Tablet Computers in Surgery

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The use of tablet computers in surgery has been increasing due to a number of reasons, such as a highly portable build, useful clinical software and wireless connectivity. Tablet computers can be used in surgical consultations, operating theatres, post-operative care and surgical education. Current intra-operative uses are mainly in thoracic, orthopaedic and ophthalmic surgery where it was shown to improve surgical performance and safety. Tablet computers also play a key role in surgical consultation and telerounding via means of videoconferencing. This allows for better communication between doctors and patients and improves care delivery. Furthermore, telerounding can facilitate rapid post-operative review by surgeons, which can increase patient turnover, resulting in financial benefits for the hospital. In addition, virtual dissection software on tablet computers improves surgical anatomy teaching, reduces the need for cadavers and simplifies the process of dissection.

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Tablet computers – otherwise commonly known as "tablets" – are devices that possess both the computing powers of an average computer and the portability of a mobile telephone. Measuring 7–10 inches in diagonal length, about 1 cm in thickness and around 600–700 grams in weight, most tablets can fit anywhere a paper notebook can. Common features of tablets include touch-enabled high-definition screens, quality cameras with video recording capabilities, long-lasting batteries (up to ten hours in some models) and wireless Internet connectivity. This combination of highly sought-after features have earned tablets a growing user base.

Tablets have also found their way into the medical field. Soon after the launch of the iPad (Apple Inc., Cupertino, USA), a number of major medical schools, including Stanford University and the University of California, began incorporating the iPad into their curriculum in an attempt to improve the performance of their students.[1–3] This initiative has extended beyond medical schools – the University of Chicago integrated the iPad into their residency training program and found that the use of iPads was associated with improvements in both perceived and actual efficiency of their residents.[4,5] The impact of tablets has been particularly prominent in surgery, with various applications in surgical consultations, operating theatres, ward activities and surgical education.

The nature of surgery requires a surgeon to be highly knowledgeable and thus it helps to have an easily-accessible source of information when required. A number of useful surgical texts are available as electronic books – colloquially known as "e-books" – which can be read on tablets. Examples include *Zollinger's Atlas of Surgical Operations* and *Current Diagnosis and Treatment in Surgery*.[6,7] There are also important online resources such as *Therapeutic Guidelines* and *UpToDate®* from which a surgeon can conveniently obtain quality information,[8,9] as well as print patient information handouts for patient education.

An important aspect of surgical consultations is the pre-operative assessment, where the patient's current health is evaluated with the aim of minimising peri-operative risks. Tablets can run software such as PreOpEval (conceived from recommendations from the American College of Cardiology and American Heart Association), a program which provides an algorithm for pre-operative cardiac assessment, medications and investigations.[7] In addition, there are also other software that can be used on tablets in the pre-operative phase to help determine the type and extent of surgery required, by referencing vast collections of medical scoring systems.[6]

Videoconferencing via a tablet is a novel addition to surgical consultations – surgeons at different physical locations are able to communicate with one another by means of real-time video. The advantage of videoconferencing is that off-site surgeons are able to see patients and the surgical problems rather than relying only on verbal descriptions via telephone. This is particularly useful in orthopaedic surgery and trauma cases – for example, a team of surgeons in California utilised the videoconferencing feature on a tablet to discuss the details of a novel surgical approach pre- and intra-operatively in order to save a patient from a limb-threatening infection.[10]

The effective intraoperative use of tablet computers requires their integration into the sterile operating field. As conventional sterilising methods may damage tablets, other techniques have been developed to maintain functionally and sterility of tablets within the operating field. The simplest of these were disposable sterile covers into which tablets were placed.[11] A team of plastic surgeons in the United Kingdom developed a similar method, using large-sized Tegaderm dressings as sterile covers for iPads.[12] Other methods are more complex and include surgeons controlling electronic devices and computers via motion-sensing devices such as the Microsoft Kinect.[13]

Tablets have been used in various types of surgery. A team of Japanese thoracic surgeons have been performing lung segmentectomies with the assistance of a three-dimensional (3D) imaging navigation software on the iPad. They found that this enhanced their ability to identify important anatomical structures, thus improving the safety of the operation.[14] Inclinometer software on tablets are also increasingly being used in orthopaedic surgeries, in particular aiding the insertion of orthopaedic prostheses. This was demonstrated through a study which investigated the use of software to accurately place acetabular cups in total hip arthroplasties, achieving minimal variance in peri-operative acetabular inclinations.[15] Similarly, tablets have the potential to improve computer-assisted orthopaedic surgery (CAOS). Multiple studies have found that acetabular cup placements performed with the assistance of CAOS devices were more accurate compared to the conventional method of free-hand placement or placement with a cup positioner, with significantly less variability in the resulting abduction and anteversion angles of the hip.[16–20] Furthermore, small and inexpensive video microscope devices can be attached to cameras on tablets to facilitate their use as microscopes in low resource settings.[21,22] Ophthalmic surgeons have also accurately measured the peri-operative eye alignment of patients undergoing lateral canthopexy using an augmented reality software available on tablets. Results indicating good inter-observer agreement as verified by manual measurements.[23]

Tablets are also particularly useful in the ward setting. They are capable of providing access to medical records, investigation results and radiographic images at the bedside.[24] Mount Sinai Hospital in Canada has developed VitalHub – a software that presents patients' medical records, investigation results and nursing observations on tablets.[25] The incorporation of tablets into daily ward activities has also been well-received by clinical staff. In a mixed-methods study, a system using smartphones, for communication enabled a more thorough transfer of information among healthcare staff as compared to the traditional paging system, thus improving the coordination of patient care.[26]

Post-operative care can also be improved with the use of tablets. Many surgeons practice at multiple locations and the concept of telerounding was introduced to aid the provision of patient care. Telerounding enables a surgeon to conduct an interactive ward round without being physically present through the use of mobile remote videoconferencing equipment. Through telerounding, surgeons can visually examine their patients and make informed decisions regarding further management.[27] In addition, surgeons can use other software to complement telerounding. SurgiChart is one such program, allowing surgeons to log their surgical case records, including operation notes, charts, images and videos, into their tablets so that they have access to their patient's case history whilst conducting rounds. An example of telerounding in use is at the Royal National Orthopaedic Hospital in London, which has produced their own software through which the patients can input their post-operative progress into tablets to allow their surgeon to track their progress remotely.[28] Furthermore, a combination of regular bedside visits with telerounding has been shown to result in a reduced length of stay amongst patients undergoing laparascopic gastric bypass at Sinai Hospital in the United States. This particular study demonstrated that the earlier discharge of patients resulted in significant financial gain to the hospital due to additional capacity created within the hospital.[29] Studies suggest that telerounding is associated with similar morbidity rates, postoperative complications and length of stay[30], and increased patient satisfaction as compared to traditional bedside rounds.[31]

Tablets also serve as highly useful adjuncts to surgical education. The availability of e-books has already been discussed. Internationally renowned journals and surgical associations, such as the European Journal of Cardiothoracic Surgery and the AO Foundation for orthopaedics and trauma science are producing their own tablet software to provide surgeons access to their vast online database of up-to-date journals and clinical practice.[32,33] Clinicians are also able to upload endoscopic videos to an online database allowing for simultaneous viewing by surgical trainees.[7] A recent innovation is the creation of a life size virtual dissection tablet with a touch-screen surface large enough to fit a human cadaver. Anatomy instructors at the Stanford University of Medicine have used this device to good effect – it has the advantage of reusability, which negates the need for a source of cadavers, and rapid dissection without the need for actual dissection devices.[34] Although hardly a conventional tablet due to its size, further technological advances may incorporate more compact virtual dissection software into smaller tablets – a revolution in surgical education.

Conclusion

Tablets are remarkably versatile and useful devices with vast potential for applications in various aspects of surgery. The principal features of tablets – superior portability, technological strengths and wireless connectivity – open up new doors for advancement of new and existing surgical technologies. This may translate to better patient care, higher hospital income and enhanced surgical training. Further research and innovation is the key to unlocking new prospects for tablets in improving the field of surgery.

Competing interests

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

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