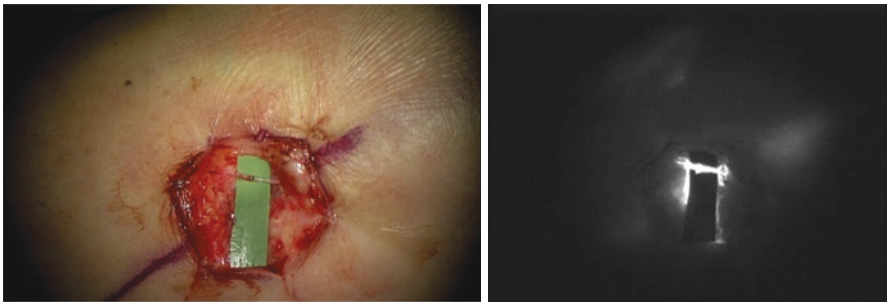

Fig. 10.1 A hand-sewn LVA of 0.7 mm with ICG passing through the anastomosis, a procedure suitable for future robotic microsurgery

representative support from the device company. It is important to note that often these companies will not offer support to non-FDA-approved procedures, even if the machine itself has been approved for use.

3. *Training*

   Since robotic surgery is not an established sub-specialty within the field of plastic surgery, it is up to each individual surgeon to seek out training in this domain. This means that he would need to find an apprenticeship with one of the few established robotic plastic surgeons, or learn the technique on his own. This is much more difficult, as this would require not only access to a robotic simulator, but possibly also a robotic animal or cadaver lab in order to practice robotic skills prior to operating on live patients. Finally, it is important to keep in mind that no simulator can replace expert guidance, clinical experience, and feedback.

4. *Credentialing/hospital approval*

   Similar to training, credentialing is quite tricky in this field due to the lack of established protocol. Factors to consider are both governmental regulations and institutional regulations. Smaller community hospitals may offer more flexibility in this case than larger academic centers, which have more regulations, administration, and red tape. In general, hospitals in the United States will require at the minimum: proof of machine proficiency (certificate offered by Intuitive Surgical), a case log of patients who have been operated on during training, and either fellowship certificate or other equivalent document from a proctor who can attest to the requesting physician's safety and efficacy using this technique. Alternatively, those physicians who are not able to learn through a mentor would need to apply for institutional review board (IRB) or investigative device exemption (IDE) approval in order to practice this technique on animals or cadavers prior to getting temporary privileges for patient interaction.

5. *Support*

   Just because the hospital approves of the surgery, this does not mean that the system will support the physician's endeavors. Both administrators and other surgeons may see the robotic plastic surgeon as an inconvenience or even a threat to their current status quo. There is often pushback from other services utilizing robotic time, so the surgeon may need to search for other nearby facilities were the robotic time is not monopolized. Shockingly, one might even find resistance from his/her own plastics department, as older surgeons feel threatened by new technology and a competing practice that appears to be more advanced than theirs. Finally, the surgeon may even find negative feedback from their own institution despite bringing in positive publicity, due to pressure regarding utilization of equipment and financial resources.

6. *Financial*

   The next most important question in feasibility is whether it is even *worth* it to add this endeavor to a plastic surgery practice. Note that in the United States, there is currently no robotic CPT code or modifier for plastic surgery cases, although this is likely on its way. The only option for additional reimbursement would be to use the code for "additional complexity" which is not always accepted by the insurance company. Therefore, there may be no additional

financial compensation for performing this longer and more complex procedure on the professional fee side. If one is lucky enough to have a cash-only practice and willing patients, then this may be a worthwhile financial endeavor on a case-by-case basis. However, as mentioned above, the broadening of new prospects among patients, physicians, and institutions has an immeasurable price. On the technical fee side, ORs in which the robot is utilized are reimbursed at a higher rate than regular operating rooms. This means that the facility fees are higher in robotic surgery, translating into a higher hospital revenue. Depending on your hospital facility or system, this may make the contribution margin for a robotic procedure higher than a comparable open procedure.

7. *Time/perseverance*

   Since the robotic sub-specialty is still emerging within the field of plastic surgery, this endeavor is a massive undertaking. Interested parties will most likely encounter multiple obstacles on their way to learning the skill and achieving acceptance within their communities. Therefore, it would not be advisable for a clinician with limited time to dedicate to this. It would be best for those who are just starting their practices or who are willing to give up a portion of their established practice in order to cultivate the development of this fledging field.

Feasibility of a Robotic Practice (International Perspective)

The process of incorporating robotics into plastic surgery practice outside of the United States is in many ways similar to what is described above. Each country, culture, and system offers a unique set of practical and cultural challenges that should not be underestimated when deviating from old traditions and introducing new concepts. Some general aspects and perspectives on the challenges of building a robotic practice in a socialized system are as follows:

1. *Indication*

   In a socialized system, patient recruitment is different than in the United States. Referrals are based on diagnosis and hospital uptake area, and cannot be made to individual surgeons unless they are the only ones providing a specific treatment. Therefore, indication for whether to pursue robotics in plastic surgery is primarily up to the motivation of the plastic surgeon. Unlike patient recruitment, introducing a new procedure to the country in question does still take a significant amount of time and effort. One must prove the value of new techniques within the system. If the surgeon is exceptionally interested in starting a new technique such as robotic-assisted plastic surgery, he can start the approval process through research studies or efficacy/cost analysis (see section "Practical Approach to Starting the Robotic Practice" below).

2. *Availability*

   The acquisition of a robot can be a considerable expense. In certain settings, it may be easier to apply for research funds rather than ordinary healthcare funds to acquire a robot. If the surgeon is successful in motivating a consensus about

the need for robotic-assisted plastic surgery, robot access is often provided by the hospital system. However, similar to the US situation, there is a competition between specialties in using the robot. Working together as part of another team and allowing more patients to benefit from minimally invasive surgery, such as is the case in robotic-assisted APRs, allow a fruitful cooperation rather than a competition.

Hospitals are in general required to keep their waiting lists for other "regular" procedures as short as possible or may otherwise be penalized. Operating room time is not as available in a socialized system. The number of hours is set and not very flexible. A longer waiting list or a longer procedure is thus not favorable for a socialized hospital. Therefore, when considering new technology, it is important to keep the procedure efficient.

In terms of equipment, there are many other machines available overseas than compared to the United States, where it is limited to a monopoly. At the University of Maastricht, the robotic LVA is currently being tested using the Microsure robot. Microsure (Holland) has developed a bolt-on system that utilizes optimal operating microscopes and allows the use of regular supermicrosurgical instruments. Medical Microinstruments (Italy) has developed a robotic system with specialized supermicrosurgical instruments. This system is also compatible with high-resolution microscopes and exoscopes. The commercialization of these systems will allow robotic LVA on a wide scale. These robots will likely not have many applications outside of plastic surgery, which decreases the competition for availability but requires the plastic surgeon or department to be financially responsible for the acquisition of these machines. Thankfully, the prices for these robots will likely be considerably less than for the Da Vinci system, favoring an expeditious commercialization process.

3. *Training*

Sound knowledge and experience is the foundation of any practice to provide safe and efficient surgery. As robotic plastic surgery is in its infancy, it is recommended to pursue a fellowship at a known robotic plastic surgery center or some other comprehensive training program to provide a solid foundation, regardless of whether practicing in the United States or overseas.

Robotic plastic surgery offers a mix of microscopic and laparoscopic surgery skills. Mastering these skills separately first is an advantage but not a necessity. In many countries, obtaining highly specialized training with the robot in other specialties than plastic surgery often requires joining a sub-specialty training program other than plastic surgery. This is not always easy to arrange for a plastic surgeon in training and may be considered a waste of time by program directors if the scholar is not intending to stay within the same subspecialty.

For many smaller and isolated countries, a lack of plastic robotic surgery centers means that training under a skilled plastic robotic surgeon as part of a microsurgical fellowship often is not possible without travelling abroad. An ECFMG certificate is required for a non-US resident to get a fellowship in the United States, and the preparations and efforts to obtain such a certificate are substantial and time consuming [7]. This certificate does not allow further

practice in the United States beyond fellowship. A visa will also be needed as well as if planning a microsurgery fellowship match at a location that actually offers robotic plastic surgery [8].

4. *Credentialing/hospital approval*

   When introducing an innovation such as robotic surgery in a socialized system, the focus is often on providing a consensus about the proof of overall benefit for the patient and comprehensively for the health system. The use of limited resources has to be justified. This is often done in a university setting, but it can also be done at a hospital with a strong academic and innovative background if the appropriate knowledge is present. In some countries, a formalized consequence analysis aiming for a 360-degree overview of the topic has to be performed and presented to the administration at the hospital in question. Efficacy of the method, cost, safety, ethical aspects, organizational consequences, training needs, staffing, evaluation of the current premises, current resources, need for investments, possible effects on other departments, patient logistics, number of patients who can benefit from the method, and new referrals from outside of the hospital's uptake region are all factors that are evaluated. A formal literature search has to be performed. The application goes through an independent peer review and also a review by an economic controller before a decision is made by the administration. This structured multistep evaluation process can be a valuable tool in that it offers a structured and clear path for the applicant. However, the process may be lengthy depending on the system. With fairly new methods that show promising results, but where the documentation is somewhat limited, it may be decided that an organized prospective research study may be called for.

   The introduction of a new technique in a socialized system is not easy and requires a supportive and innovation-friendly environment. Willingness of the administration to make an investment in time and funds for the patients to reap the benefits of minimally invasive robotic surgery and robotic supermicrosurgery is crucial. The novel use of the robot must also not interfere with the hospital's compulsory activities. This may incur penalty fees for the hospital. A university hospital setting is often more favorable for innovation.

5. *Support*

   A supportive environment on all levels is crucial. Having the support from a mentor to help start up a robotic program is an invaluable resource both for technical, cultural, and organizational issues. An external mentor, through his connections, may also facilitate the process of being welcomed in certain communities and cultures.

   Another part of networking involves building the team that one will be working with in clinics and in the operating room. The dynamics of these relationships can be very different in different cultures. The experience of the authors is that involving the team in decisions and encouraging team input is always favorable and promotes the end goal. Nurses and operative technicians will have knowledge from procedures in different specialties that very likely can be applied to the plastic surgery procedure. Performing new surgeries that will revolutionize the field of plastic surgery often is associated with a steep learning curve, not

only for the surgeon but also for his team. The operating time will initially be increased and at times "technological stand-still time" has to be expected. It is important to have the team onboard to prevent frustration at these times and to make the surgeries an exciting experience. This kind of "grass-root" support is important. Selber compares the team to a racing pit crew that can be a key part of the surgeon's success [2]. Work with a small team and choose dedicated staff if possible. Showing interest in the logistics of the procedure gives a greater understanding and also shows the team that the surgeon cares about all aspects of the procedure.

Finally, in modern socialized countries, patient-driven demands are generally handled by patient support groups; however, patient choice is more limited than in the United States. Patient support groups can be powerful allies in the process of introducing new techniques.

6. *Financial*

Socialized medicine also uses CPT codes to determine the allocation of funds to treatment and also to incentivize hospitals to provide efficient as well as high quality care. The individual surgeon, however, does not benefit from these codes. As an example, in Norway, the code ZXC 96 "Robot assisted procedures" is a modifier that increases the reimbursement by 29.3–58.6% for the procedure performed. This, of course, is a strong argument for management to support a robotic plastic surgery program.

In addition to the academic acclaim that comes from introducing a novel technique such as robotic-assisted surgery, the possibility of obtaining governmental or other research funds for the introduction of the technique also makes a good incentive for the management.

Practical Approach to Starting the Robotic Practice

Once the interested surgeon has committed to pursuing robotic-assisted plastic surgery, then he/she may consider the following steps:

1. *Learn the technique*

The easiest method is to find an apprenticeship through one of the few specialists in the world whose practice population matches up closest with the practice you are trying to build. Note that most plastic surgeons that participate in robotic-assisted surgery trend toward a narrow scope, such as either latissimus dorsi or rectus abdominis harvest. A secondary possibility is to find a robotic surgeon in a different field, such as urology or general surgery, as a mentor. While the procedures are not the same, a significant portion of the robotic technique is similar, including access and docking. If this were not feasible, then the surgeon would have to seek out a robotic simulator or laboratory. A robotic cadaver laboratory would be preferred, but these are also limited in location and may not be made available to "experimental" surgeons by the device company.

2. *Consider research*

   Instigating a research project is a great way to introduce a new technique to a health care system. Developing new procedures may require that the initial efforts be evaluated in animal labs (with IACUC approval or similar) with a consequent progression to cadaver labs and later to full human operations. When looking for a place to practice robotic surgery, the presence of an animal lab with robotic competence and access to these resources represents a very valuable asset. As the research progresses to human trials, prospective randomized studies are preferable, but may be difficult to establish. In the early stages of a new treatment, simple observational studies are also of great importance and can lead the way for later prospective studies.

   In addition to gathering data for the approval process, part of building an innovative practice is to document and share clinical results. A structured and well-thought-out plan from the start of a new practice will simplify later research efforts and improve their quality. Clinic and operative notes with a structured template can be beneficial for later retrospective studies. Keeping databases and registering data about patients comes with a great responsibility that should not be taken lightly, and often requires IRB approval. Internal audit is also of high importance in the beginning of the introduction of the new technique to provide the surgeon with feedback. Finally, peer reviews are not only of academic interest and self-improvement, but also of value for further building a practice. Today's patients are well oriented about the academic efforts of their surgeon.

   If possible, one should strive toward getting grants from the state, universities, or other neutral funds, and not taking grants from the industry to avoid any conflicts of interest. However, when working with groundbreaking technology, any support and cooperation with a technology partner can certainly help to further the field. In these cases, all conflicts of interest should be clearly stated.

3. *Credential for patient care*

   Once the technique is mastered and appropriate data presented, there are still restrictions to operating on live patients in most countries. If a mentor or fellowship is used, then the hospital usually requires an online certificate from Intuitive Surgical, a case log of patients, and a letter from the fellowship director/mentor validating the competence of the surgeon. If no mentor is involved, most institutions will require an experimental protocol to be approved prior to trying a new technique (see research section above). The surgeon would then be allowed to operate on a set number of patients and the results reviewed to assess for benefit versus harm. Once credentialing is obtained at one institution, particularly if a large and reputable one, then it may be used to support access at other surrounding hospitals as well.

4. *Network and build a team*

   Assuming both the confidence and the credentials to practice are obtained, the next step would be to establish confidence in the community and the team. Surprisingly, newly invented procedures and recently minted surgeons are occasionally not welcomed with open arms in established communities. This may be due to more experienced surgeons not wanting competition, or due to support staff not wanting to learn new protocols. Nevertheless, it is the responsibility of

the plastic surgeon to reach out to these colleagues and promote a positive relationship and hopefully circumvent any bitter sentiments. The first department to reach out to is the one that is currently using the robot the most in the hospital, as they will likely be territorial about their machine access. In most cases, this is urology. Others to consider are gynecology, general surgery, and otolaryngology. It may benefit the surgeon not only in the sense of getting approval for his endeavors, but also to cultivate a relationship for referrals. If colorectal surgery performs a robotic-assisted abdominoperineal resection, for example, then it would benefit the patient to also have a robotic-assisted perineal reconstruction.

Next, it is important to cultivate a relationship with the surgical support staff, that is, nurses and surgical technicians. They may need to be formally trained if not previously familiar with the process, or "borrowed" from another service that routinely performs robotic procedures. Either way, they would have to be notified of the necessary equipment and setup, which takes extra time for them to learn. It is crucial to go over this prior to actually performing the case for the first time. If the device representative is willing to participate (which may not be allowed for new procedures), then they are extremely helpful to the process, particularly for supplies, setup, and trouble-shooting.

5. *Advertise*

   Once the plastic surgeon has a couple of successful cases under his belt, he may be interested in broadcasting the results to the local community. This could lead to benefits both in recruitment of new patients and referring physicians, and in proving to the hospital and community that this is a worthwhile investment. In a large institution, this is as easy as reaching out to the media department and asking for assistance. They can usually offer either a local institutional broadcast of print/electronic news, or utilize their connections with the outside media to promote a larger scope. If no organized media department exists, then the physician may need to personally call local radio or news stations to generate interest. Though this step is not crucial, it certainly is beneficial for the cultivation of a new technology.

6. *Balance finances*

   Certainly, one would expect to operate at a financial loss for the first few cases due to longer times. However, this is not sustainable long term, so it is necessary to figure out the financial aspects of a robotic practice. In a hospital with a robot available for sharing, then the physician mostly has to worry about the robotic instruments, OR time, and staff. The robotic instruments are charged per-use, so it is advisable not to open or equip a certain instrument unless necessary to the case. However, it is also not advisable to use too few instruments if it causes inconvenience for the surgeon, because this would then increase operative time and therefore expense. This is where good planning comes in prior to surgery. The author usually prefers a grasper and a hot scissor to start a latissimus harvest, and a Maryland bipolar if needed for vessel ligation. Occasionally a surgical clip may be needed, but this could be done with a laparoscopic instrument instead of a robotic one. In general, the instrument count does not need to be excessive for most robotic-assisted plastic surgery procedures.

The next item to consider is the operative time. Robotic-assisted surgery has a sharp learning curve. The setup and docking time of the robot is often the largest obstacle. In breast reconstruction with latissimus dorsi, the muscle harvest time has been reported to average 1.5 hour with a range of 1–2.5 hours, as compared to an open technique of 1 hour [9]. The setup time does appear to decrease with experience. Again, preoperative planning and coordination with the team are crucial to a successful first few cases.

Unfortunately, at this time, there is no extra robotic code for the plastic surgeon. As mentioned above, in the United States one could try to use the −22 modifier for "extra complexity," which may or may not be accepted by the insurance company. Currently there is no immediate financial incentive to performing robotic-assisted reconstructions, unless the patients are willing to pay extra themselves. Many independent physicians, physician groups, or medical staff have built in agreements with the hospital that involve some type of revenue sharing. Given that technical charges are higher for the robotic cases, the well-organized and informed physician should be able to realize financial benefit from overall increased contribution margin of the case to the hospital.

Future Challenges

As if the challenge of training, credentialing, research, networking, and organizing finances were not enough, there are plenty of obstacles that may come up during the plastic surgeon's journey to achieve a robotic practice that have not been encountered as of yet. One could imagine litigation, equipment malfunction, competing technologies, and certainly others that we cannot even envision at this time. It is therefore important to maintain perseverance in all these circumstances, and keep in mind that those who do not embrace the future will fall behind!

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