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KAP ASSESSMENT FOR EXPLORING QUICK RESPONSE CODE INTEGRATION IN TELE RADIOGRAPHY, DIAGNOSIS, AND DIGITAL IMAGING

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Abstract

Background: Dental radiology plays a pivotal role in the diagnosis of dental diseases. The integration of modern technology, such as Quick Response (QR) codes, can potentially streamline data management and enhance the efficiency of the healthcare professionals. QR codes offer an innovative solution for encoding both patient details and radiographic interpretations. **Objectives:** The primary objectives of this questionnaire study were to assess the knowledge, attitude and perception of dental professionals regarding QR codes and to explore the perceived benefits of incorporating QR codes into dental radiology practices in the domains of diagnosis, reporting, treatment planning and also to identify potential challenges and concerns related to the integration of QR codes in these fields. **Methods:** A structured questionnaire was designed and distributed to dental professionals and specialists. The survey sought feedback on their familiarity with QR codes, their opinions on the potential applications of QR codes in dental radiology, and their perceptions of the benefits and challenges associated with this technology. **Results:** This study underscores the advantages of employing QR codes as a preferred method for disseminating patient radiographic information including the images and diagnostic reports. The user-friendly and familiar nature of QR codes, in contrast to traditional radiographic films, appears to be a key factor driving their preference among dental professionals. This approach not only enhances efficiency and accessibility but also minimizes physical contact with printed materials, contributing significantly to infection control efforts emphasizing scalability, technology adoption considerations, educational initiatives, data security, cost-benefit analysis, and the long-term viability of QR code implementations in different healthcare settings.

Keywords: Quick Response Codes, QR Codes, Dental Radiology, Radiographs, OPG, CBCT.

INTRODUCTION

QR, short for "Quick Response," refers to a type of two-dimensional barcode or matrix bar code. It was originally conceived in Japan in the 1990s by the Toyota subsidiary Denso Wave in 1994 for the purpose of tracking automotive parts.(1) Over time, QR codes have gained widespread adoption and diversified their uses.

They are frequently employed to store data, such as website URLs, contact information, text, medical records, laboratory results and much more.(2) QR codes have become an integral part of contemporary technology, finding applications in marketing, information sharing, authentication, dental radiographs and various other domains related to healthcare. (3) The adaptability of QR codes has sparked interest in their utilization in various healthcare contexts. Researchers have examined their potential for storing medical data, including patient case histories, Digital Imaging such as RVGs (RadiovisioGraphy), CBCTs (Cone Beam Computed Tomography), and 3D reformatted images in the field of maxillofacial radiology.(4)

Approximately 90 years after the initial discovery of X-rays and the introduction of film-based dental radiographs, Mouyen envisioned a groundbreaking idea; utilizing a charge-coupled device (CCD) in conjunction with a scintillator to generate instantaneous images. This innovative method is commonly referred to as Radiovisiography (RVG).

In the subsequent two decades, five more iterations of RVG systems have emerged, with the most recent ones being built on complementary metal oxide semiconductor (CMOS) technology.(5) Digital Imaging in Dentistry involves the utilization of advanced imaging technologies and digital methods to record, store, and analyze images of the oral cavity, teeth, and surrounding structures for the purposes of diagnosis and treatment planning in dental practice.(6)

This innovative approach has fundamentally changed the field of dentistry by providing several advantages over traditional film-based radiography and other imaging modalities. (7) A digital image is essentially a mosaic of tiny picture elements called pixels. These pixels are arranged in a structured grid, typically in a rectangular fashion.

Each pixel is like a building block of the image, possessing specific attributes that contribute to the image's overall appearance. The arrangement of pixels in a digital image is often referred to as a bitmap or raster. Importantly, a pixel is the smallest indivisible unit in a digital image. When dealing with radiographic images, it's common to use shades of gray, with intensity values typically ranging from 8 bits (equivalent to 256 shades of gray) to 12 bits (equivalent to 4096 shades of gray).

Image resolution, which relates to the image's sharpness and detail, is influenced by factors like the number of pixels per unit length (pixels/mm), the bit depth (number of gray levels per pixel), and how these gray levels are managed. Notably, certain digital imaging devices are capable of producing digital volumes or three-dimensional (3D) images. (8) While teleradiology may have initially gained prominence in the United States, its adoption and expansion have indeed been remarkable on a global scale.

Teleradiology's reach has extended far beyond U.S. borders, and it has experienced substantial growth and acceptance in healthcare systems worldwide including India. This proliferation reflects the increasing recognition of the benefits it offers in terms of improving healthcare access, facilitating remote consultations, and enhancing diagnostic capabilities across diverse regions and healthcare settings.(9) Tele radiography is also known as teleradiology, is a medical imaging technology and practice that involves the remote transmission of radiographic images (such as X-rays, CT scans, MRI scans, and other diagnostic images) from one location to another for interpretation and consultation by radiologists or other healthcare professionals.

It allows medical images to be transferred electronically over a network, typically the internet, to a remote location where a radiologist or specialist can review and analyze the images. (10) During the pandemic, to mitigate the risk of COVID-19 transmission, it was advisable to steer clear of film-based or printed radiographic copies when there is a clear need for radiographic examinations. These traditional copies posed potential sources of contamination. Moreover, the logistics of sending hard copies to remote locations become cumbersome and may necessitate healthcare professionals to put themselves at unnecessary risk if interpretation assistance is required. This risk can be effectively minimized through the utilization of digital images. Oral radiologists, for example, can work remotely from the safety of their homes and provide valuable assistance to clinicians without the looming threat of contamination. This approach not only ensures the safety of healthcare professionals but also facilitates the swift and secure transmission of crucial diagnostic information, ultimately enhancing patient care during these challenging times. (11) As healthcare embraces the digital age with innovations like QR codes, digital imaging, and tele dentistry, the imperative to protect patient confidentiality remains undiminished. Robust security measures, including encryption, access controls, and secure communication platforms, are not only essential for compliance with legal and ethical standards but also for preserving the trust patients place in the healthcare system. By upholding these principles, healthcare providers can confidently navigate the digital landscape while ensuring the privacy and security of their patients' sensitive medical information.

While QR codes saw extensive adoption across various sectors during the pandemic, their application in the field of radiology particularly in tele radiography, diagnosis, and digital imaging has remained relatively unexplored presenting an intriguing opportunity for innovation and enhancement within the healthcare industry.

METHODOLOGY

Study Setting: This study was conducted at the School of Dental Sciences, Sharda University, to investigate the familiarity of participants with QR codes as part of their daily academic and clinical routines.

Participants: A total of 228 participants were selected as the study cohort. The participants were categorically divided into four groups: **1. Senior Faculty Members**: Esteemed members of the academic faculty with significant experience in dental education and practice. 2. **PGs (Postgraduate Students)**: Enrolled in various dental specialties, pursuing advanced education. **3.Interns**: Participants currently undertaking their internship program within the dental school **4. Final Year BDS Students**: Undergraduate dental students in their final year of the BDS program.

Questionnaire Development

A structured questionnaire was designed to assess the participants' familiarity with QR codes. The questionnaire included multiple-choice and open-ended questions to gather information on the following aspects:

- Knowledge of QR codes and their applications.
- Attitude of use of QR code use in academic and clinical activities.
- Perception in having Perceived benefits and challenges associated with QR code utilization.

Characteristic	N = 228	
Highest Qualification	MDS	33 (14.47%)
	INTERNS/HOUSE SURGEONS (BDS)	111 (48.68%)
	POST GRADUATES	26 (11.41%)
	UNDER GRADUATES	58 (25.44%)
Currently Practicing as	ACADEMICIAN	33 (14.47%)
	CLINICIAN	112 (49.10%)
	BOTH	123 (53.94%)
	STUDENT	83 (36.71%)
Years of Practice	0-2	83 (36.72%)
	2-5	26 (11.40%)
	5-10	85(37.28%)
	>10	34(14.90%)

N=228	QUESTIONNAIRE ITEM	POSITIVE RESPONSE	NEGATIVE RESPONSE
KNOWLEDGE DOMAIN	Heard of QR codes?	212 (92.98%)	16 (7.02%)
	Full form of QR codes?	175 (76.75)	53(23.25%)
	For which sector were QR codes used initially?	99 (43.42%)	129(56.58%)
	Can we Trust Data from QR?	190 (83.33%)	38(16.69%)
	Do you Know about different versions of QR?	88 (38.60%)	140(1.40%)
	Do you think that QR codes can be Used in Radiology?	115 (50.43%)	113(49.57%)
ASSESMENT DOMAIN	Are you comfortable scanning QR for reports?	188 (82.45%)	40 (17.55%)
	Do QR codes enhance or complicate the user experience when interpretating the radiograph?	201 (88.15%)	27 (11.85%)
	Do you think QRs are a sustainable and ecofriendly solution compared to conventional film-based radiology?	207(90.78%)	21(9.22%)
	Do you trust the security of QR codes when using them for confidential patient information?	140(61.40%)	88(38.60%)
PRACTICE DOMAIN	Did you need any assistance?	211(92.54)	17(7.46%)
	Would you like to incorporate QR codes in other field of dentistry?	201(88.15%)	27(11.85%)
	Is QR easy to use?	213(93.42%)	15 (6.58%)
	Did you use any app use to scan the QR?	166 (72.80%)	62(27.20%)

Data Collection:

The questionnaire was distributed electronically to the participants via a secure online survey platform. Participants were given a reasonable time frame to complete the survey, ensuring that they had adequate time to respond thoughtfully.

Data Analysis:

Responses from the participants were collected, and quantitative data were analyzed using statistical software. Descriptive statistics, including percentages and frequencies, were employed to summarize the data. Open-ended responses were subjected to thematic analysis to identify recurring themes and opinions.

Ethical Considerations:

Ethical approval for this study was obtained from the institutional ethics committee, ensuring that the research adhered to ethical standards and safeguarded the participants' privacy and confidentiality.

Informed Consent:

Prior to participating in the survey, all participants were provided with informed consent forms, outlining the study's objectives, potential risks, and their rights as research

subjects. Only those who voluntarily consented to participate were included in the study.

Limitations: The study may be subject to limitations such as self-reporting bias, limited sample size, and potential biases inherent to questionnaire-based research.

Statistical Analysis: Quantitative data were analyzed using appropriate statistical tests, and significance levels were established to evaluate the research hypotheses.

This "Materials and Methods" section outlines the key aspects of the questionnaire study conducted at the School of Dental Sciences, Sharda University, focusing on participants' familiarity with QR codes.

Creation of a QR Code

1) Reformatting Patient Information Leaflets (PILs): Initially, three PILs were reformatted into a user-friendly A4 JPEG format suitable for viewing on smartphones.
2) Uploading to Hospital Website: The reformatted patient information leaflet was then uploaded to the Sharda hospital website within the dedicated patient information leaflet section of the Oral Medicine and Radiology Department webpage.
3) QR Code Generation: QR codes were generated for these specific webpages by the photography team using a web-based application, which was freely available.
4) Tagging and Placement: Laminated sheets containing these QR codes were strategically placed in easily accessible areas in the Xrays card of the patient. (Figure 1)
5) Patient Engagement: Patients undergoing treatment or parents accompanying their children were encouraged to scan the QR code using their smartphones. Upon scanning, they could access and read the linked reports as shown in figure 2.

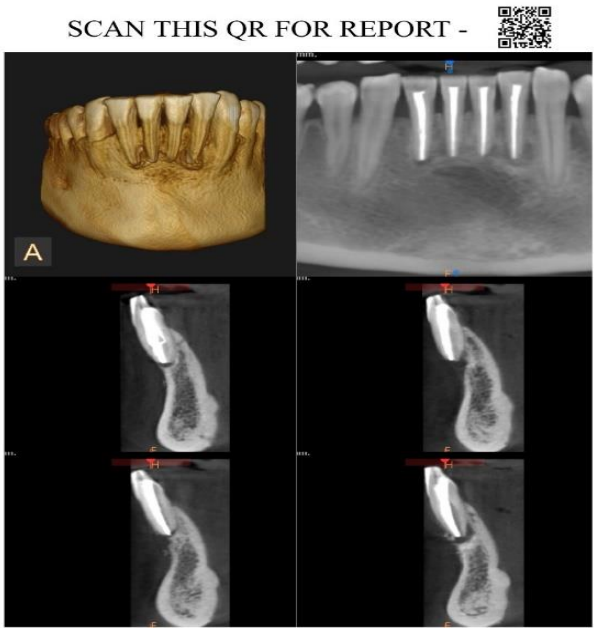

Figure 1: CBCT of the Patient with QR code to open the Report

Figure 2: OPG of the Patient with QR code to open the Report

Data Collection:

Alternative Provision: In cases where the QR code did not function or if patients declined to participate, paper PILs were made available as an alternative. Data were systematically recorded for those instances when the QR code did not work or when patients opted out of participation.

Data Management: Information such as the age and gender of the QR code users was meticulously recorded and organized within a Microsoft Excel database.

Statistical Analysis: Descriptive analyses of the collected data were performed using SPSS version 26.0, with additional statistical analysis conducted using Stata 17 Statistical Software. Multinomial logistic regression was employed to determine the impact of age group and gender on the response variables, following established statistical methods (Agresti, 1996; StataCorp, 2019).

This comprehensive process allowed for the effective utilization of QR codes to disseminate patient information, gather data, and analyze the impact of age and gender on user response within the context of this study.

DISCUSSION

In the survey conducted with a sample size of 228 participants, the highest qualification of the respondents was diverse. Approximately 14.47% of them held an MDS degree, while the majority, constituting 48.68%, were INTERNS/HOUSE SURGEONS with a BDS qualification. About 11.41% of participants had postgraduate degrees, and 25.44% were categorized as undergraduates. Regarding their current professional roles, 14.47% identified as academicians, while the majority, accounting for 49.10%, considered themselves clinicians. An interesting 53.94% claimed to be engaged in both academic and clinical practices, showcasing the dual nature of their roles, while 36.71% were students pursuing further education in the field.When it came to the years of practice, the respondents' experience varied. A significant proportion, 36.72%, had 0-2 years of practice, while 11.40% fell in the 2-5 years range. A substantial 37.28% had practiced for 5-10 years, and 14.90% had over a decade of experience, demonstrating a broad spectrum of experience levels among the participants.

In this survey involving 228 participants, various aspects of knowledge, assessment, and practice regarding QR codes in radiology were explored.

Knowledge Domain: Almost all respondents (92.98%) indicated that they had heard of QR codes. However, when asked about the full form of QR codes, 76.75% were aware of it. Regarding the initial sector of QR code use, 43.42% correctly identified it, while 16.69% expressed doubts about trusting data from QR codes. Furthermore, only 38.60% of participants were familiar with different versions of QR codes. Lastly, in terms of the applicability of QR codes in radiology, 50.43% believed they could be used effectively.

Assessment Domain: A large majority (82.45%) of respondents reported being comfortable scanning QR codes for reports. Moreover, a significant 88.15% found that QR codes enhanced rather than complicated the user experience when interpreting radiographs. In terms of sustainability and eco-friendliness, 90.78% of participants saw QR codes as a favorable alternative to conventional film-based radiology. Additionally, 61.40% expressed trust in the security of QR codes when handling confidential patient information.

Practice Domain: The survey revealed that 92.54% of respondents did not require any assistance when using QR codes. Interestingly, 88.15% expressed a willingness to incorporate QR codes into other areas of dentistry. The ease of use of QR codes was confirmed by 93.42% of participants. Regarding scanning QR codes, 72.80% of respondents reported using a mobile app for this purpose.

Overall, the survey reflects a generally positive attitude toward QR codes in radiology, with respondents showing awareness and a willingness to adopt this technology in their practice.

CONCLUSION

This questionnaire study gives light on potential advantages of employing QR codes into dental imaging practices for patient management, cybersecurity, and diagnostics. While the potential benefits are generally recognized, resolving data security issues and creating clear protocols will be critical for effective implementation. The study emphasizes the necessity of investigating novel technologies to improve the efficacy of dental radiography in different areas, as well as the need for more research and collaboration among stakeholders in this sector.

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