Current uses of smartphones and apps in orthopaedic surgery

Smartphones have high levels of functionality, allowing them to have useful clinical applications. This article presents a structured review of various apps and a Medline search of relevant MESH headings, and looks at current uses of smartphone technology in orthopaedic surgery.

Since its introduction in the mid-1990s, the smartphone has revolutionized the way that people communicate and access information (Mohan and Branford, 2012). Modern devices now support e-mail, web browsing and still imaging, have video capability and a myriad of other free and paid-for applications, and have even been developed as medical tools.

Smartphones have developed into useful devices for hundreds of millions of people around the world. Their accessibility, portability, wide array of apps and internet connectivity is helping to extend their use in the healthcare environment.

In the first quarter of 2013, 210 million smartphones were sold worldwide, up 42.9% year-on-year. Samsung (the market leader, with 30.8% of smartphone sales) and Apple raised their combined share of the smartphone market to 49.0% (Gartner, 2013). Data suggest that, in 2010, approximately 81% of UK health-care professionals owned a smartphone (Devices 4 Ltd, 2010). In 2012, 97.7% of Australian orthopaedic surgeons used a smartphone (Churchill, 2012).

The utility of smartphones is greater in the current climate of reduced working hours and reduced clinical and operative experience, as trainees seek ways to maximize training opportunities and identify alternative avenues for furthering their levels of knowledge (Al-Hadithy et al, 2012).

The last few years has seen a handful of articles published on the use of smartphones in surgical practice. These have focused on the iPhone (Dala-Ali et al, 2011), the use of iPhones in plastic surgery (Mohan and Branford, 2012) and orthopaedic surgery, which have been relatively limited in their scope (Al-Hadithy et al, 2012), or are older publications (Franko, 2011). There have been considerable advances in the technologies developed and an explosion in the number of apps that are downloaded in a relatively short period of time. (ABI Research (2013) estimates that 56 billion apps will be downloaded in 2013.)

This review discusses the current uses of smartphones and their applications for orthopaedic surgeons, trainees and their patients.

Mr Ravi Popat *is Specialist Registrar in the Department of Trauma and Orthopaedic Surgery, Imperial College Healthcare NHS Trust, London W2 1NY,* **Miss Anita T Mohan** *is Specialist Registrar in the Department of Plastic Surgery, Addenbrooke's Hospital, Cambridge, and* **Mr Olivier A Branford** *is Extremity Reconstruction Fellow in the Department of Plastic Surgery, Imperial College Healthcare NHS Trust, London*

Correspondence to: Mr R Popat (ravipopat@doctors.org.uk)

Method

A literature search was performed through PubMed, Embase and Google Scholar in the English language up to May 2013, using the following search / MESH terms – orthopaedics, cellular phone(s), musculoskeletal and surgery.

A search for apps with relevance to orthopaedic clinical practice was performed in Apple's App Store and on Google Play using search terms including surgery, orthopedic, orthopaedic, ortho, surgery, trauma, musculoskeletal, bone and fracture.

Relevant examples of appropriate apps were recorded and categorized and the available reviews for individual apps were evaluated with respect to customer satisfaction.

The grey literature was also reviewed, which included websites that provide consumers with reviews of apps.

Results

The literature review revealed 45 articles relating to the use of smartphones in 'surgery'. The focus of these articles included using smartphones to monitor free-flaps postoperatively, the use of smartphones for urology trainees and the use of smartphones in the paediatric setting.

A total of 13 articles have been published since 2010 with specific relevance to the use of smartphones in orthopaedic surgery (three of which provide level 5 evidence and 10 which have level 3 evidence). The majority of information that is available on the topic is found in the grey literature.

The authors found 120 apps for use on Apple iPhones and 49 apps that are available on phones that use the Android operating system. These were divided into the following categories:

- Validated measurement tools
- Clinical management tools
- Clinical guidelines
- Research referencing
- Educational apps

- Product information
- Conference information
- Patient-focused applications.

Medical apps are not categorized into specialties within any of the portals through which apps can be purchased, with no differentiation made between apps that are intended for clinicians and patients.

There are websites which review and recommend apps (*Table 1*), one of which focuses on applications specifically for orthopaedics (www.toporthoapps.com).

There are a large number of smartphone apps and functions that orthopaedic surgeons can use in the clinical environment (*Table 2*), particularly on Apple's iOS and Android OS, but very few have enough customer reviews to provided information about whether they are useful. Apps that are featured under the relevant headings are mentioned because they feature well in review websites, or are the most commonly downloaded apps.

Validated measurement tools

Studies have been performed to validate the use of smartphones in measuring acetabular cup orientation (Peters et al, 2012), use as a goniometer (Ockendon and Gilbert, 2012), measuring hallux valgus angles (Walter et al, 2013) and as a scoliometer (Franko et al, 2012).

Clinical management tools

Clinical apps that are suitable for orthopaedic surgeons and trainees are continually entering the market. These apps usually have a simple, interactive interface, allowing easy access to information or tools for assessment, and provide an aid to the surgeon in his/her clinical decision-making process. Ortho Traumapedia (*Figure 1*) is a useful companion for junior orthopaedic trainees during on-calls, providing information about injuries and their management. This app allows users to glean the pertinent information about most injuries that are likely to be encountered during an on-call. AO Surgery Reference provides an excellent resource that supplies the AO classification of injuries and outlines the management options, both non-operative and operative. The app also provides information about patient preparation and positioning, surgical approach, techniques on performing the operative intervention and offers information about postoperative care.

Table 1. Examples of popular reviewer sites

Websites for reviews on medical apps	www.iphonemedicalapps.com
	blog.softwareadvice.com
	www.imedicalapps.com
	www.skyscape.com/index/home.aspx
	www.medicalsmartphones.com
	www.download.cnet.com
Websites for reviews on orthopaedic apps	www.toporthoapps.com

There are apps that provide an interactive reference tool for scoring systems or classifications used in orthopaedics. The AO Muller Classification app helps users to determine the classification of long bone fractures. OrthoScore provides a fast approach to calculate scores in clinic, based on validated systems used in the assessment of function in hip and knee arthroplasty, and a gonio-

Table 2. Examples of surgeon-targeted apps

	iPhone	Android
Medical education	Instant Anatomy Gray's Anatomy CORE (Clinical Orthopaedic Exam) Zollinger's Atlas of Surgical Operations Campbell's Operative Orthopaedics Skeletal System Pro III Medscape Radiopaedia iRadiology Realworld Orthopaedics	Instant Anatomy Gray's Anatomy mobile CORE (Clinical Orthopaedic Exam) Zollinger's Atlas of Surgical Operations BoneFeed OnExamination – Exam Revision
Reference	PubMed Science Direct WebMD Traumaline LWW OrthoSuperSite Papers	PubMed Science Direct Web MD for Android Medscape St George's Antibiotic Guide
Journals	JBJS Br Abstract Manager Acta Orthopaedica Journal of Orthopaedic Trauma	JBJS Br Abstract Manager Acta Orthopaedica
Guidelines	SIGN guidelines NICE guidelines Lower limb trauma (BOA and BAPRAS) Thrombosis guidelines	SIGN guidelines NICE guidelines
Logbook	Mobile elogbook	None found
Communication	EFORT 2012 AOSSM 2011 OrthoEvent Medical Conferences	EFORT 2012 AOSSM 2011
Clinical tools	AO Surgery Reference AO Muller Classification Tumorpedia Bone Tumorpedia Soft Tissue Ortho Traumapedia OrthoScore Knee Goniometer Septic Hip OrthoCare Epocrates	AO Surgery Reference AO Muller Classification Tumorpedia Bone Tumorpedia Soft Tissue Goniometer SugarSync Dragon Dictation Epocrates Skyscape OCM Outlines in Clinical Medicine
Product information	Sigma Knee Replacement (DePuy) OrthoFind (Breg Inc) Stryker IVS	None found

AOSSM = American Orthopaedic Society for Sports Medicine; BAPRAS = British Association of Plastic Reconstructive and Aesthetic Surgeons; BOA = British Orthopaedic Association; EFORT = European Federation of National Associations of Orthopaedics and Traumatology; NICE = National Institute for Health and Clinical Excellence; SIGN = Scottish Intercollegiate Guidelines Network

meter app can be used to measure angles of flexion and extension more precisely.

Elogbook, which is a popular site for UK trainees to document surgical procedures, has developed an app, making it more simple and effective for trainees to prospectively log their operations.

Clinical guidelines

The National Institute for Health and Clinical Excellence (NICE) guidance app and the Scottish Intercollegiate Guidelines Network (SIGN) app allow users to gain easy access to summaries of the guidelines that have been produced by the respective organizations. Both apps are designed to allow users to quickly explore guidelines and can provide surgeons with an excellent reference tool. The British Orthopaedic Association and the British Association of Plastic, Reconstructive and Aesthetic Surgeons have collaborated to produce 'Leg Fractures', which provides a readily accessible summary version of the 2009 standards for management of severe lower limb trauma. The app includes access to key management points, diagrams on arteriography, surface anatomy and fasciotomy incisions.

Research referencing

Popular apps for reviewing literature include PubMed, Papers and SciVerse ScienceDirect. Orthopaedic-specific reference apps including OrthoSupersite and Traumaline, which enable users to search for peer-reviewed articles focused on trauma and orthopaedics.

Currently only a few orthopaedic journals provide apps including the *Journal of Orthopaedic Trauma*, the *Journal of Bone and Joint Surgery* (*Figure 2*) and *Acta Orthopaedica*. These apps provide consumers with faster, more convenient access to up-to-date knowledge providing a valuable resource in the practice of evidence-based medicine. It seems likely that the number of journal apps will rapidly increase over the next few years.

Educational apps

Reference or educational apps for orthopaedic trainees include those relating to anatomy, basic science, clinical orthopaedics and textbooks. Examples of these include:

- Radiopaedia, iRadiology (*Figure 3*) and Realworld Orthopaedics – apps designed to help trainees interpret plain radiographs and other forms of imaging
- CORE (Clinical Orthopaedic Exam) – an app that provides information about performing clinical orthopaedic examinations and also includes video footage of many examination techniques
- Anatomy apps – examples include Gray's Anatomy, Zollinger's Atlas of Surgical Operations and Instant Anatomy. The majority of these apps appear to be designed for use by students or junior trainees who are studying for their Intercollegiate Membership of the Royal College of Surgeons (IMRCS) examinations and lack the level of information that would be required by trainees at registrar level and above.

Figure 1. Screen-shot from Ortho Traumapedia.

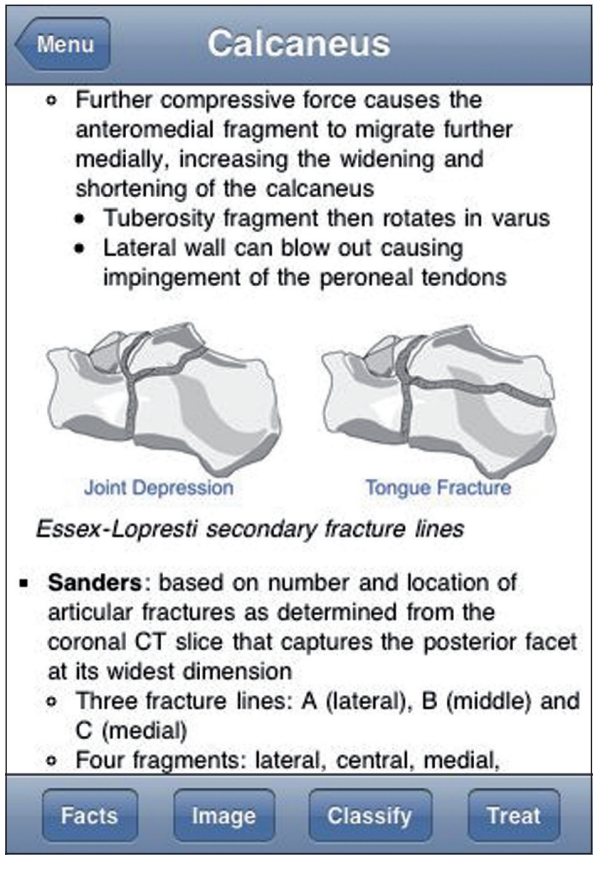
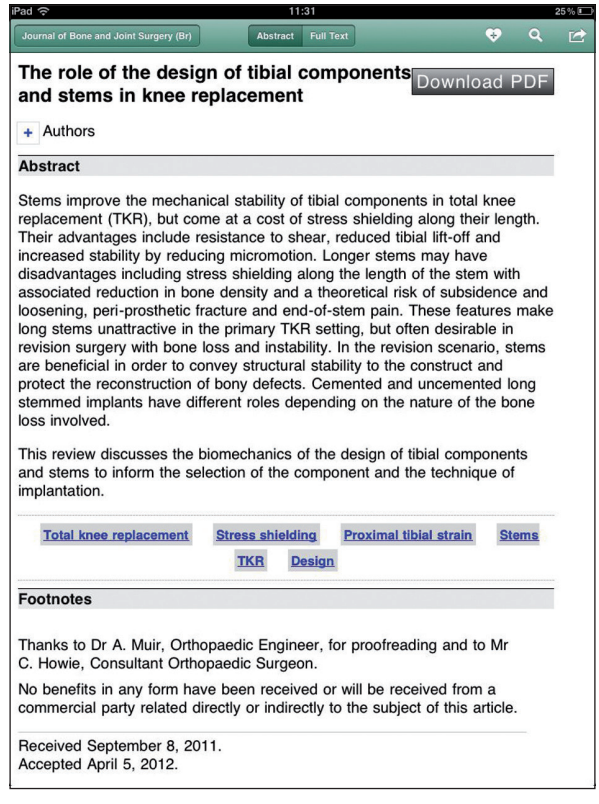


Figure 2. Screen-shot from JBJS Abstract Manager.



There is great scope to develop apps and educational platforms targeted to surgical examinations such as the Member of The Royal College of Surgeons and Fellowship of the Royal College of Surgeons (Tr & Orth), with multiple choice questions, e-learning modules and continuing medical education accredited apps.

Apps such as iBooks, Google Play Books and Kobo allow you to store versions of your favourite textbooks on your smartphone, transforming your smartphone into a mobile library.

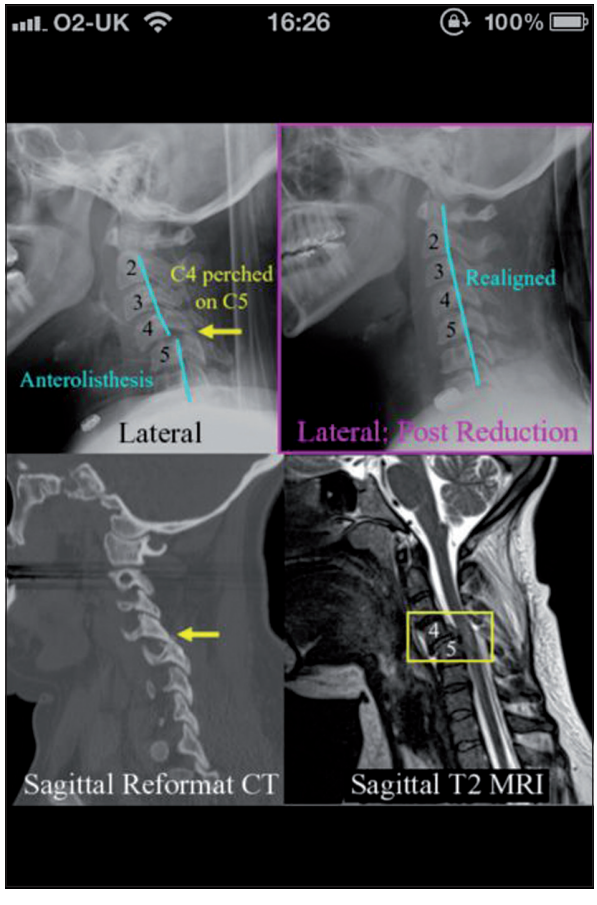
Product information

Orthopaedics has a vast array of equipment from various manufacturers available on the market. Even the most well-intentioned surgeon can find it difficult to know the specifications and inner workings of all products available at his/her hospital. Manufacturers such as DePuy (with Sigma Knee Replacement) and Stryker (with Stryker IVS) have started to produce apps to provide product information and training on surgical technique.

Conference information

Ortho Event and Medical Conferences are apps that are designed to provide information about upcoming conferences for orthopaedic surgeons. The European Federation of National Associations of Orthopaedics and Traumatology (EFORT) produced an app for EFORT 2013, allowing users to browse through the scientific programme and exchange thoughts and ideas in real-time with colleagues and other experts.

Figure 3. Screen-shot from iRadiology.



Patient-focused applications

There are patient-related apps (*Table 3*) that provide relevant information to increase awareness and understanding about conditions and procedures related to orthopaedic surgery. Apps such as SpineDecide provide simplified details about specific pathology to better inform patients or their carers about their condition. Other apps, including CARE, provide personalized physical therapy and rehabilitation protocols.

Within the UK, there are apps for NHS Direct and NHS Quit Smoking. NHS Bristol, NHS Yorkshire and Humberside and St George's Healthcare Trust are apps that help patients make the most of the services provided by these trusts.

Regulation of the industry

Mobile technologies have the potential to revolutionize the provision of health care and regulation of the market is required to safeguard against potential abuse. As it stands, regulation covering apps in the UK is driven at a European level under the Medical Devices Directive.

Under the Medical Devices Directive, it is stated that before placing a medical device on the market, manufacturers are required to register with their competent authority and label their device with the European Conformity (CE) mark; however, the definition of a medical device is still fairly ambiguous and open to interpretation. As of the end of 2012, the number of apps that carry the CE mark could be counted on one hand (Devices 4 Ltd, 2012).

In the United States of America, the Food and Drug Administration have produced guidance which is now available to developers and manufacturers of new mobile medical applications or devices (US Department of Health and Human Services and Food and Drug Administration, 2013).

Table 3. Examples of patient-related apps

	iPhone	Android
Hospital or institutional information	NHS Direct NHS Yorkshire and Humberside NHS Bristol NHS Quit Smoking NHS Welcome to St George's	NHS Direct NHS Yorkshire and Humberside Orthopedic Pain Management Injury Institute Choose Better Choose Well Gloucestershire
Advice	iPrevent Running Injuries iPrevent ACL injuries AgingSpine FootDecide HandDecide CARE for patients SpineDecide	iPrevent Running Injuries iPrevent ACL injuries Meniscal Tears Medial Collateral Ligament

Conclusions

The role of smartphones, apps and other mobile technologies in surgery will transform the health-care industry and delivery of care. There is a spectrum of useful clinical tools and reference apps available to orthopaedic surgeons and these will become more widely available and sophisticated.

This rapidly evolving clinical and patient tool has huge implications, but at present the literature on use in orthopaedic practice is very limited. It seems inevitable that with the growth of the smartphone market and mobile technologies, their use will be integrated into health-care delivery and availability of clinical apps will rise concomitantly with this. The challenge for clinicians will be to use tools that best aid their clinical practice and therefore provide benefits, not only to surgeons, but to patients as well, and randomized controlled trials are required to inform their use. BJHM

KEY POINTS

- The vast majority of health-care professionals have access to a smartphone in the clinical environment and these devices have the potential to be useful clinical tools.
- There are a large number of apps that orthopaedic surgeons can use to help with clinical decisions, research and to further their training.
- There are also apps that have been designed for use by patients.
- The U.S Department of Health and Human Services and Food and Drug Administration have produced guidance for developers of medical apps to regulate the industry in the USA – the authors have not been able to find comparable guidance elsewhere in the world.

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