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Research Paper
Orthognathic Surgery

Efficacy of three-dimensional visualization in mobile apps for patient education regarding orthognathic surgery

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Abstract. 'Sur-face' is an interactive mobile app illustrating different orthognathic surgeries and their potential complications. This study aimed to evaluate the efficacy of Sur-face by comparing two methods of delivering patient information on orthognathic surgeries and their related potential complications: a mobile app with interactive three-dimensional (3D) animations and a voice recording containing verbal instructions only. For each method, the participants' acquired knowledge was assessed using a custom-designed questionnaire. Participants in the 'app' group performed significantly better ($P < 0.0034$) than those in the 'voice' group and retained more knowledge, suggesting that interactive visualizations play a key role in improving understanding of the orthognathic surgical procedure and its associated complications. This study emphasizes the impact of 3D visualizations in delivering information regarding orthognathic surgery and highlights the advantage of delivering validated patient information through mobile apps.

Key words: orthognathic surgery; mobile apps; patient education; informed consent; interactivity; unity 3D; mHealth; medical education.

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Orthognathic surgery is an elective procedure and hence it is essential to involve the patient in the treatment planning and to obtain informed consent. This will allow the patient to play a more active part in the delivery of their surgical care.[1,2] However, the level of understanding that patients have of their planned surgery and its associated complications has often been underestimated.[3,4] Conventional techniques of delivering education to patients through verbal, illustrative, and leaflet-based instructions may not be effective enough to adequately explain the surgical procedure and potential postoperative complications. The low efficiency of these methods in delivering the required information may be attributed to the educational and cultural barriers between patient and clinician. The use of complex scientific jargon and the mental state of the patient during appointments act as additional barriers to obtaining informed consent. Williams et al. found that patient satisfaction levels varied according to the method of delivery of the necessary information.[5]

Other research has shown multimedia resources to be better than conventional techniques in improving the patient's understanding of the surgery that they were about to undergo.[6,7] The illustrations and the interactive manipulation of images in

graphical resources help the patient to acquire a more satisfactory level of knowledge. Studies on multimedia have shown that patients appreciate the use of video and moving images over other methods of delivering medical information.[8] Also, the use of videos for patient education was found to significantly reduce their anxiety.[9] Beranova and Sykes studied computer-based patient education methods for congestive heart failure and suggested that patients are eager to know more about their health and computers are serving this purpose.[10] Later, Mladenovski and Kieser compared the effectiveness of information leaflets to multimedia methods of delivering education relating to the surgical removal of impacted third molars.[11] In their research, 93% of the participants found graphic animations to be helpful. In support of these findings, Cleeren et al. used three-dimensional (3D) animations to explain periodontal conditions and described how patients preferred 3D visualizations to sketches or written instructions.[12] In the case of orthognathic surgery, El Azem et al. used two-dimensional graphical illustrations of Le Fort I maxillary surgery on a tablet device.[13] They evaluated the effectiveness of graphical illustrations by assessing the capacity of a group of volunteers to retain the knowledge delivered using a questionnaire. Participants were divided into a 'tablet' group and a 'verbal' group based on the mode by which instructions were received. The tablet group outperformed the verbal group significantly ($P < 0.001$), showing that the multimedia tablet devices helped the participants to retain more information than the conventional verbal approach.

The application of these multimedia resources has gained further attention with the current rise in usage of smart devices with uninterrupted Internet access. According to Google, one in every 20 searches on Google is regarding health-related information.[14] Internet and American Life Project reported that 59–80% of Internet users browse topics related to health care.[15] More than 1,65,000 healthcare apps were found, of which 90,000 apps were on Apple's iTunes's store alone.[16] Despite these studies clearly suggesting that patients are increasingly considering information from the Internet and on mobile apps for healthcare purposes, a multimedia mobile app providing information on orthognathic surgery and its complications has not yet been developed. The Sur-face app was developed to meet this need, using computer-generated interactive 3D visualizations.

The aim of this study was to investigate the impact of the Sur-face mobile app, which provides 3D visualizations to deliver patient education, through a questionnaire-based analysis. The null hypothesis was that there is no difference in the information retained by volunteers regarding orthognathic surgery when delivered by two different methods: 'app' and 'voice'. This paper presents the steps in the design, development, and evaluation of the Sur-face app.

Methods

Design of the app

In the design of Sur-face, information was divided into pre-surgical preparation, surgical procedure(s), and post-surgical changes. For pre-surgical preparation, scenes illustrating the doctor–patient appointment (Fig. 1) and preparation of the patient for surgery were used. In addition to the 3D models, an image of the consent form was included to reinforce the responsibility of the patient in making an informed decision. The surgery section consisted of interactive 3D animations illustrating orthognathic surgical procedures including Le Fort I maxillary osteotomy, sagittal split mandibular osteotomy, and bimaxillary osteotomies, as well as augmentation genioplasty (Fig. 2) and hip graft procedures (Fig. 3). The post-surgical changes section covered potential side effects of the surgical procedure, including swelling, pain, nose bleeding, and restricted mouth opening (Fig. 4). This section also provided information on complications, including numbness, devitalization of teeth, and post-surgical relapse.

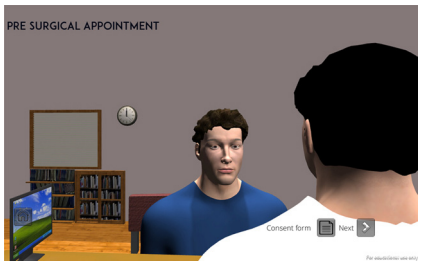

Fig. 1. Pre-surgical appointment.

Fig. 2. Chin surgery procedure.

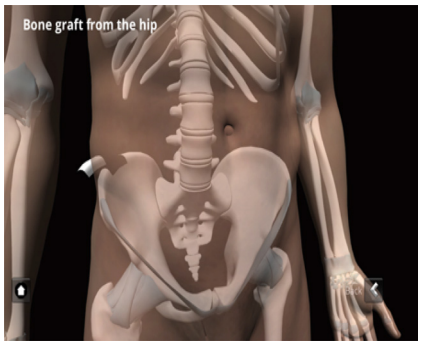

Fig. 3. Hip graft procedure.

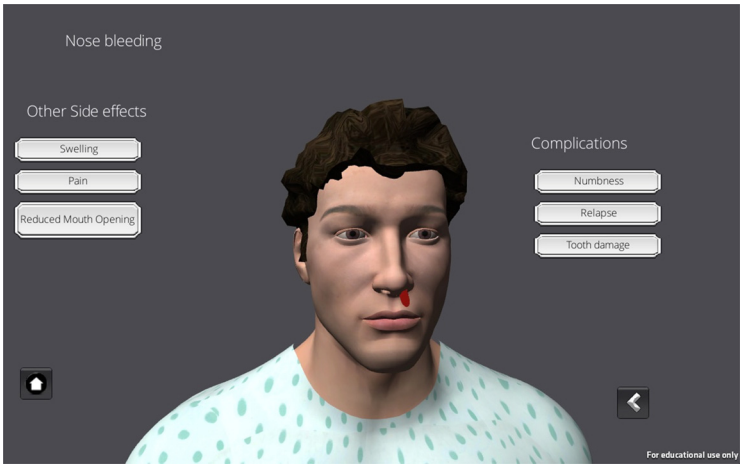

Fig. 4. Postoperative nose bleeding.