

Online Resources in Plastic Surgery Education: A Toolbox for Modern Trainees and Plastic Surgeons

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Summary: Plastic surgery is a rapidly evolving field that requires novel approaches in providing continuous and dynamic educational resources to address the increasing time and skill demands from residents. Online resources in their various forms, such as books, journals, simulators, and applications, are increasingly used by residents, notably over traditional print and in-person counterparts. In this digital era, it is imperative to understand the scope and utility of online resources that have the potential to revolutionize plastic surgery education. In this review article, we first discuss the current model of plastic surgery education and the challenges of meeting its goals and then suggest reasons by which online resources close this gap. We also offer an exposition on the benefits of distinct types of resources and current trends regarding their use. Our goal is to create a framework within which learners and educators are able to organize online resources in plastic surgery. (*Plast Reconstr Surg Glob Open* 2020;8:e2894; doi: [10.1097/GOX.0000000000002894](https://doi.org/10.1097/GOX.0000000000002894); Published online 17 July 2020.)

INTRODUCTION

Over the past 100 years, graduate education in plastic surgery has been greatly shaped by the classical Halstedian surgery model. In this system, which was pioneered by William Steward Halsted in the late 1930s at Johns Hopkins Hospital, the surgical resident is expected to develop knowledge of basic sciences, productivity in research, and independent operating responsibility in a graduated fashion.^{1,2} This principle has forged the curriculum of surgical education across the nation. The American College of Surgeons states:

The foundation of surgical anatomy, physiology, pathology, and other basic sciences is fundamental to this specialty. Competency in plastic surgery implies a special combination of basic knowledge, surgical judgment, technical expertise, ethics, and interpersonal skills in order to achieve satisfactory patient relationships and problem resolution.³

Given the almost doubling of available plastic surgery postgraduate year 1 positions in the United States from 69

in 2010 to 130 in 2014, it is imperative to scale the access for quality plastic surgery education resources for the next generation of plastic surgeons.⁴ Recently, the role of online resources has shown promise to expand the traditional training of plastic surgery residents in a modern, easily accessible way, which is able to keep pace with the latest innovations in the field.

The goal of this study was to provide a review of available online resources in plastic surgery, their benefits, and current data regarding their use among plastic surgery trainees, including students, residents, and fellows. We hope to provide a framework that can be used as a reference to organize resources and supplement educational goals (Fig. 1).

LIMITATIONS OF THE CURRENT SYSTEM AND RATIONALE FOR CHANGE

Given physicians' extensive reliance on electronic technology to supplement their knowledge base, it is worth reexamining the role of traditional learning tools in graduate education. In a survey of 447 resident/fellow members of the American Society for Aesthetic Plastic Surgery (26.2% response rate) that evaluated preferred types of educational resources, textbooks were used on a weekly basis by 34% of residents, whereas content from the Plastic Surgery Education Network demonstrated weekly use of textbooks by 42% of residents. In addition, when comparing resources that were used daily, 45% of residents reported using an electronic version of a textbook versus <20% reported using printed textbooks.⁵ Thus, it is imperative to make known the broader range

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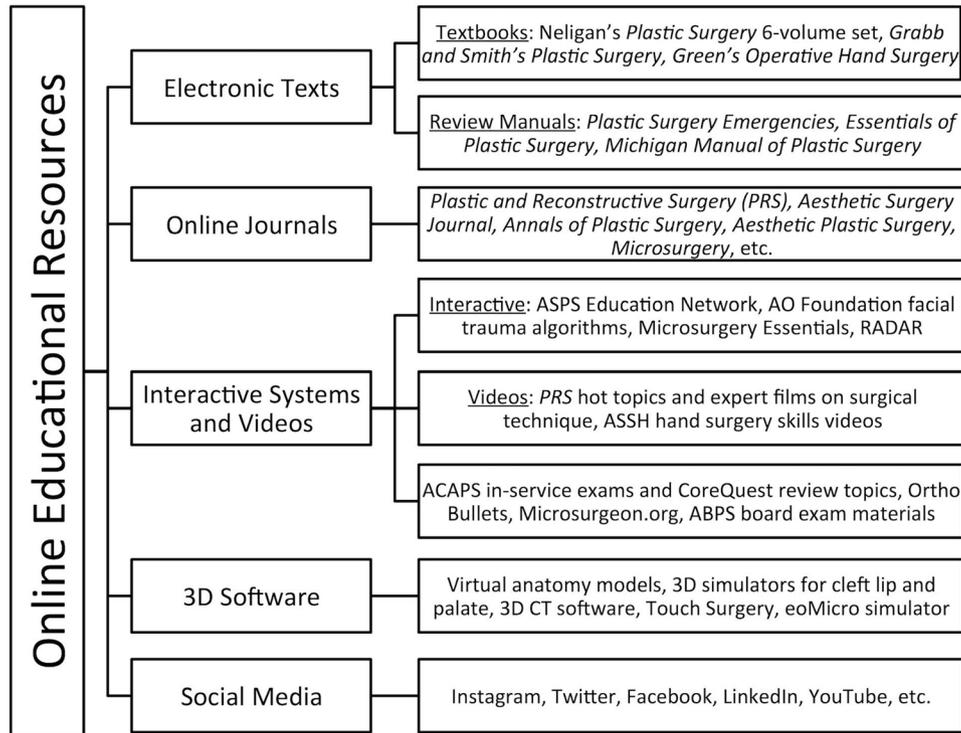


Fig. 1. Map of educational materials available online. Trainees can use this map to find the content they are seeking and to organize resources. 3D, three-dimensional; ABPS, American Board of Plastic Surgery; ACAPS, American Council of Academic Plastic Surgeons; ASPS, American Society of Plastic Surgeons; ASSH, American Society for Surgery of the Hand; CT, computed tomography; RADAR, Readily Available Digital Aesthetic Resource.

of online resources readily available to plastic surgery residents to supplement their education.

In addition to textbooks, grand rounds and conferences have long been a mainstay of resident education. Grand rounds typically consist of a notable speaker who presents on a specific topic involving personal clinical experiences and research to update others within the field. In plastic surgery, this may involve an overview of surgical principles, commonly practiced procedures, technique innovations, product developments, and novel perspectives on particular patient populations. While the goal of grand rounds is relevant to surgeons at all levels, it may not efficiently meet the demands of a faster-paced training environment with expanding breadth and depth of information required to succeed. Experts propose developing a learner-centered model where information is reviewed in preparation and discussed during the conference.⁶ In the current age, there is no better and effective way for residents to prepare for conference and grand rounds than by reviewing the most up-to-date information available: online resources. Thus, residents are able to optimize their learning during conference and grand rounds by already having a strong foundational knowledge base obtained beforehand by studying online materials and collective reviews.

THE FUTURE OF PLASTIC SURGERY EDUCATION IS DIGITAL

Former president of the American Society of Plastic Surgeons (ASPS) and surgical education author Edward Luce summarized the following recommendations for the future of plastic surgery education:

- Adopting the “flipped classroom” concept of conference didactics.
- Replace the teacher-centered educational style with a learner-centered model.
- Promote universal acceptance of a uniform curriculum, Plastic Surgery Education Network, supplemented with faculty discussion guides.
- Innovate simulation tools for resident acquisition of technical skills and use of contemporary technology for instruments of objective assessment of technical proficiency and nontechnical aptitudes.⁷

The future of plastic surgery education is inevitably digital.⁸ For residents already using mobile devices for academic purposes, utilizing online resources over traditional ones becomes a logical progression.^{5,8}

Online technology offers numerous benefits to resident education: (1) data can be easily accessed in line with the most current research and practice^{9,10}; (2) resources can be updated in real time and disseminated immediately^{9,11}; (3) online resources and interactive exercises

Table 1. The Benefits of Adopting the Digital Era into Residency Training Programs

Benefits of Online Avenues for Resident Education
Most up-to-date data, advances, and expert opinions in one place
Quality data continuously updated and disseminated in real time
Collaboration of researchers and clinicians within the field
Easy access to foundations and surgical principles for learners at all levels
Convenient on-the-go access to review materials, anatomy, and surgical videos
Efficient synthesis of information for comprehensive learning
Interactive exercises and 3D models for active and visual learning
Easy transfer and showcase of presentations and research data at conferences

allow for synthesis of information for comprehensive learning¹²⁻¹⁵; and (4) information can be viewed quickly via a variety of mobile electronics, allowing for convenience in a busy clinical environment⁵ (Table 1). While there is a plethora of online resources available, residents can use those best suited for their personal learning styles and work demands to optimize their education.¹⁶ Thus, technology is increasingly woven into the formal curriculum of plastic surgery residency programs to enhance education in the digital age.^{9,17}

ELECTRONIC TEXTS AND BOOKS

Printed textbooks cover a broad range of topics necessary to be well versed in all areas of plastic surgery. These texts are subsequently published in newer editions; however, the time between drafting and publication creates a delay in information dissemination. The material can become outdated as newer techniques are described while the textbook is still undergoing the publication process. By transitioning to online versions, plastic surgeons can describe novel surgical approaches and dispense the material much more quickly.⁸

Peter Neligan's *Plastic Surgery*, 6-volume set,¹⁸ *Green's Operative Hand Surgery*,¹⁹ and *Grabb and Smith's Plastic Surgery*²⁰ are popular textbooks referenced by residents. Many trainees carry handheld manuals as a quick resource, such as *Plastic Surgery Emergencies*,²¹ *Essentials of Plastic Surgery*,²² and the *Michigan Manual of Plastic Surgery*.²³ These books are invaluable in describing the most fundamental principles of plastic surgery and expanding on specific subtopics, making them comprehensive and timeless resources. Nonetheless, it can be cumbersome to carry hard copies throughout the workday. Electronic versions, accessed through Ovid, OpenAthens, or institutional library memberships, increase speed of access and the ability to search for specific keywords anytime or anywhere. For example, *Microsurgery: Transplantation and Replantation* by Buncke et al (buncke.org/book/contents.html)²⁴ is an easily accessible online textbook describing numerous free flap reconstructive options.

ONLINE JOURNALS

Plastic surgery journals containing original research represent an invaluable resource for residents to keep up with rapid developments, to access expert opinions, and

Table 2. Top Plastic Surgery Journals Listed in the 2019 Journal Citation Reports Based on Highest Impact Factors¹⁷

Journal	Impact Factor
<i>Plastic and Reconstructive Surgery</i>	3.946
<i>Aesthetic Surgery Journal</i>	3.480
<i>JAMA Facial Plastic Surgery</i>	3.056
<i>Burns</i>	2.247
<i>Journal of Hand Surgery (European Volume)</i>	2.225
<i>Journal of Hand Surgery (American Volume)</i>	2.090
<i>Microsurgery</i>	1.945
<i>Journal of Reconstructive Microsurgery</i>	1.837
<i>Annals of Plastic Surgery</i>	1.448
<i>Aesthetic Plastic Surgery</i>	1.399
<i>Clinics in Plastic Surgery</i>	1.215
<i>Journal of Plastic Surgery and Hand Surgery</i>	1.037

to directly contribute to the field by showcasing their own research.¹² Currently, there are over 60 journals that are either specifically geared for plastic surgeons or heavily feature plastic surgery topics.²⁵ Among these, *Plastic and Reconstructive Surgery*, *Aesthetic Surgery Journal*, *JAMA Facial Plastic Surgery*, *Burns*, and *Journal of Hand Surgery (European and American Volumes)* have some of the highest impact factors (Table 2).^{26,27} Most plastic surgery journals are now available in online formats, including downloadable PDFs for offline viewing.¹² While some may critique access costs, most academic institutions now grant open access to most major journals and electronic textbooks through Ovid, OpenAthens, or similar library databases.¹⁷ Some programs also cover member subscription costs to plastic surgery societies and popular journals such as *Plastic and Reconstructive Surgery* for their residents to encourage scientific investigation and lifelong learning habits.

Awareness of resident preferences is vital to the future of online education in plastic surgery. In studies of online medical journal use, students, residents, and faculty preferred online versions due to convenience, ease of searching keywords, and accessibility.²⁸ A study of 1141 articles from 6 major plastic surgery journals in 2018 found that the average time from acceptance to in-print publication was 10.3 months (from 7.2 months for *Aesthetic Plastic Surgery* to 16.1 months for *Microsurgery*). Articles were available online for a median of 21 days from acceptance, which was much earlier than the print date.²⁹ Thus, trainees can access new information more quickly online rather than waiting for printed copies to arrive months later.¹⁰ Overall, online journals boast significant benefits of "escolarship" with open access to journal articles and electronic publications ahead of print because of the ease of access, searchability, and faster access to the newest information compared with print journals.¹⁷

ONLINE VIDEOS AND INTERACTIVE SYSTEMS

Digital resources allow for more interactive methods of learning via videos, simulations, and forums.^{11,30} Many trainees seek to synthesize information by watching review or step-by-step videos outlining an operation.¹³⁻¹⁶ This process allows for a thorough understanding of anatomy and surgical approaches in an interactive, visual fashion.⁹

The ASPS Education Network,¹³ formerly known as Plastic Surgery Education Network, is a standardized curriculum of

all plastic surgery specialties. Residents and faculty can make use of the curriculum by viewing lectures, surgical videos, and monthly case reports created by experts in the field. Learners can track competency through self-assessment modules and also learn about practice management and quality improvement. This exclusive online resource truly encompasses the learner-centered model for self-teaching and lifelong learning. Access is granted for free with an ASPS membership (currently \$100/year for residents and \$1299/year for active membership faculty).¹³

Other educational interactive systems include Hand.e (<https://www.assh.org/hande/s/14>), which includes surgical skills videos by American Society for Surgery of the Hand, and craniomaxillofacial trauma algorithms by AO Foundation (<https://www2.aofoundation.org/15>). Readily Available Digital Aesthetic Resource³¹ is an online expansive library sponsored by American Society for Aesthetic Plastic Surgery, which provides didactic aesthetic surgery videos, videos from educational meetings, advice on business and clinical practice management and discussion forums to complement resident learning. *Plastic and Reconstructive Surgery* also showcases podcasts and videos by experts within the field on recent hot topics, novel techniques, and surgical concepts that all plastic surgery residents should master.³² By participating in some of these online modules organized by plastic surgery societies, individuals can obtain Continuing Medical Education credits as well.

Although not necessarily interactive, orthobullets.com³³ provides a comprehensive overview of hand surgery topics in a bullet-point format to outline initial findings, radiographic signs, operative techniques, and postoperative or nonoperative management. Similarly, microsurgeon.org³⁴ reviews relevant anatomy and dissection techniques of commonly used free flaps in plastic surgery. The format is both intuitive and comprehensive as the resource describes free flap blood supply, innervation, vessel caliber, pedicle length, techniques for harvest, and postoperative care. The introductory level of information on this website is ideal for students and residents to prepare for reconstructive cases. Nevertheless, there are more interactive web-based microsurgery curriculums—Microsurgery Essentials³⁵ is an online module by Stanford to review basic microsurgery principles, suturing techniques, and microsurgical skills. In a study by Satterwhite et al,³⁶ residents reported Microsurgery Essentials as valuable in improving technical competency, and they would use the modules again.

Finally, the American Council of Academic Plastic Surgeons provides online study materials for residents to prepare for in-service examinations, such as prior questions and CoreQuest review topics (acaplasticsurgeons.org/16). The website also provides details on research grant opportunities, visiting student rotations, and pathways to plastic surgery for students interested in a plastic surgery career. Furthermore, the American Board of Plastic Surgery outlines the board examination process and provides candidates with online preparation materials for board certification.³⁷ Interactive systems are so widespread into the educational sector that all in-service and written

board examinations are on electronic testing platforms. Weblinks to the above online resources are provided in the references.

THREE-DIMENSIONAL SOFTWARE

Software with three-dimensional (3D) visualization is among the newest online resources that plastic surgery learners can use to enhance surgical knowledge and skills. Plastic surgery is a field that arguably requires the most detailed mastery of human anatomy. Thus, 3D models and anatomic simulations can aid in resident education by providing an interactive visual model to learn intricate anatomy and prepare for operative cases. For example, Smile Train³⁸ has a free, interactive 3D cleft repair training module (www.cleftsim.com) available globally. Touch Surgery (touchsurgery.com/39) is an interactive simulator for users to practice microsurgical operations in a 3D format, while eoMicro Simulator⁴⁰ is a device that allows residents to use their smartphones to create a home microsurgical setup that simulates viewing through a microscope and using microsurgical tools to suture on a base plate.⁴¹ Additionally, Craniofacial Virtual Surgical Atlas (www.myface3d.com/42) provides students, residents, fellows, and experienced surgeons an interactive platform to learn 3D surgical principles relevant to complex craniofacial anomalies and to simulate surgical procedures in discrete steps with voice-over and 3D label features.

Case studies regarding the effectiveness of online 3D simulators for cleft lip and palate reconstruction have shown a widely favorable opinion of its usefulness as a training tool, with global usage in over 136 countries and over 4000 active users during a 5-year implementation period.^{43,44} The success of this novel technology not only highlights its effectiveness as a teaching tool but also its potential in mitigating economic differences among plastic surgery programs by providing widely available, quality, standardized education.

Another suggested use unique to online 3D simulators has been to help effectively communicate complex procedure-related information to patients. Plastic surgeons have been able to illustrate pre-, intra-, and postoperative descriptions of craniofacial procedures to patients.⁴⁴ Additionally, both trainees and plastic surgeons can use the visual features of 3D computed tomography software to study complex anatomy and to virtually plan surgical procedures requiring custom hardware, such as in complex craniomaxillofacial trauma or oncologic reconstruction. Perioperative simulations are also used in the setting of aesthetic surgery to help patients envision the results of surgery, such as breast augmentation. Thus, residents are able to use 3D software for their own learning experience while also empowering patients by involving them in the decision-making process.⁴⁴

SOCIAL MEDIA

In the Information Era, most individuals, regardless of career, have transitioned to creating professional social media profiles to not only promote their practice and products, but also showcase their expertise and research endeavors to patients and colleagues.^{45–49} Twitter,

Instagram, Facebook, Snapchat, YouTube, and LinkedIn are among the numerous social media outlets used by plastic surgeons.^{12,45}

Most recently, social media have revolutionized the plastic surgery field and become enshrined as part of the formal educational curriculum.^{10,18} Twitter and Instagram have been used as powerful tools for discovery and dissemination of newly published and upcoming articles, with the click of a button.^{10,12,47,50} The Interactive Plastic Surgery Network⁵¹ and the International Microsurgeons Club⁵² are Facebook groups centered on allowing plastic surgeons and microsurgeons to collaborate on research, discuss challenging cases, propose novel ideas that may differ from traditional principles, and share relevant educational information on a global scale.³⁰ In a survey of American Academy of Facial Plastic and Reconstructive Surgery members, YouTube was increasingly used to review techniques in facial aesthetic surgery as a supplement to textbook and journal education, especially among the less-experienced surgeons.⁵³ Nonetheless, these instructional videos must be verified and trainees should use discretion when studying these videos, as they may lack key benchmarks and indications of surgical techniques.⁵⁴ The seamless sharing capabilities of educational links using these platforms allow for a rapid distribution of and give access to learning materials for trainees who are often on-the-go.⁵

The use of these virtual tools in plastic surgery has been on the rise over the last decade. Quinlan et al⁵⁵ evaluated the number of plastic surgery journals that used social media to propagate research. In 2014, only 1 of the major plastic surgery journals (*Plastic and Reconstructive Surgery/PRS GO*) had active Twitter, Facebook, YouTube, and LinkedIn accounts. Only a third of the journals surveyed used Twitter, the most common social media outlet.⁵⁵ By 2019, Asyied et al⁵⁶ showed that half of plastic surgery journals surveyed now had a Twitter profile. However, this latest study found that, since joining Twitter, 5 of 6 journals experienced increases in impact factor.⁵⁶ Hence, social media has become an important avenue in our virtual era to distribute the most up-to-date advances within the field and to enhance online education.¹² With regard to Instagram use, analyses of the photograph-sharing platform show that the top social media “influencers” driving the dissemination of plastic surgery–related educational information via hashtags are board-certified plastic surgeons, though there are still many nonphysicians marketing themselves as “cosmetic surgeons.”^{48,57,58}

Plastic surgery societies are using the power of social media to complement the educational experience of surgical conferences and meetings.⁵⁹ Conference dates and locations are now posted on social media outlets to increase awareness and attendance. Furthermore, social media use is encouraged at society meetings for individuals to view live videos of events, showcase published research, and immediately network with other professionals via Facebook Messenger, Instagram, Twitter, etc.⁵⁹ ASPS has recently sponsored Instagram takeovers where a plastic surgery residency program takes over the ASPS Instagram account for a day to highlight the program’s facilities, faculty, residents, and academic innovations.

Overall, the plastic surgery field’s professional embrace of social media platforms as academic and networking tools provides significant educational value with virtual learning and collaboration opportunities at a global level.

Although it is crucial to safeguard the quality of information on the sphere of social media, Instagram has been proposed as a valuable network for plastic surgeons and residents to circulate novel information regarding both their surgical techniques and recent research advances.^{18,57,60} Instagram and its story feature are a popular platform used to regularly discuss surgical techniques and highlight salient points for followers in an interactive lecture-series fashion. Like Twitter, Instagram can link journal and news articles in posts for those seeking additional educational information.⁴⁷ Social media can serve both as a quick tool to expose the plastic surgery trainee to new, evidence-based information and as a platform to collaborate with other members of the field.^{46–48} Perhaps, the greatest value of this novel type of resource is its use during downtime hours, providing a stress-free avenue for trainees to engage with educational resources.¹⁸

CONCLUSIONS

As technology evolves, plastic surgery trainees are increasingly seeking electronic resources for convenient and speedy access to quality information and data. Online education is crucial to plastic surgery curricula, as only digital systems can truly encompass the broad scope of practice of all plastic surgery specialties in a single location. The digital age has allowed plastic surgeons to efficiently and promptly collaborate with each other on rapidly evolving innovations within the field while staying updated on all things plastic surgery.

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