



Smartphone applications (apps) in general surgical practice: An insight into their reliability and usefulness

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ABSTRACT

Objective: In today's day and age with the advent of smartphones along with the handy apps available for download, there is increasing opportunities for surgeons to integrate such technology into clinical practice with great ease. This study aims to provide a systematic classification of apps in order to provide dependable data for choosing the right app by both surgeons and trainees.

Material and Methods: A series of methodical searches were carried out on "Google Play Store" and "Apple's App Store" with pre-decided keywords. The results were then sorted and segregated into relevant categories like core surgery, apps related to surgical practice, patient utility apps and other surgical branches. Thereafter, the apps that met with our cut-offs, were assessed for their credibility and utility, based on predefined parameters.

Results: There were a lot of variations in between the categories we segregated the apps into. Using predefined cutoff criteria, (rating >3 and reviews >30), 48 of the apps were assessed finally for their utility and credibility. Out of these 48 apps, 42 were on android platform while the remaining 6 were on iOS. Ten apps were found to be having high credibility and 15 apps have high utility.

Conclusion: The role of smartphone apps in surgery and surgical training appears highly promising and using apps with high credibility and utility will provide dependable and updated information for the surgeons and trainees.

Keywords: Smartphone applications, surgical apps, surgical learning

INTRODUCTION

Technological advancements have always had a major impact in the medical field. The smartphone is a shining example. It is a ubiquitous and dynamic device and has a myriad of functions (1). Smartphones have the potential to enhance many aspects of the continuum of surgical care by not only providing a systematic and methodical means of communication amongst surgeons, healthcare workers and patients but also to conduct consultations (telemedicine), clinical learning, research and e-learning, medical referencing etc. to name a few (2). The ease of use of smartphone, it's easy accessibility, mobility and connectivity provides the potential to improve the quality of surgical care from pre-rehabilitation to rehabilitation stage (3). This article aimed to analyze different smartphone surgical applications (apps) available in the popular online application stores (app store) and to provide a systematic classification of apps in order to provide a dependable data for choosing the right app by both surgeons and trainees.

MATERIAL and METHODS

A systemic search of two most widely used smartphone app online store "Google Play Store" which runs on android operating system (OS) and "Apple App Store" which runs on Apple operating system (iOS) was done using the keywords "Surgery" or "Surgical" or "Operative Surgery" till July 2021. Cross search with suggested apps was also done for apps related to surgical practice which are not general surgical apps but are related to surgical practice and are being used by surgeons/residents frequently for clinical purpose. These apps were then categorized into 5 groups: core general surgery apps, apps related to surgical practice, patient utility apps, apps related to other surgical branches and irrelevant apps (or others). After

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Table 1. Parameters used for assessment of credibility

Parameters	Points
Rating	
>3	1
3.1-4	2
>4.1	3
Reviews (number)	
30-100	1
101-500	2
501-1000	3
>1000	4
Updates (number)	
None	0
≥2 years ago	1
≥1 years ago	2
1 per year	3
2 per year	4
>2 per year	5
Quality of content (assessed by the investigator)	1-5
Owner of app	
Single/multiple individual/company	1
Established institute/authorised body	3
Total score	20

Table 2. Parameters used for assessment of credibility

Parameters	Points
Rating	
>3	1
3.1-4	2
>4.1	3
Interface	
Difficult	1
Intermediate	2
Easy	3
Cost of app	
Paid	1
Free	2
In app purchase	
Yes	1
No	2
Quality of content (assessed by the investigator)	1-5
Downloads	
<10,000	1
10,001-50,000	2
50,001-1 lakh	3
>1 lakh	4
>10 lakh	5
Total score	20

Table 3. Divisions of credibility and utility based on total score

Total score (20)	Credibility and utility
<11	Low
12-15	Medium
>15	High

excluding 'apps related to other surgical branches' and 'irrelevant apps (or others)', remaining three categories of apps were sorted on the basis of ratings and reviews. Apps with rating >3 and ≥30 reviews were included in this study. Their utility and credibility were then assessed based on predefined criteria (Table 1,2). The scoring system took into consideration the ratings, reviews, app updates, developers' credibility and the quality of the app content to ascertain the credibility of an app. Utility of the app was adjudged based on its ratings, user interface, cost of app, in-app purchases, number of downloads and the quality of the app's content. The total score was 20 for both credibility and utility. Minimum score was four for credibility and six for utility. The apps were then categorized as low, moderate or high credibility and utility based on their total score (Table 3).

Utility: Utility was assessed for the usefulness of the app. It gives an objective assessment about how user friendly the app is.

Credibility: Credibility was assigned according to the authenticity of the app. An Institution/University/Association/Journal developing an app was given higher level of credibility as compared to individual owned or company owned apps.

RESULTS

The systemic search in "Google Play Store" and "Apple App Store" respectively resulted in a total of 667 hits till July 2021. Out of these 667 apps, 420 apps were on android platform and 247 were found on the iOS.

436 apps were excluded for its irrelevancy or repetitions. Sixty-seven apps (11.4%) related to other surgical branches were also excluded. Rest of 164 apps were assessed and categorized as core surgical apps, apps related to surgical practice and patient utility apps. One app belonging to core surgical app group was excluded to avoid conflict of interest with one of the authors (owner of the app). Among the 164 apps, 91 (55.48%) fell into core surgical apps, 62 (37.8%) were apps related to surgical practice and 11 (6.7%) were patient utility apps.

Next, the apps were segregated based on their ratings and reviews. It was found that 116 apps had either <3-star rating or had <30 reviews (Figure 1). 48 of the remaining apps were assessed based on our pre-defined criteria to check their utility and credibility. Out of these 48 apps, 42 were on android platform while the remaining six were on iOS. Lack of important information required for assessment of iOS apps (number of downloads) led to exclusion of all six apps.

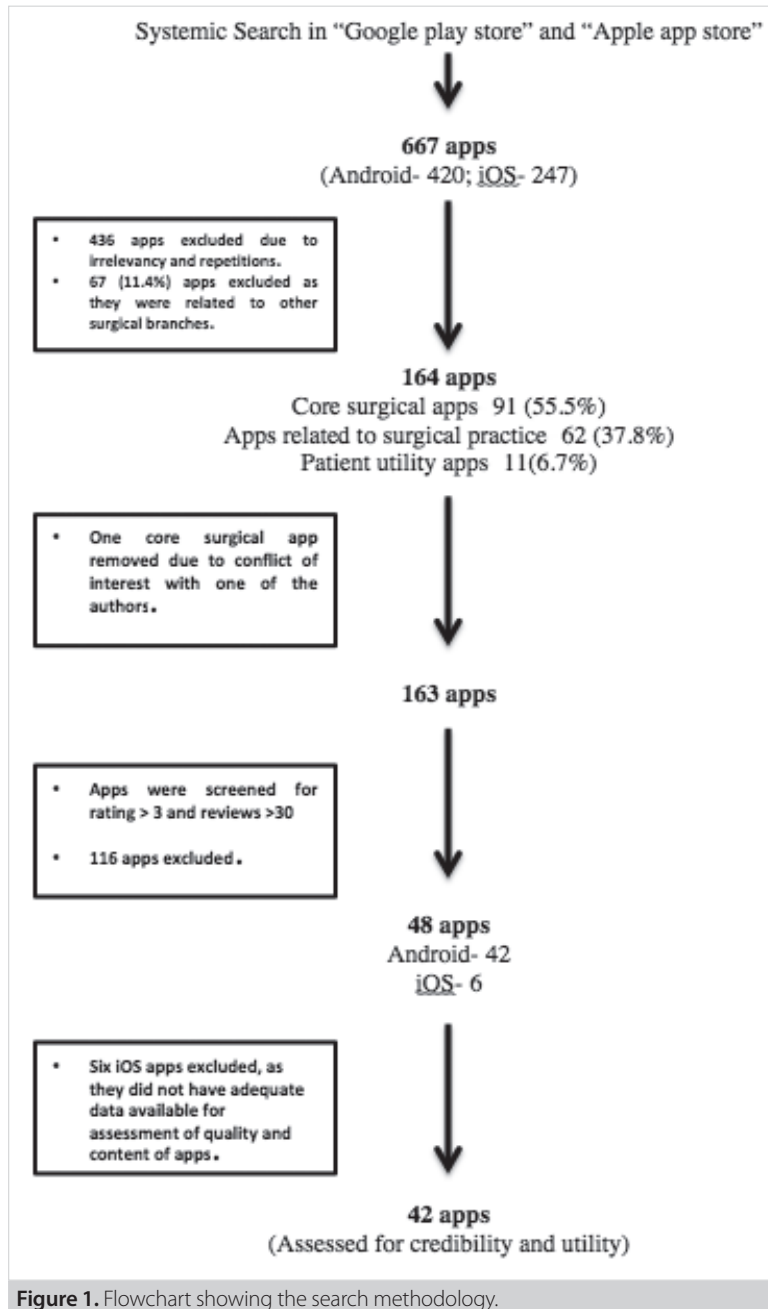


Figure 1. Flowchart showing the search methodology.

Finally, 42 apps were included in our study, which were assessed for their utility and credibility (Figures 2,3). It was found that 20 apps belonged to the core surgical group, and the rest 22 were related to apps for surgical practice group. Ten apps were found to be having high credibility and 15 apps have high utility (Table 4,5).

Core surgery apps: Out of the 20 core surgery apps, two apps were deemed highly credible, 10 were moderately credible and eight were low on credibility. Noteworthy apps like Touch Surgery has an amazing interface that allows its users to practice surgeries on anatomically accurate 2D and 3D models. This app

also allows medical professionals from authorized countries to complete their surgical training modules and bag CPD (continuing professional development) credits. Other highly credible app was the NCCN Guidelines®, in oncology consist of recommendations for the prevention, diagnosis and management of malignancy across the continuum of care. These incorporate real-time updates in keeping with the rapid advancements in the field of cancer research and management. Few other remarkable apps in this category were the Tokyo Guidelines (TG18), SimuSurg and General Surgery Instruments. These were graded as moderate on credibility.

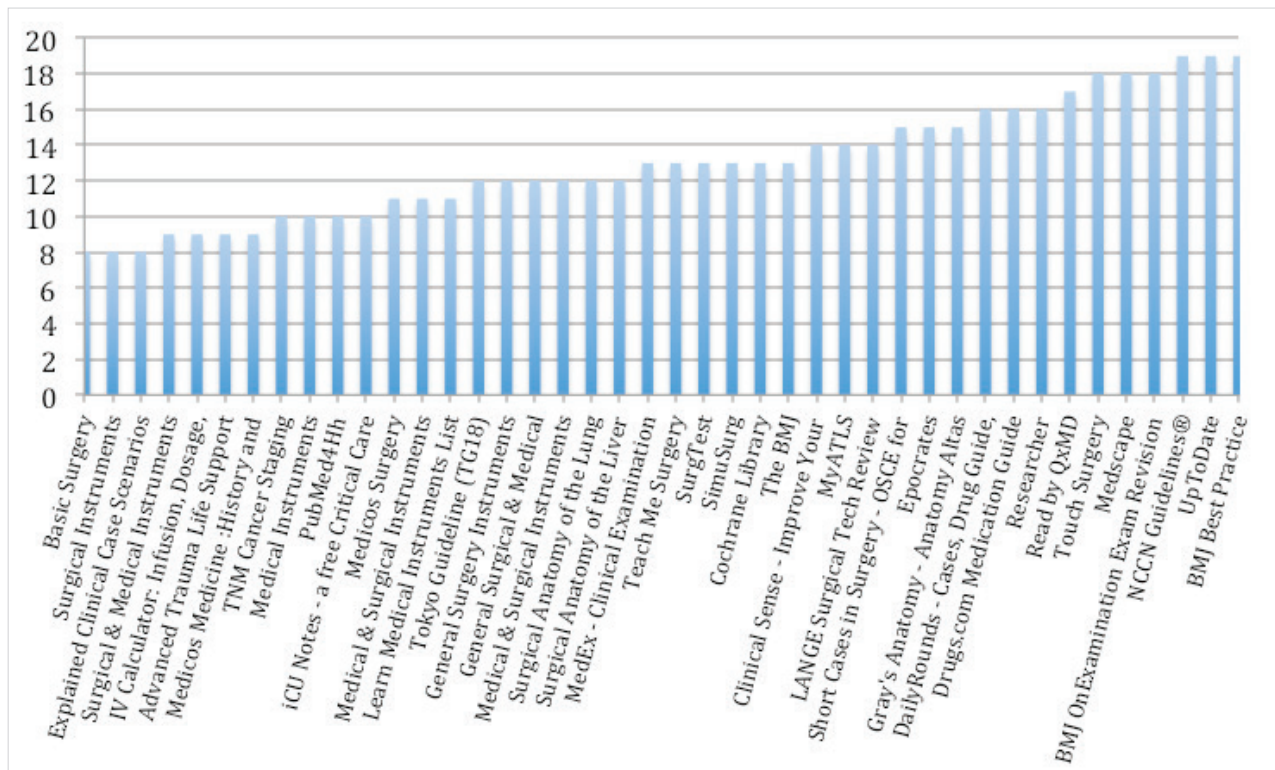


Figure 2. Bar diagram showing credibility score of surgical apps.

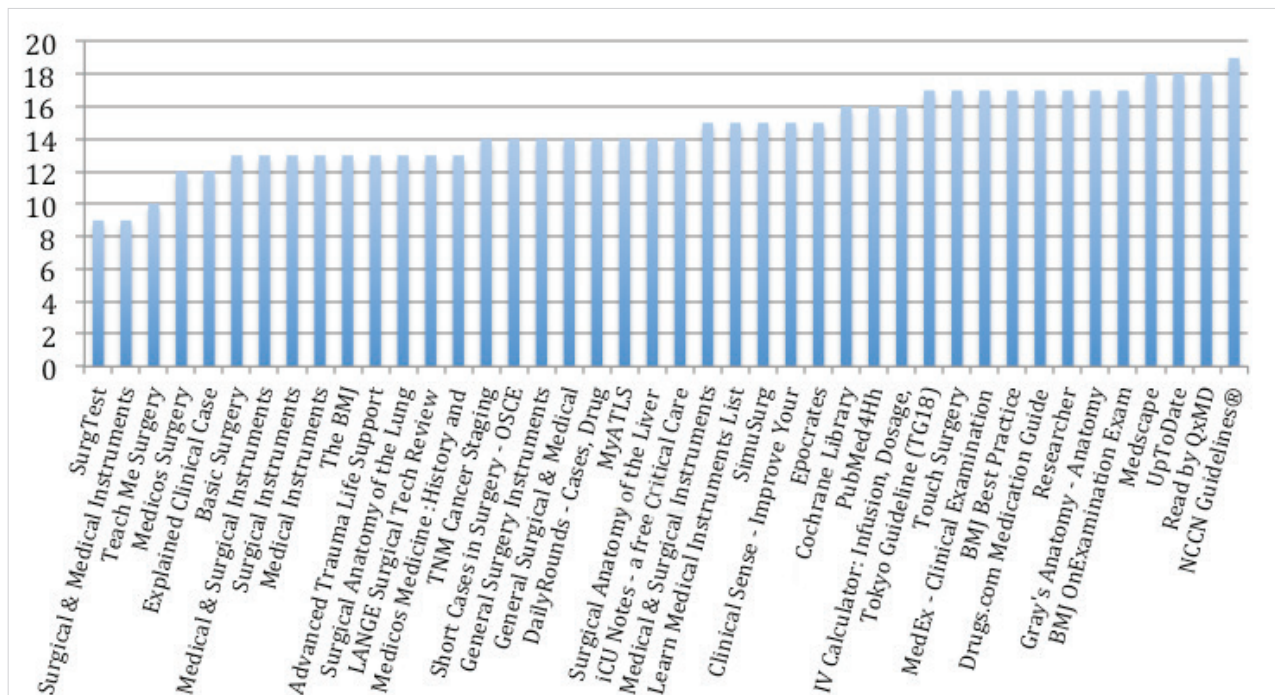


Figure 3. Bar diagram showing utility score of surgical apps.

Table 4. Credibility scoring and grading of the apps

S. No.	App Name	Developer	Credibility Score	Grade
1	Basic Surgery	Salina Akter	8	Low
2	Surgical Instruments	Koby Apps	8	Low
3	Explained Clinical Case Scenarios With Answers	Radioapps	8	Low
4	Surgical & Medical Instruments	Kadira Apps	9	Low
5	IV Calculator: Infusion, Dosage, Drug, Drip Rate	iMedical Apps	9	Low
6	Advanced Trauma Life Support	Current Clinical Strategies	9	Low
7	Medicos Medicine: History and Clinical Exam	Medicos	9	Low
8	TNM Cancer Staging	PGquest	10	Low
9	Medical Instruments	Alpesh Patel	10	Low
10	PubMed4Hh	NLM OHPCC	10	Low
11	iCU Notes-a free Critical Care Medicine	dev@doc-notes.com	10	Low
12	Medicos Surgery	Medicos	11	Low
13	Medical & Surgical Instruments Images & Uses	NassApp	11	Low
14	Learn Medical Instruments List	GIF Developer	11	Low
15	Tokyo Guideline (TG18)	株式会社C2 (C2, Inc.)	12	Medium
16	General Surgery Instruments	K.S.M. Studios	12	Medium
17	General Surgical & Medical Instruments-All in 1	First-rate-apps	12	Medium
18	Medical & Surgical Instruments	Dagana Apps	12	Medium
19	Surgical Anatomy of the Lung	Emory University	12	Medium
20	Surgical Anatomy of the Liver	Emory University	12	Medium
21	MedEx-Clinical Examination	Bharath Reddy	13	Medium
22	Teach Me Surgery	TeachMeSeries Ltd	13	Medium
23	SurgTest	SurgTest	13	Medium
24	SimuSurg	Royal Australasian College of Surgeons	13	Medium
25	Cochrane Library	The Cochrane Collaboration	13	Medium
26	The BMJ	BMJ	13	Medium
27	Clinical Sense-Improve Your Clinical Skills	Medical Joyworks LLC	14	Medium
28	MyATLS	American College of Surgeons	14	Medium
29	LANGE Surgical Tech Review	Higher Learning Technologies Inc	14	Medium
30	Short Cases in Surgery-OSCE for Medical	RER MedApps	15	Medium
31	Epocrates	Epocrates, Inc.	15	Medium
32	Gray's Anatomy-Anatomy Atlas 2020	SEStudio	15	Medium
33	DailyRounds-Cases, Drug Guide, ECG for Doctors	Neuroglia Health	16	High
34	Drugs.com Medication Guide	Drugs.com	16	High
35	Researcher	Researcher	16	High
36	Read by QxMD	QxMD Medical Software, Inc.	17	High
37	Touch Surgery	Digital Surgery Limited	18	High
38	Medscape	WebMD, LLC	18	High
39	BMJ OnExamination Exam Revision-Free Questions	BMJ	18	High
40	NCCN Guidelines®	National Comprehensive Cancer Network (NCCN)	19	High
41	UpToDate	Wolter Kluwer Health	19	High
42	BMJ Best Practice	BMJ	19	High

Table 5. Utility scoring and grading of the apps

S.No.	App Name	Developer	Utility Score	Grade
1	SurgTest	SurgTest	9	Low
2	Surgical & Medical Instruments	Kadira Apps	9	Low
3	Teach Me Surgery	TeachMeSeries Ltd	10	Low
4	Medicos Surgery	Medicos	12	Medium
5	Explained Clinical Case Scenarios With Answers	Radioapps	12	Medium
6	Basic Surgery	Salina Akter	13	Medium
7	Medical & Surgical Instruments Images & Uses	NassApp	13	Medium
8	Surgical Instruments	Koby Apps	13	Medium
9	Medical Instruments	Alpesh Patel	13	Medium
10	The BMJ	BMJ	13	Medium
11	Advanced Trauma Life Support	Current Clinical Strategies	13	Medium
12	Surgical Anatomy of the Lung	Emory University	13	Medium
13	LANGE Surgical Tech Review	Higher Learning Technologies Inc	13	Medium
14	Medicos Medicine: History and Clinical Exam	Medicos	13	Medium
15	TNM Cancer Staging	PGquest	14	Medium
16	Short Cases in Surgery-OSCE for Medical	RER MedApps	14	Medium
17	General Surgery Instruments	K.S.M. Studios	14	Medium
18	General Surgical & Medical Instruments-All in 1	First-rate-apps	14	Medium
19	DailyRounds-Cases, Drug Guide, ECG for Doctors	Neuroglia Health	14	Medium
20	MyATLS	American College of Surgeons	14	Medium
21	Surgical Anatomy of the Liver	Emory University	14	Medium
22	iCU Notes-a free Critical Care Medicine re	dev@doc-notes.com	14	Medium
23	Medical & Surgical Instruments	Dagana Apps	15	Medium
24	Learn Medical Instruments List	GIF Developer	15	Medium
25	SimuSurg	Royal Australasian College of Surgeons	15	Medium
26	Clinical Sense-Improve Your Clinical Skills	Medical Joyworks LLC	15	Medium
27	Epocrates	Epocrates, Inc.	15	Medium
28	Cochrane Library	The Cochrane Collaboration	16	High
29	PubMed4Hh	NLM OHPCC	16	High
30	IV Calculator: Infusion, Dosage, Drug, Drip Rate	iMedical Apps	16	High
31	Tokyo Guideline (TG18)	株式会社C2 (C2, Inc.)	17	High
32	Touch Surgery	Digital Surgery Limited	17	High
33	MedEx-Clinical Examination	Bharath Reddy	17	High
34	BMJ Best Practice	BMJ	17	High
35	Drugs.com Medication Guide	Drugs.com	17	High
36	Researcher	Researcher	17	High
37	Gray's Anatomy-Anatomy Atlas 2020	SEStudio	17	High
38	BMJ OnExamination Exam Revision-Free Questions	BMJ	17	High
39	Medscape	WebMD, LLC	18	High
40	UpToDate	Wolter Kluwer Health	18	High
41	Read by QxMD	QxMD Medical Software, Inc.	18	High
42	NCCN Guidelines®	National Comprehensive Cancer Network (NCCN)	19	High

Furthermore, under the core surgery category, four apps were graded high on utility, 13 apps were moderate on utility while only three apps were graded as low on credibility. Tokyo Guidelines (TG18), Touch Surgery, NCCN Guidelines® along with MedEx-Clinical Examination were found to be highly useful for surgeons and surgical trainees. Many apps that dealt with surgical instruments or clinical case scenarios in surgery or those that simply dealt with the common surgical conditions and clinical examinations fell under moderate utility. Medicos Surgery, Basic Surgery, SurgTest, Clinical Sense-Improve Your Clinical Skills are examples of such apps. The TNM Cancer Staging app also fell under moderate utility.

Apps related to surgical practice: Out of the total 22 apps that fell under this category, eight were highly credible, eight were moderately credible, whereas six apps were graded as low on credibility. DailyRounds claims to be India's largest academic network of doctors with more than five lakh active users in India and more than 10 lakhs across the globe. It is a platform to discuss clinical cases and keep oneself updated with the latest practice-relevant journal articles, and treatment guidelines etc. This app was categorised as high under credibility and moderate under utility. One of the most popular and comprehensive apps for drug information is drugs.com and it was rated high under both credibility and utility. Other noteworthy apps were, Medscape, Researcher, UpToDate, Read by QxMD, and BMJ On-Examination, BMJ Best Practice and The BMJ that offer a plethora of uses to its users ranging from intensive topic searches to access to latest journals to practice revision for standardized examinations. All these apps were graded high on credibility.

Under the apps related to surgical practice category, out of the total 22 apps, half of the apps (11 apps) were graded as high on utility while the other half fell into the moderate utility. The Cochrane Library app contains a collection of high-quality independent evidence to inform the healthcare workers decision making. The Cochrane Database of Systemic Reviews is one of the leading resources of systematic reviews in healthcare and is continuously being updated for its users. This was categorized as high on utility. Gray's Anatomy-Anatomy Atlas 2020 is a free application that can be used in offline mode to view and learn anatomy using brilliant illustrations. It also has quizzes to test oneself. This app was also graded high on utility.

DISCUSSION

There has been a revolution in the mobile phone industry in the last three decades that involves both the hardware and software development (4). With the continuous improvement in hardware there has been increased processor performance, better display screens with increased resolution and display quality, increased random access memory and storage memory, widely available long and short-range wireless data communication capabilities, improved camera quality, better battery

life and last but not the least miniaturization of the hardware size. With hardware development, mobile software has become more complex and diverse leading to replication of functions of a computer in a phone what we call as smartphone (4).

As mobile platforms become more user friendly and readily available, innovators have begun to develop highly complex mobile apps to leverage the portability that mobile platforms offer. Some of these new software functions are specifically targeted at assisting individuals with their own health and wellness management (5). Other software functions are targeted at health care providers as tools to improve and facilitate the delivery of patient care and improved medical education (6), especially in resource-constrained environments (like the COVID-19 pandemic). There has been significant increase in the number of surgical apps in past decade (7-9). However, there is a need for classification of apps based on their purpose and the audience that they are intended for. We suggest that the surgical apps may be further divided into apps for clinicians and students and apps suitable for patients. Apps for clinicians and students can further be divided into core surgery apps (apps for clinical learning, surgical simulation and practice management) and apps related to surgical practice (apps for journal reading, research, clinical database, medical networking, tele-communication, online teaching, digital note taking and drug prescription).

Concerns have been raised and reported about the unreferenced content of smartphone apps, lack of qualified professional involvement, absence of surgical society endorsement and lack of regulation by clinical or governing bodies (10). The United States Food and Drug Administration (FDA) had issued recommendations in the form of "Policy for Device Software Functions and Mobile Medical Applications" in 2013 and it was modified later in 2019 (11). However, it does not include majority of surgical applications and has only included certain software applications that meet the definition of a 'medical device' and identified specific regulatory requirements that apply to them.

FDA regulation applies to only those software/apps that are 'medical devices' and whose functionality could pose a risk to a patient's safety if the device does not perform as intended (11). So, the intended use of a mobile app determines whether it will come under FDA regulation or not. Mobile medical apps, according to FDA, include only those mobile apps that meet the definition of a 'device' (by FDA) and either intended to be used as an accessory to a regulated medical device or to transform a mobile platform into a regulated medical device. In simple terms, if an app is intended to be used for performing a medical device function (for diagnosis, treatment or prevention of disease) it is a 'medical device'. For example, mobile apps intended to run on smart phones to interpret ECG waves in order to detect cardiac rhythm abnormalities.

There is also a group of software or apps, which are not considered as 'medical devices' by FDA such as apps that are intended to provide access to electronic copies (e.g., e-books, audio books) of medical textbooks or other reference materials (PubMed, UpToDate etc.). So both of these two groups of app doesn't need FDA approval (11). Hence, many of the apps used in the field of surgery will not fall into the FDA regulation (e.g., simulations, surgical database etc.). The lack of medical professional involvement, evidence-based content and peer review makes it challenging for even an experienced consumer in choosing the right app. In this study, we have tried to sub classify the surgical apps into groups (low, moderate and high) based on both utility and credibility, in order to make it easy for the students, clinicians and patients to choose the right apps for their purpose.

One of the drawbacks of our study is that we have excluded apps with lesser than three rating and 30 reviews, in order to remove all applications with very poor quality and unreliable content. However, in order to do so, we had to exclude few apps which are noteworthy. Many apps, which we came across during our search, but they lacked adequate reviews as well as ratings, due to fewer number of downloads. So, they have not been assessed for utility and credibility but they might benefit the trainees and surgeons because of their rich content. "3D skull Atlas", "surgery on call" were amongst those few to mention. Similarly, few iOS apps which were also deserve to be mentioned because of their content. However, we could not include them in our study due to lack of important data needed to classify the apps based on the predefined criteria. "LapGuru-Surgery Training" which is one of a kind app that enables its users to view and learn about laparoscopic surgery. It has a step-by-step description of various laparoscopic (lap) surgeries from various disciplines. It has more than 6500 videos of lap surgeries in its library. "Journal of Surgical Oncology" an iOS app by Wiley Publications is one of the reputed sources of information in the field of surgical oncology. It not only has the latest updates, articles and developments in its field, but also allows its users to download various articles for offline reading/review. However, they were excluded from our study in view of adequate reviews as well as ratings.

CONCLUSION

Using surgical smartphone apps have their own set of drawbacks. App dependency of trainees for complex classifications or guidelines, lack of clinical skill development (especially in the middle of COVID-19 pandemic), lack of updated content of highly credible apps are a few worth mentioning. However, their benefits surpass these drawbacks. Incorporation of author details, a greater number of surgical societies endorsed apps,

periodic updates and increased regulation should help maintain the credibility and utility of the apps in future.

Ethics Committee Approval: For this study, it is not necessary to have the ethical approval.

Peer-review: Externally peer-reviewed.

Author Contributions: **Author Contributions:** Concept - S.V.G., W.F.K.; Design - S.V.G., W.F.K.; Supervision - P.A.; Data Collection and/or Processing - A.S., W.F.K.; Analysis and/or Interpretation - A.S.; Literature Search - A.S., W.F.K.; Critical Reviews - P.A., S.V.G.

Conflict of Interest: The authors have no conflicts of interest to declare.

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ORİJİNAL ÇALIŞMA-ÖZET

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Genel cerrahi pratiğinde akıllı telefon uygulamaları (apps): Güvenilirlikleri ve kullanılabilirlikleri üzerine bir çalışma

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ÖZET

Giriş ve Amaç: Akıllı telefonların icadı ve bu telefonlarda kullanılabilen indirmeye hazır faydalı uygulamalar ile birlikte bu çağımızda cerrahlar, bu tür teknolojileri kolaylıkla cerrahi pratiklerine entegre etmek için her geçen gün daha çok fırsat ile karşılaşmaktadır. Bu çalışma, hem cerrahlar hem de cerrah adaylarının doğru uygulamayı seçmesi için güvenilir veriler sağlamak adına uygulamalar için sistematik bir sınıflama sunmayı amaçlamıştır.

Gereç ve Yöntem: Önceden karar verilen anahtar kelimeler kullanılarak "Google Play Store" ve "Apple App Store" üzerinde bir dizi metodolojik araştırma yapıldı. Daha sonra sonuçlar, ilgili kategorilere ayrıldı: ana cerrahi branşlar, cerrahi pratik ile ilgili uygulamalar, hastaların fayda sağlayacağı uygulamalar ve diğer cerrahi branşlar. Daha sonra, eşik değerlerimiz ile uyuşan uygulamalar, önceden belirlenmiş parametreler doğrultusunda güvenilirlikleri ve kullanılabilirlikleri açısından değerlendirildi.

Bulgular: Uygulamaları ayırdığımız kategoriler arasında çok fazla varyasyon vardı. Önceden belirlenmiş eşik kriterlerini kullanarak (derecelendirme >3 and değerlendirme >30), kullanılabilirliği ve güvenilirliği için 48 uygulama değerlendirildi. Bu 48 uygulamadan 42'si android platformdayken 6'sı iOS platformundaydı. On uygulamanın yüksek güvenilirliği ve 15 uygulamanın yüksek kullanılabilirliği olduğu bulundu.

Sonuç: Cerrahide ve cerrahi eğitiminde akıllı telefonların rolü yüksek oranda ümit verici gözükmekte ve yüksek güvenilirliğe ve kullanılabilirliğe sahip uygulamaların kullanılması hem cerrahlara hem de cerrah adaylarına güvenilir ve güncellenmiş bilgiler sağlamaktadır.

Anahtar Kelimeler: Akıllı telefon uygulamaları, cerrahi uygulamalar, cerrahi eğitim

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