Augmented Reality and Wearable Technology in Image-guided Navigation and Preoperative Planning

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Dear Sir:

Augmented reality (AR) and wearable technology have many potential applications in health care. Upcoming technologies such as Microsoft HoloLens (Microsoft Corporation, Seattle, Wash.) and Oculus Rift (Oculus VR, Menlo Park, Calif.) are gaining popularity with the wider audience, but Google Glass (Google Inc., Mountain View, Calif.) is the prototype that has gained the most traction in plastic and reconstructive surgery.[1] The revised model of Google Glass ("Glass") is intended for enterprise use and will be consumer driven, taking into account the feedback and suggestions from its end users. Within plastic surgery, these wearable technologies can potentially incorporate current services such as image-guided navigation and preoperative planning software.

The hands-free, wireless features of Glass can be utilized to improve existing surgical technologies, such as intraoperative laser angiography to assess tissue perfusion. The Spy Elite (Novadaq Technologies, Inc., Bonita Springs, Fla.) allows surgeons to capture and review high-quality images of microvascular flow in tissue perfusion. Although this apparatus allows the surgeon to capture and review images in less than 2 minutes, the machine is bulky in the operating room, weighing 500 pounds with a 6-foot articulated arm. Liu et al[2] developed a prototype hands-free wearable device that allows the surgeon to visualize fluorescence information directly through the eyepiece. The authors demonstrated that the wireless device could aid in tumor resection and sentinel lymph node mapping without the use of large, freestanding systems in the surgical suite.[2] Further research and development is needed to minimize the bulkiness of wearable devices without compromising spatial resolution and quality of fluorescence imaging. Such studies can focus on how Glass can be integrated with fluoroscopic techniques to determine tissue perfusion.

Computer-aided design software is also a growing trend in reconstructive and aesthetic surgical planning. Computer-aided design utilizes 3-dimensional (3D) imaging tools to enhance case documentation and treatment planning. These tools allow for easy acquisition and transfer of digital imaging and communications in medicine data to various proprietary software in craniomaxillofacial surgery.[3] These images and others such as standard preoperative photographs can be integrated into Glass via third-party applications. AR technology was recently integrated in maxillofacial surgery with success in sentinel lymph node biopsies of head and neck tumor resection.[4] Peregrin[5] described a rhinoplasty procedure conducted in December 2013 using Glass.[5] The plastic surgeon had the ability to review preoperative images on the Glass screen intraoperatively to help guide his decision-making process. This ability could improve operative efficiency by allowing surgeons to view various images without leaving the operating table. Further studies can examine how to merge 2D images visualized on the Glass display with the real-time 3D surgical site. Many companies are aiming to incorporate wearable AR technology into surgery, such as overlaying imaging modalities with the surgical field. Such disruptive innovation in third-party software development will certainly require continuous feedback from surgeons.

Surgeons must continue to validate the relevant use of AR and its integration into plastic surgical practice before its widespread use. Further peer-reviewed studies of wearable technology and third-party surgical software will better demonstrate its future clinical relevance. AR in wearable technology is an exciting development that has the potential to enhance existing surgical technologies, increase perioperative efficiency, and improve aesthetic and reconstructive results. We hope this unique perspective will spur further disruptive innovation in integrating cutting-edge technology to our creative surgical practice.

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