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| ORIGINAL

ImplantoPUC: an educational application for mobile computing devices aimed at patients and professionals in the field of Implantology

ImplantoPUC: aplicativo para orientação de pacientes, estudantes e cirurgiões-dentistas sobre os implantes osseointegráveis

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ABSTRACT

Objective: development of an application for mobile computer devices, mobile phones and tablets, which contains educational material for patients and professionals in the area of Implantology. The use of ImplantoPUC at PUC Minas implant dentistry clinics aims at a more effective communication between professionals and patients, with better visualization of the proposed treatments, improving the understanding of patients. **Methods**: for the development of ImplantoPUC, a responsive technology was used, and the application windows can adapt to different screen formats, consequently, the application can be made available on different platforms such as: Web, Android and Apple. The application size is 13.4 MB and was developed using the OutSystems platform using Apache Cordova. The prototype of the ImplantoPUC application can already be accessed through the link https://includesistemas.outsystemcloud.com/implantpuc/homescreen. **Results**: the application is still under test at PUC Minas implant dentistry clinics, but due to the pandemic its use is still below expectations. In the Play Store your rating has a maximum rating of 5.0, with more than 50 downloads so far. **Conclusion**: ImplantoPUC makes the task of informing more interactive and easy to understand for patients, also assisting professionals in the area in obtaining updated information and at the reach of hands, and can also be used in other Dentistry Educational Institutions, becoming a reference in the area of implant dentistry.

Indexing terms: Computers handheld. Dental Implantation. Information.

RESUMO

***Objetivo**: desenvolvimento de um aplicativo para dispositivos móveis de informática, celulares e tablets, que contém material educacional para os pacientes e profissionais da área da Implantodontia. A utilização do ImplantoPUC nas clínicas de Implantodontia da PUC Minas visa uma comunicação mais efetiva entre profissionais e pacientes, com melhor visualização dos tratamentos propostos,*

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melhorando o entendimento dos pacientes. ***Métodos****: Para o desenvolvimento do ImplantoPUC foi utilizado uma tecnologia responsiva, podendo as janelas do aplicativo se adaptarem a diferentes formatos de telas, consequentemente, o aplicativo pode ser disponibilizado em diferentes plataformas como: Web, Android e Apple. O tamanho do aplicativo é de 13,4 MB e foi desenvolvido utilizando a plataforma OutSystems, utilizando a Apache Cordova. O protótipo do aplicativo ImplantoPUC já pode ser acessado através do link https://includesistemas.outsystemcloud.com/implantpuc/homescreen.* ***Resultados****: O aplicativo ainda continua em teste nas clínicas da PUC Minas, mas em virtude da pandemia o seu uso está abaixo do esperado. Na Play Store a sua avaliação tem nota máxima 5,0, com mais de 50 downloads até o momento.* ***Conclusão****: O ImplantoPUC torna a tarefa de informar mais interativa e de fácil compreensão para os pacientes, auxiliando também os profissionais da área na obtenção de informações atualizadas e ao alcance das mãos, podendo também ser utilizado em outras instituições de ensino da Odontologia, tornando-se uma referência na área da Implantodontia.*

Termos de indexação*: Computadores de mão. Implantação dentária. Informação.*

INTRODUÇÃO

An application is a specialized program downloaded within mobile devices, as in Smartphones and Tablets. Applications (APPS) can perform multiple functions, and with the development of applications for the health area, there was a major transformation in the medical performance within the daily clinic [1,2].

Health applications for mobile devices (commonly designated mHealth) are wireless (Wi-Fi) communication devices developed to assist public health policies and to assist clinical practice. Mobile devices are portable by nature and include mobile phones, personal digital assistants (iPads, tablets), patient monitoring devices, and other wireless devices [3,4].

These applications, mHealth, are getting more attention due to the widespread global penetration of mobile technologies. It is estimated that more than 85% of the world's population has commercial Wi-Fi signal coverage and over 5 billion people have cell phone signatures. More than 70% of people living in middle and low-income countries have cell phones, and the availability of mobile technologies in these countries is more advanced than highways and electricity supply [4,5].

Mobile medical applications present several purposes and can be used for communication between individuals, communication with health systems such as call centers, scheduling of medical appointments, reminders of adherence to treatment, patient monitoring and medical surveillance, access to information pertinent to the proposed treatment, medical data record of patients and distance treatment support [2,4,5].

The Royal Tropical Institute defined eight areas in the application of these apps in the health area [4].

a) Educational Informative systems: provide information on health promotion and disease prevention.

b) Support for medical care: used to provide the clinician with information for special care with the patient, as well as assistance for the diagnosis;

c) Patient monitoring and support for adherence to the proposed treatment;

d) Health surveillance: monitoring of epidemic outbreaks and infectious diseases, promoting the tracking of these diseases in real time;

e) Medical emergency systems: promote disaster and accident alerts;

f) Health Management Systems: manages patient data, used in clinical care;

g) Education systems (e-mLearning): Educational platforms to support health professionals (doctors and dentists);

h) Financial support systems: applications to facilitate the use of smart cards and vouchers for paying bills through cell phones (ePay).

Applications for distance learning, also called e-learning, are listed in categories according to educational purposes for which they were developed into four main categories:

– Educator Support: Refer to the resources that can be used to assist in the learning and commitment of students. Examples: KeyNote, IMovie, Design 2.

– Learner Support: They refer to instruments that in addition to promoting learning, also help students in many roles. Example: Notes, Kindle, Dropbox.

– Performance Support: These applications are resources that help professionals in the medical field just-in-time, for use in the work setting. Examples: BMI calculator, Medscape, Pocket Lab values, PubMedMobile.

– Learning Activities: include those aimed for the specific purpose of learning and can be divided in those aimed at learning of healthcare students and professionals, as well as those designed for patient education or to assist healthcare professionals in providing patient education. Examples: Human Body, ECGtest, Clinical Sense, Elder Guide, among others [6] ImplantoPUC is included within this last classification.

Within the context of health surveillance, we can mention Google Flu Trends (*https://brasil.googleblog.com/2010/06/google-tendencias-da-gripe-agora.html*) that guides low-income populations on how to prevent the transmission and dissemination of diseases in the affected places, monitoring data of school absenteeism, increase in the purchase of antivirals, among other measures, monitoring and exercising surveillance in the control of diseases.

Another example of how the use of Information and Communication Technologies can be used to identify outbreaks and control diseases is the HealthMap tool (http://www.healthmap.org) that uses online sources such as government websites, social networks, and local press reports to map potential disease outbreaks and monitor public health trends. This software was able to detect Ebola outbreak in Liberia nine days before its announcement by the World Health Organization (WHO).

In the last 50 years, Dentistry, more precisely Implantology, has evolved to replace missing teeth by implant prostheses with high success rates around 95%. Currently, it has become a wide modality of treatment used in daily clinical practice for the oral rehabilitation of patients with partial and total edentulous, with significant functional and biological advantages when compared to conventional prostheses [7].

However, the explanation of treatment often complex for patients is a difficult task by the very nature of oral rehabilitation by implants, which has several phases of execution, which demands time and whose means available for this guidance are limited.

The area of implant lacks satisfactory instruments that allow the patient to visualize the planned procedures, as well as the result. Verbal explanations usually are not enough, and photographs of real cases and photos of books are often inadequate and inefficient to assist patients in the decision making of treatment. Thus, the use of technologies through mobile applications can improve the dentist-patient interaction [8,9].

In the face of the above, the goal was to develop a mobile and tablet app, the ImplantoPUC, which contains educational material for patients and professionals in the Implantology area. This didactic and instructional material presents information on the numerous possibilities of dental treatment through osseointegrated implants. The use of the ImplantoPUC in the implant clinics of PUC-MG it seeks a more effective communication between professionals and patients, leading to a better visualization of the proposed treatments and understanding of the results, and consequently to a greater involvement of the patients and increased adherence to treatment.

METHODS

For the development of ImplantoPUC, a responsive technology has been used, and the application windows can adapt to different screen formats, so the application can be made available on different platforms such as: Web, Android, and Apple. However, in its first version the application is better formatted for mobile devices. The minimum and recommended requirements for installing the application are shown in the table below. The application size is 59 MB and was developed using the following technologies: Html, Java script and jquery, Cordoba and Framework 7. ImplantoPUC can be accessed through the *links*: Web and Google Play. To develop ImplantoPUC, an application developer was hired. Several meetings were held to establish the necessary requirements for the application to have excellent usability. Initially a prototype was elaborated in images, from this prototype some information were scored to be possible to arrive at a development proposal. After the first version was released, some adjustments were required to achieve the currently available version.

The application is composed of explanatory texts developed in scientifically correct language, simple and easy to understand by the patients. Images of implants, prosthetic connections, types of existing prostheses, images of treatments, among others, facilitated the understanding of patients were also used. The text and images are authored by the project team.

The application explains in detail all the steps to an oral rehabilitation through osseointegrated implants, containing information on the following topics:

Table 1. Minimum requirements and recommended specifications.

	Android	IOS
Minimum requirements	Android 4.4 or later	IOS 8 or later
Recommended specifications	Android 5.0 or later	iPads and iPhone 5s or later

Source: Elaborated by the author

1) Basic information:

a) What are dental implants?
b) What types of existing implants?
c) What material are dental implants made of?
d) How do they work?
e) How were they invented?
f) Is the use of implants safe?
g) What are the indications and contraindications in the use of osseointegrated implants?
h) Am I a candidate for dental implants?
i) What are the advantages and disadvantages of using osseointegrated implants?

2) Implant prostheses:

a) What types of prostheses are available for implants?
b) What material can prostheses be made on implants?
c) Is it necessary to maintain implants prostheses?
d) Are these implants prostheses durable and resistant?

3) Surgeries related to the placing of implants:

a) How are performed surgeries for the placement of implants?
b) What are limits of implant installation?
c) What is the post-operative care?
d) How long will it take to heal the surgical area?
e) What are the complications that may occur after surgery?

4) Maintenance of implants and possible complications:

a) What could cause loss of implant?
b) Is there rejection of the implant?
c) What is Peri-implantitis?
d) Procedures for the maintenance of implants and implants prostheses.

To assess the usability and level of satisfaction of ImplantoPUC users, a questionnaire was elaborated with the following questions:

The ImplantoPUC application is in the testing phase and for this was elaborated a questionnaire with 4 (four) questions that will be applied in implantology clinics of PUC-MG among patients undergoing treatment in the year 2020 to verify the possible needs of adaptations and / or modifications of usability and satisfaction of users with ImplantoPUC.

1) Has the ImplantoPUC application clarified your doubts regarding the treatment of dental implants? Yes ( ) No ( )

2) Were the images and figures of the application enlightening and useful in your decision-making regarding the treatment of dental implants? Yes ( ) No ( )

3) Have you had difficulty handling or browsing the app? Yes ( ) No ( )

4) Would you indicate this app to other people interested in the treatment with dental implants? Yes ( ) No ( )

This questionnaire will be applied to patients undergoing treatment at implantology clinics at PUC-MG. After reaching a sample of at least 100 patients, an analysis of the results will be performed to measure the quality and usability of the ImplantoPUC application proposal and its results will be demonstrated in another future study. Due to the pandemic, research and classes were interrupted, as well as the evaluation of the app in the implantology clinics of PUC-MG in 2020.

RESULTS

In this section we present the results of the application development ImplantoPUC. It was developed with responsive technology, can adapt to different types of screen, consequently, easy to adapt to platform Web and mobile devices. In its first version, the ImplantoPUC is optimized to be available for devices with operating systems Android. On GooglePlay the app was rated by some users getting an average of five stars. ImplantoPUC can be accessed later via the web(link).

Examples of some of the application screens will be presented, running on both mobiles and tablets. The figure 1 and 2 are examples of the implementation of ImplantoPUC in an Tablet, in figure 1 displays the opening screen and figure 2 shows the menu after the user accesses the input button. This menu allows the user to browse through the application screens, selecting the desired option, being possible access all information made available by ImplantoPUC, through the button located up to the left, shown in figure 3.

This same example of access is exemplified in the figures 4 and 5 when accessing the application in an iPad Tablet. To exemplify responsive technology used in the application implementation, the figure 6 shows the layout of the screen when rotating the Tablet, positioning it horizontally. It can be observed that in this format the menu is already shown directly, without the need to drive.

Figure 1. ImplantoPUC Application Start Screen Viewed by the app on a Tablet.

In the main menu presented, the icons refer to the informative screens for each step of the treatment with osseointegrated implants. The information in each of the icons are described below:

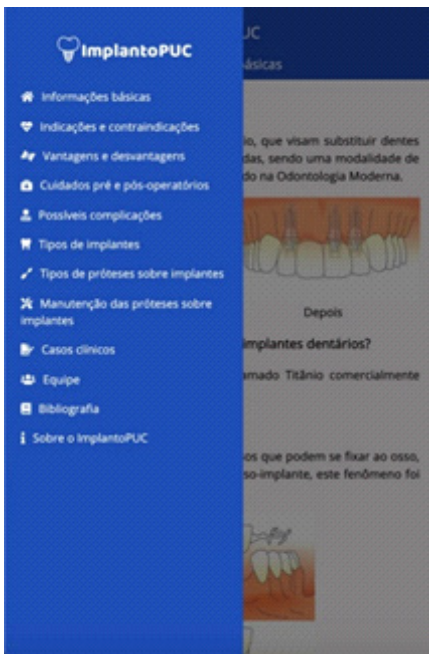

Figure 2. ImplantoPUC Application Menu. The menu gives direct access to 12 distinct information provided by the application.

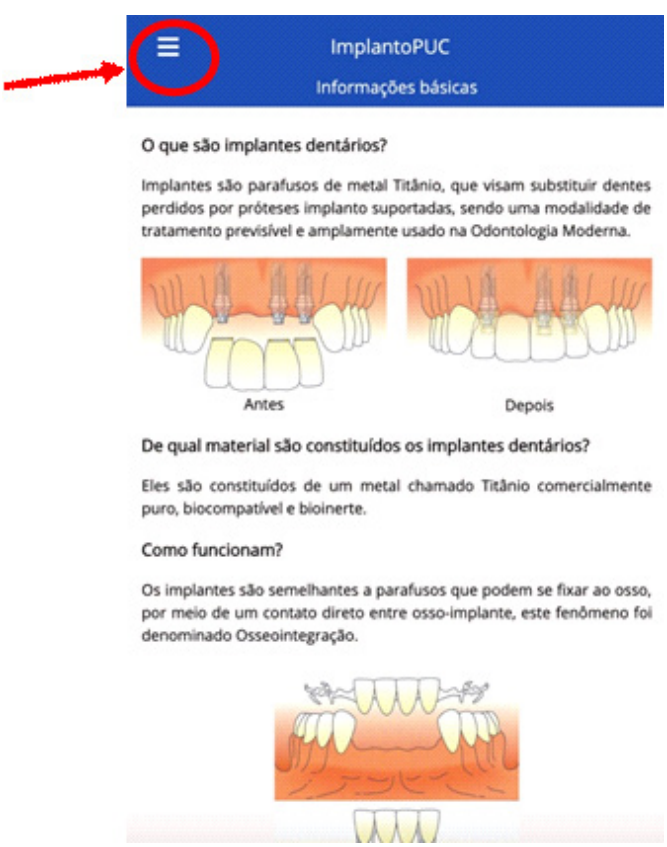

Figure 3. The figure shows through the arrow and the red circle the button to access the application menu. This button can be accessed at any time. In the case of this figure the user was on the basic information screen.

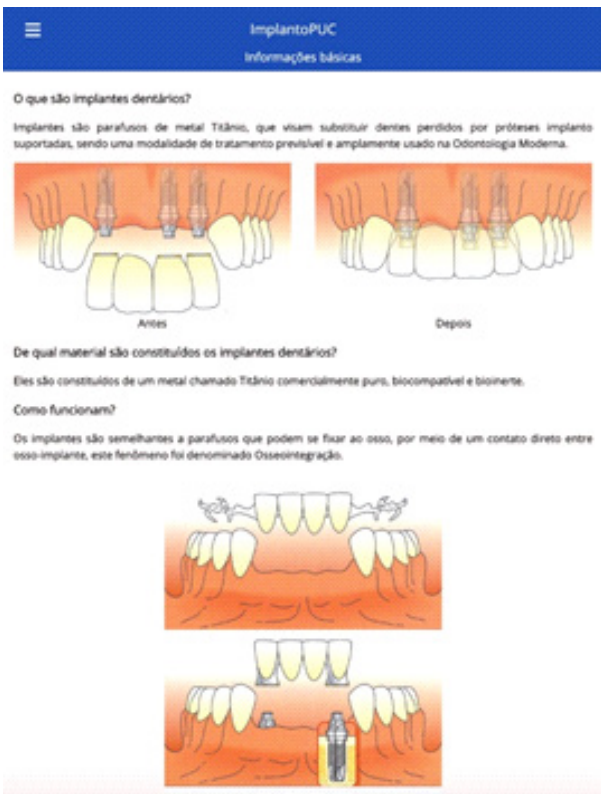

Figure 4. View the App Basics screen on a tablet.

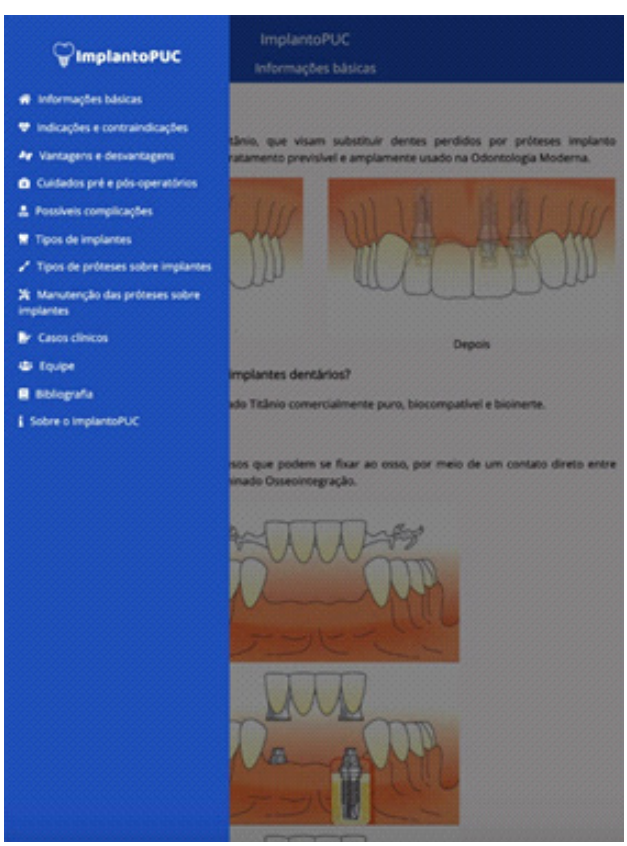

Figure 5. View the access of the application menu on a Tablet.

• Basic information: Presents the user with the general information about what are dental implants and how they work, and how the implants have been discovered (figure 1). These information's guide the patient about the use of the implants.

• Indications and Contraindications: Inform the user when it is indicated the use of dental implants to recover the masticatory function and the contraindication in rehabilitation with implants when the presence of certain morbidities definitive and/or transitional character, that makes it impossible performing the surgery. This will allow the patient to be clarified whether or not he is a good candidate for implant placement.

• Advantages and Disadvantages: The benefits of full or partial implant rehabilitation are detailed in this section as well as the disadvantages that occur when the patient is not a good candidate for placement of implants due to their systemic condition or due to the need for additional surgical procedure details that make the procedure more expensive or even impossible. This information helps the patient in decision making.

• Pre- and post-operative care: This section presents a primer of recommendations for patients when they are good candidates for placement of implants before and after the surgical stage, to guide and instruct patients in all procedures, avoiding future complications.

• Possible complications: In this section the patient is informed of details of the initial postoperative, and how to position yourself before it, as well as inform of problem that may occur after placement of the implants, and how to avoid and prevent solve such complications. This information aims to ensure long-term success in rehabilitation with implants.

• Types of implants: Here is described the types of implants that are possible to be used and the characteristics of the prosthesis's seating surfaces, as well as the various types of prosthetic components. This information helps professionals in the dentistry area in choosing the best type of implant to be used in your patient (figure 7).

• Types of implants prostheses: Through carefully executed drawings is explained the various possibilities of rehabilitating cases of patients completely or partially edentulous. Allows the patient to have a vision of the result to be achieved (figure 8).

• Maintenance of implants prostheses are guidelines to inform the patient of the need for monitoring and

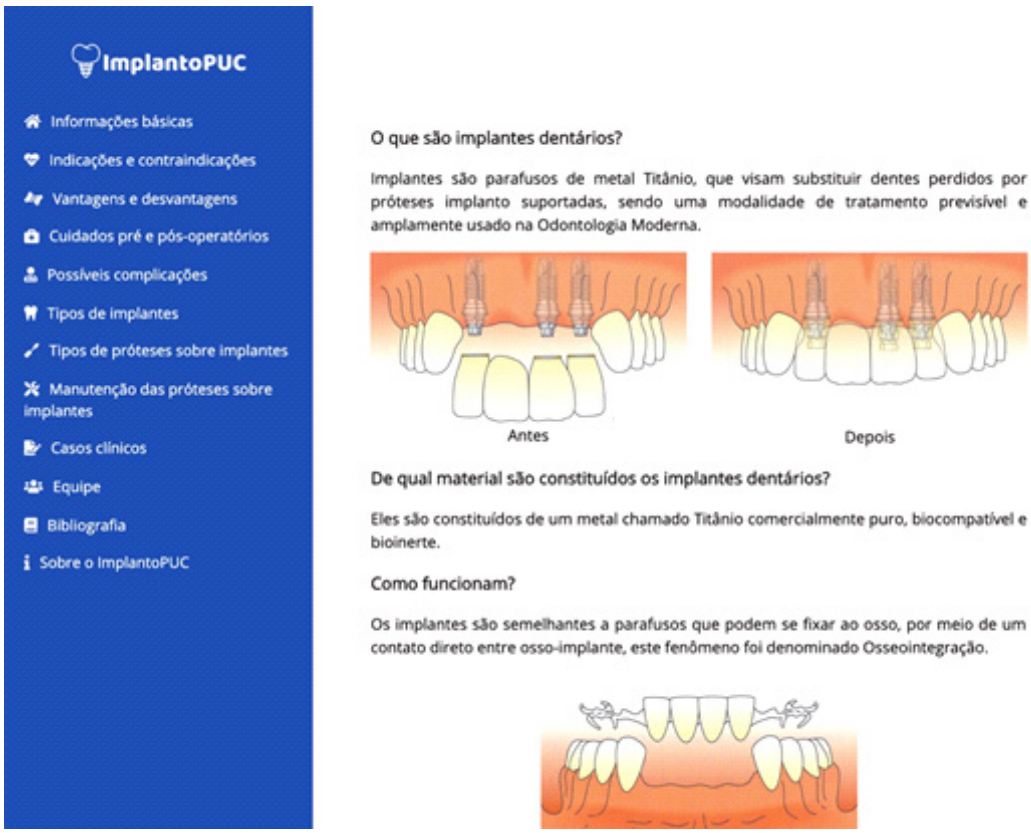

Figure 6. View the app on a Tablet with the screen horizontally. In this case, due to the screen format and responsive technology, the menu is positioned fixedly in the left corner, not being required by the access button.

Figure 7. View the Implant Types screen after the user selects this option from the menu on the left on a Tablet.

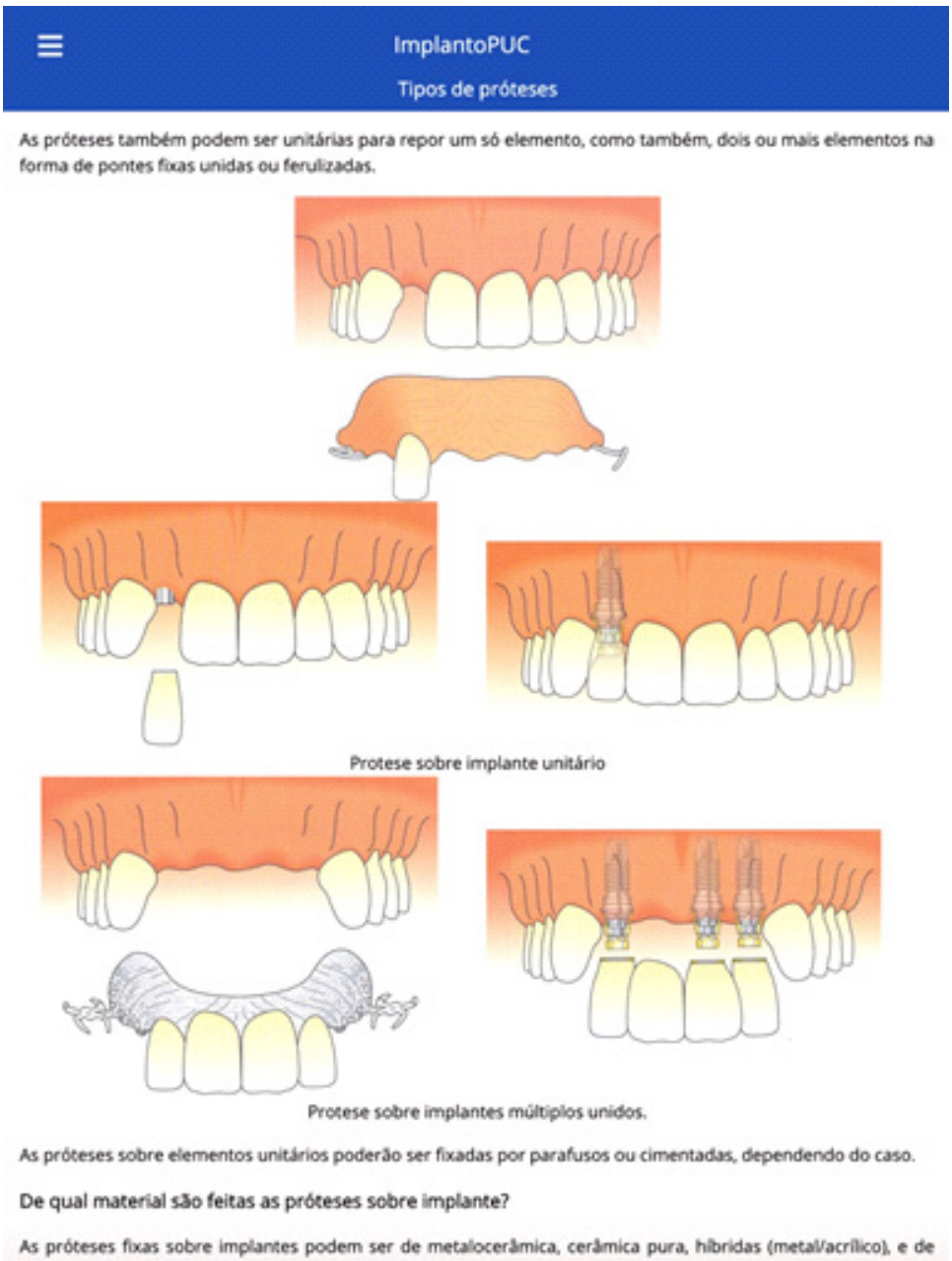

Figure 8. Viewing the Prosthesis Types screen on a tablet upright. Tablet Examples of rehabilitation with osseointegrated implants.

maintenance of implant prostheses, to maintain long term success.

• Clinical cases: Section where clinical cases are shown rehabilitated with osseointegrated implants, for a better understanding of the patients to the proposed treatments (figures 9 and 10)

• Team: It cites the integral parts of the project's director team.

• Bibliography: Summary of all literature consulted for the elaboration of the project.

• About the ImplantoPUC: Summary about the application and its utility within the College of Dentistry at the Pontifical Catholic University of Minas Gerais, PUC-MINAS (figure 11).

The use of the ImplantoPUC provides enlightening information to patients about the types of treatment,

their advantages, limitations and guides them on the various stages of treatment. Through various illustrations and representation of real clinical cases, this application also facilitates communication and professional/patient interaction by improving the work flow of professionals in the area and empowering them to explain clearly the treatment thereby increasing the confidence of the patient regarding the proposed treatment.

Figure 9. Screen view Types of prostheses on implants on a Tablet in the horizontal position.
Clinical case of anterior fixed prosthesis on implants.

Figure 10. Screen view Types of prostheses on implants on a Tablet in the horizontal position.
Clinical case of anterior fixed prosthesis on finished implants.

Figure 11. Viewing the screen on ImplantoPUC on a Tablet in the horizontal position.

DISCUSSION

Mobile applications have become an important tool in the search for professional improvement in the medical area. When these applications are aimed at teaching they are called educational platforms or e-Learning, which are teaching technologies both for medical students as well as established professionals [6] These applications are listed in categories according to educational purpose for which they were developed into four main categories:

– Educator support: refer to the resources that can be used to assist in the learning and commitment of students. Examples: KeyNote, iMovie, Design 2.

– Student support: refer to the instruments that in addition to promoting learning, also help students in many roles. Example: Notes, Kindle, Dropbox.

– Performance support: these applications are features that help medical professionals just in time. Examples: BMI calculator, Medscape, Pocket Lab Values, PubMedMobile.

– Learning activities: include those specific applications for learning and can be divided into those intended only for students and medical professionals, as well as for health professionals to assist them in education and information to patients. Examples: Human Body, ECGtest, Clinical Sense, Elder Guide, among others [9]

The characteristics of mobile phones and tablets allow access to information at any time (just-in-time), which improves and individualizes the bases for learning, allowing to distribute, aggregate and share information easily. The concept of usability of these mobile technologies is defined as the integration of a new tool to learning activities [10]

ImplantoPUC would be within this classification of e-learning applications, and was developed with scientifically correct, simple, and easy-to-understand language to become an educational reference within Implantology. Its menu is easy to handle providing the user with a simplified and direct navigation, and its content encompasses all relevant information in the area of Implantology. The drawings are clear and explanatory, and the clinical cases masterfully finalize the main possibilities of treatment with osseointegrated implants, without leaving doubts to the user, this being a professional in the area or a patient. The adoption of mobile applications in Dentistry for educational purposes, such as ImplantoPUC, is an alternative to conventional methods of communication.

Hu et al., in their study in the application of a multimedia system for mobile phones and tablets, to improve the understanding of patients in relation to the treatment proposed by dentists, concluded that this method of communication is effective in understanding and adhering to the proposed treatment. Patients reported that they preferred this multimedia system, to the traditional means of verbal explanation through books and figures [9].

Canbazoglu et al. [8] developed a mobile application with 3D photographs and drawings, explaining the steps for the different types of dental treatment with osseointegrable implants, concluded in their study that the application proved more efficient in convincing patients to adhere to the proposed treatments.

In recent years, there has been a growth of applications in the area of Dentistry, as an example we can mention the RadioXtudy application, for the radiology area, developed by the Piracicaba School of Dentistry (FOP/UNICAMP), where through Google Analytics, 31,622 downloads had already been registered in 2016 in 2,087 cities in 140 countries. The app has already won English and Spanish versions [11].

Another application worthy of note is the Bucal, for the area of Stomatology and Oral Pathology, exemplifies the 100 most common oral lesions, as well as explains 25 different syndromes and their possible oral manifestations, being a great reference for dentistry students. Positivo University has developed the Therapeutic Guide application, to assist dental professionals and students in the prescription of the most different types of drugs, used in the daily clinic.

In the area of nutrition applications are available with the purpose of leading to behavior change, helping individuals to reflect on food choices and identify their weaknesses in the eating routine. The DIGITAL Food Guide (GAD) is a smartphone app with guidelines on healthy eating [10].

All these applications, as well as ImplantoPUC, aim at improvements in communication and distance learning, accessible to all layers of the population since mobile technologies are increasingly a constant in people's lives.

The entire implementation of the ImplantoPUC application was user-centered, so that this interactive technology facilitates professional/patient communication, establishing a relationship of trust essential for the success of Restorative Dentistry.

CONCLUSION

In the field of Implantology Dentistry there is a difficulty in making patients understand the proposed treatment plan and their result. This is because many professionals are technical specialists, but with little ability to explain the treatments, as well as to make themselves understood. There are barriers of communication between the professional/patient who need to be overcome, and the development of this application ImplantoPUC, has the goal to make this task easier to achieve by viewing real clinical cases, as well as providing educational and enlightening information about all stages of treatment, always with the follow-up of the professional responsible.

This application was developed to inform, clarify and instruct patients in treatment at the implant clinic of PUC-MG, as well as students of this faculty and graduate professionals, to function as a source of information fast, short and easy to access, allowing to break the barriers related to Implantology. The ImplantoPUC it makes the task of reporting more interactive and easier to understand for patients, also helping professionals of the area in obtaining updated information and the reach of the hands, may also be used in other educational institutions in Dentistry, becoming a reference in Implantology.

Collaborators

ER NEJM, conducted bibliographical research on the subject, made available all the financial resources for the preparation of the application. MG CÔSSO, made available the images to be inserted in the application. EG ZENÓBIO, was the co-coordinator of the project.

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