

Smartphone Applications and its Role in Foot and Ankle Surgery

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ABSTRACT

Introduction: The coronavirus disease 19 (COVID-19) pandemic has exposed inherent weaknesses in global healthcare systems. Conversely, it has encouraged innovation, research and collaboration. Digital technology has the ability to tackle these difficulties via the use of applications. However, the reliability and validity of unregulated medical applications must be questioned. The aim of this study was to review surgical foot and ankle themed applications and specifically assess the level of involvement from medical professionals in the design and content.

Methods: The App Store (iOS), Google Play (Android) and the BlackBerry App World (Blackberry) were searched for foot and ankle themed applications. The following search terms were used: bunions, ankle sprains, diabetic foot, foot and ankle deformities, pre-op templating, Patho-anatomy, post-operative rehab, gait, measurement of clinical angles of foot and ankle. Data were collected on target audience, patients, healthcare workers, number of applications, applications with customer satisfaction reviews, applications with medical professional involvement and applications available within the UK application stores.

Results: 35 individual foot and ankle themed applications were identified. 30 applications had customer satisfaction ratings, 11 applications were predominantly health-worker centric and 3 were patient centered. 23 applications had medical professional involvement in their development or content.

Conclusion: The benefits of applications are offset by the lack of Foot and ankle specification. There is relatively little medical professional involvement in their design. Increased regulation is required to improve accountability of application content.

KEYWORDS: Foot and ankle, Smartphone applications, The Apps store, Google play, BlackBerry

INTRODUCTION

The COVID-19 pandemic has exposed inherent weaknesses in healthcare industries across the world (1). Simultaneously, it has had a positive impact on scientists to innovate and develop research to ultimately improve healthcare systems. Digital technology is fundamental to the future of healthcare systems and automation is particularly on the rise. This enhances the capacity to process store data, whilst translating this information into functional tools. It has contributed immensely to automation learning-based medical systems and data mining. Additionally, it has highlighted digital hot spots where further innovation and research is required: mobile applications (apps) are one of these areas. In 2015, Franko et al (2) estimated that there are approximately 300 orthopaedic focused apps available on iOS and Google Play. The orthopaedic apps currently available have a variety of uses – they can be related to patient education, physician education, clinical evaluation, clinical treatment and surgical training. As of April 2020

there were 2.56 million apps available to download on Google Play, making it the largest app store on the market (3). Apple's app Store is the second-largest with approximately 1.85 million Apps available for iOS (3). Smartphone Apps provide platform for surgeons and software developers to collaborate and create novel tools to assist surgeons in practice and education. The purpose of this review is to identify and assess all smartphone apps related to the field of foot and ankle surgery.

The March 2014 Mobile Technology and Social Media Usage study from the Journal of Bone and Joint Surgery (JBJS) reported that, on average, Orthopaedic surgeons spend about 42 minutes a day on tablets. Similarly, according to the JBJS 2014 Readership study, 76% of residents use medical apps on their phones, and it is expected that over the next 2 years, apps will play an even more important role in daily activities.(2)

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The aims of this review are as follows:

- To summarize the most popular and useful foot and ankle apps.
- To provide an overview about app usage, customer satisfaction and availability.
- To provide recommendations to the foot and ankle community regarding medical profession involvement in the development of these apps.

Materials and Methods

A team of reviewers searched the The App Store (iOS), Google Play (Android) and the BlackBerry App World (Blackberry) for foot and ankle themed applications. Due to Official shut down of blackberry World on 31st December 2019 and most of Blackberry devices since 2015 used Android reviews were restricted to Android and iOS stores. The following search terms were used: bunions, ankle sprains, diabetic foot, foot and ankle deformities, pre-op templating, Patho-anatomy, post-operative rehab, gait, measurement of clinical angles of foot and ankle. A qualitative analysis of the data collected was performed. Data collected included target audience of the apps, patient and healthcare worker involvement and customer satisfaction reviews. The total number of applications and their availability in the UK were also noted. These details are provided in Table 1.

Apps consisting of Educational Content/Journals

Apps have unique advantages as they are easy to access and always available. In the UK, 84% of adults had accesses online resources through a smartphone, tablet or handheld device – indicating a rise of 26% since 2013 (4). For educational contents and journals the following apps were identified: Journal of foot and ankle surgery, available on android and iOS (Elsevier Inc, Amsterdam, Netherlands). A recently updated version of Elsevier Inc. Medical Apps for foot and ankle surgeries provides innovative digital content with Article enhancements, featuring Audio Slides, Virtual Microscope, 3D Radiological Viewer and 3D Neuroimaging. These Apps are designed to consolidate the effort of tracking the latest journal articles and display of trending articles. Both the above Apps are available in UK and have involved medical professionals in their development.

Society Apps

Society Apps have a unique advantage of providing instant access to protocols, standards and guidelines. Some examples of this include pre-operative and post-operative protocols, information on available fellowships and information on upcoming Foot and Ankle conferences. The American Orthopaedic Foot and Ankle Society (AOFAS, Illinois, United States of America) and The British Orthopaedic Foot and Ankle Society (BOFAS, Bristol, United Kingdom) have apps available on Android and iOS platforms. These apps were developed with the assistance of medical professionals and are well regulated and maintained, with good customer reviews.

Bunions Apps

Apps identified in this category were targeted at both patients and healthcare workers. None of these Apps had medical professionals involved in their development, and only one has received customer reviews. Dinato et al (5) assessed the reliability of two Apps by comparing these with their traditional goniometer technique for measurement of radiographic angles in hallux valgus and the time required for analysis with the different methods, they concluded that

using the Hallux Angles application had good inter-observer reliability for measurements of the hallux valgus angle (ICC 0.962) and inter-metatarsal angle (ICC 0.935), but only when used by experienced observers. They further reported that time required for the measurements was significantly shorter for the measurements when using both smartphone Apps compared with the goniometer method.

One App, iPinPoint, (i-SmartSolutions, Chalkida, Greece) was reliable for measurements of the hallux valgus angles by either experienced or non-experienced observers. According to Otter et al (6) moderate to high intra and inter-rater reliability of joint position and passive 1st MTPJ motion can be achieved with traditional and smartphone-based goniometric measurement.

Ankle sprains Apps

There are few patients directed apps for Ankle sprain. These were Physical Therapy Rehab (Fitivity, Massachusetts, USA) and Foot exercise (Express Sports Plus) Both these apps have good customer satisfactory reviews and are available in the UK. These Apps had no input in their development by medical professionals.

Diabetic feet Apps

Seven Apps related to diabetic feet were identified of which two had the involvement of medical professionals in their development; all seven had satisfactory customer reviews and all are related to patient care. One of these (Mat Lab App, BioMedical Engineering Online) is not available in UK. FootSnap is an app created by academics (Dr MoiHoon Yap, Senior Lecturer in Computer Science, and Professor Neil Reeves, Professor of Musculoskeletal Biomechanics) at The Manchester Metropolitan University. FootSnap is designed to run on an iPad tablet and was developed to aid medical professionals in capturing consistent photographs of the underside of diabetic feet in order to better detect foot ulcers and monitor improvement. In order to test the reliability of the App, a proof of concept study was conducted; the study concluded that standardization of plantar foot photographs would aid in the future implementation of advanced computer visual algorithms. These could ultimately aid in the monitoring of changes in diabetic foot shape, texture, and colour during longitudinal clinical trials or as part of clinical monitoring (8). FootSnap is currently not available in UK and not available on smartphones. Fraiwan et al (7) developed a mobile thermal imaging system which can be used to identify developing ulcers. The App was implemented utilizing the MATLAB Mobile platform in which thermal images were analyzed and interpreted. Such technology could aid in self-assessment, hence patients could identify diabetic ulcers before they occur.

Foot and ankle deformity Apps

There are several Apps which have been developed with the involvement of medical professionals that have good customer reviews available in the UK. The app Ankle & Foot Pro III (3D4, Elsevier Inc, Amsterdam, Netherlands) gives users an in depth view and allows them to cut, zoom and rotate the ankle and foot, this app provides multiple cross sections (sagittal, coronal and transverse) as well as the ability to cut away different layers revealing the muscles, blood vessels, nerves and connective tissue down to the bone. Each cross section shows muscle, nervous, vascular and skeletal systems with detailed information on each system. Ankle & Foot Pro III has a comprehensive interface which allows for user friendly navigation. Multiplier HD 12+

(Sinai Hospital of Baltimore Inc, Baltimore, USA) has a dedicated “Solomin Foot Analysis” which shows deformity correction planning for the midfoot, hindfoot, and ankle using reference lines and angles.

Pathoanatomy Apps

CTisus: CT of the Foot and Ankle & Foot Pro - 3D4Medical.com, LLC are apps that allow thin collimation and isotropic datasets apart from axial slices and simple multi-planar reconstructions. These advances in combination with easy to use 3D software have improved our ability to image the ankle with volume display. Creative and interactive 3D models and illustrations assist in understanding the bony anatomy of the ankle and foot. Both apps are aimed at healthcare workers and patients, both are available in the UK with good customer reviews.

Apps available for the communication of digital images

The Health Insurance Portability and Accountability Act (HIPAA) (9) set the standard for sensitive patient data protection. Companies that deal with protected health information (PHI) must have physical, network, and process security measures in place and must be HIPAA compliant. The Data Protection Act 2018 (10) controls how personal information is used by organisations, businesses or the government. There are several HIPAA complaint apps for digital image transfer like DocSpera 72.5 MB (Compliant Innovations Inc, California, USA), Ping MD 13.79 (Ping MD Inc, New York, USA), Tiger Connect 56.44MB (Tiger Connect Inc, Los Angeles, USA) which are available in both android and iOS systems, all have good customer reviews and are available in UK.

Pre-operative counselling Apps

There are four apps available for pre-operative counselling which were designed with the involvement of medical professionals, all of which have good customer reviews. Johansson et al (11) demonstrated that educating patients has a positive effect pre-operatively. There is currently a major gap in the field for well-designed, methodologically robust research into the long-term impact patient education has on patient health. The app is essentially a “sketch pad” for visually showing patients their disease, and demonstrating surgical techniques whilst explaining the anatomy. The app allows for the user to annotate the image with a pen and add text box comments. Once complete, the image can be saved and emailed to the patient. This will influence better medical compliance and improves patient physician relationship.

Post-operative Apps

There are two Apps in this category which were developed with input from medical professionals, both have good customer reviews. The App ‘Implant Identifier’ (Implant Identifier, Georgia, USA) allows for identification of ankle implants based on X-ray images. The app uses industry-leading AI technology to scan and match an implant with similar implants from an implant library. The ‘Physio Med’ App (Salaso Health Solutions Ltd, USA) provides high quality HD videos of rehabilitation exercises which may be prescribed by a healthcare professional.

Tumorpedia Apps

‘Foot and Ankle’ (BoneTumor, Massachusetts, USA) contains information on 20 to 50 different bone and soft tissue tumours that occur around the foot and ankle, covering the etiology, pathogenesis, clinical presentation, and examination findings, as well as example X-rays, MRI, and CT

images of each type of tumour. Special issues and challenges related to the foot and ankle are presented. In addition, the microscopic pathology findings are described and illustrated. The App provides information on treatment options and prognosis for each tumour.

Gait Apps

The ‘Rancho Gait App’ (Rancho Research Institute Inc, California, USA) is based on the Rancho Observational Gait Analysis System, a well-known method for teaching healthcare professionals a systematic approach to analyzing a individuals gait. The ‘Rancho Gait App’ allows the user to be an active participant in learning the essential elements of a normal and pathologic Gait. The App engages critical thinking in the learning process. The ‘Rancho Gait App’ can be used as a stand-alone learning aid by an individual or as an adjunct during a lecture

Prostheses App

Accelerometer Apps provide information on how amputees use their prostheses and how their use changes over time, this data may facilitate effective rehabilitation practices and enhance understanding of prosthesis functionality. Perpetual monitoring and classification of prosthesis use may also increase the health and quality of life for prosthetic users. Existing monitoring and classification systems are often limited in that they require the subject to manipulate the sensor (e.g. attach, remove, or reset a sensor), record data over relatively short time periods, and/or classify a limited number of activities and body postures of interest

Clinometer and Goniometer Pro 4+ Apps

This App assesses and measures the kinetic angles precisely and has been successfully tested in Orthopaedic, chiropractic, and physical therapy practices. The G-Pro 4+ Apps works like a digital gravity inclinometer, it does this by using the smartphones accelerometer to calculate the angle of rotation. The Clinometer App (Smart Tool Factory, Istanbul, Turkey) is the most precise slope measurement tool; the App calculates this by using the devices sides and the camera. The App can be used for tasks such as aligning a frame or measuring slopes required for external frames when performing deformity correction surgery.

Mobile Coder Foot & Ankle

Mobile Coder Foot & Ankle offers a unique graphical interface and several search options to aid in identifying correct CPT® codes.

Foot & Ankle apps by companies

The Foot & Ankle Indications App (Zimmer Biomet, Warsaw, USA) provides the Orthopaedic community with information on surgical techniques, training videos, case studies (including X-rays and diagrams) and other educational material. These resources accompany Zimmer Biomet solutions and are intended for use in medical training and education.

The conclusion of the joint meeting between the Academy of Medical Sciences and the Royal Academy of Engineering in 2014 was that smartphone Apps have the potential to increase the quality and efficiency of healthcare, and to empower consumers to manage their health better (12).

In 2014, the MHRA published Guidance on medical standalone software (13) (including Apps), which aimed to clarify when it considered an App to be a medical device and how it would be classified various aspects of European legislation apply to health Apps, and are currently being

revised. The European Commission also published a consultative Green Paper on mobile health in 2014 (14), to explore the issues surrounding mobile health and App development. Emphasis was placed on safety as naturally a major issue but data protection and personal privacy were also noted as relevant. Through a systematic search of iOS and Android App stores, and an analysis of the identified Apps which target individuals with chronic illnesses, we assessed the degree to which these Apps are likely to be useful in patient engagement efforts. Usefulness was determined based on the following criteria: description of engagement, relevance to the targeted patient population, consumer ratings and reviews, and most recent App update. Among the 1,046 healthcare related applications identified, 43% of iOS Apps and 27% of Android Apps were considered likely to be useful.

Data protection and personal privacy are also highly legislated in the EU and worldwide. Safeguarding personal data and consent for data processing must therefore be a

high priority for developers, given the potential for large fines (up to 5% of worldwide turnover is suggested in amendments to the proposed EU Data Protection Regulation) for organizations found to be in breach of data protection regulations.

Conclusion

Dedicated smartphones apps are the futuristic indispensable trend among foot and ankle surgeons. Despite concerns about the validity and reliability of their content, they have proven useful for both educational and surgical purposes. Smart phone app development sector, deliver economic benefits to the UK, in terms of employment opportunities and trade. With increased productivity and reduced healthcare costs “Primum Non Nocere” should be of considered first, before allowing Technology to assist health care. Lack of involvement of medical professionals and scientific validation is of major concern hence there should be Industry code of conduct for a balance for ensuring patient safety while supporting innovation in development.

Table 1

Educational content, Journals	Android Jrnl of Foot and ankle surgery-11.37MB iOS 1)JFAS 92.6MB Annual OH Foot &	Health care workers	2	1	2	2
Society/Membership apps	AOFAS-17.2 MB BOFAS-94.6MB AOFAS-17.2 MB BOFAS-94.6MB	Health care workers	2	1	2	2
Bunions	HalluxValgus 1.29MB Hallux valgus and how to deal with it 6.33MB Foot Valgus deformity6.42MB iPinPoint 13.2	Both	4	1	0	3
Ankle sprains	Ankle sprain –Physical Therapy Rehab 87.62MB Foot exercise(Guide)	Patients	2	2	0	2
Diabetic foot	Diabetic foot prevention 4.39 AQR –Diabetic foot 12.99MB Signs and symptoms Diabetic 4 Foot 10.64MB 5 Shree Diabetic foot Care speciality Centre5.08MB Thermal Imaging + MATL:AB apps (unable to find on UK app stores) FootSnap (unable to find on UK app stores)	Patients	7	7	2	4
Foot and ankle deformities	Ankle & Foot Pro III 409.9 MB Multiplier HD 58.2 MB	Health care workers	2	2	2	2
Patho-anatomy pre op assessment	CTisus: CT of the Foot 22.2 MB	Health care workers	1	1	1	1
Digital image communication	DocSpera 72.5 MB Ping MD 13.79 TigerConnect 56.44MB Docspera 30.74MB Ping MD 13.79 TigerText56.44MB	Health care workers HIPAA compliant	3	3	3	3
Pre op counselling	DrawMD Orthopedics	Patients	4	4	4	3

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