ORIGINAL ARTICLE

Effect of intraoral digital sensor colour variation and connection cable position on discomfort level in periapical (PA) radiography technique

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Abstract:

Peripical (PA) technique is one of the intraoral radiography techniques that requires the image receptor such as film and sensor to be inserted into the oral cavity. This may lead to discomfort especially with the use of current digital sensor. Current design by most of the vendors highlighted the need of ergonomic shape and optimum thickness to minimize the discomfort. This study evaluated the effect of sensor's colours and cable position on discomfort feeling during PA. An experimental approach using pre and post intervention technique to evaluate the respondents' feedback with the use of the sensors was conducted. A total number of 47 respondents were selected from Faculty of Health Sciences, Universiti Teknologi MARA (UiTM) via systematic random sampling. The respondents experienced different design of digital intraoral sensor during the simulation of PA dental radiography procedure for posterior teeth. A Numeric Rating Scale (NRS) scoring were adopted to assess and compare any discomfort experienced by the respondents. The descriptive analysis showed that median NRS score value was higher for dark blue colour sensor (median = 8) as compared to the black sensor (median=7). The Wilcoxon matched paired sign rank test showed that there was a significant difference in terms of the discomfort level experienced by the respondents ($p < 0.001$). For the cable connection design, the median score value of corner position is greater recorded as 7, than the cable connection position at the centre which the median is 6. Cable connection position at the centre was less discomfort as compared to cable connection located at the corner of the sensor. As conclusion, the colour and cable connection location could affect the discomfort level during PA radiography technique.

Keywords: Periapical (PA); digital sensor; discomfort level

1. INTRODUCTION

Periapical (PA) radiography technique is one of the common dental radiographs to visualize the individual teeth including the root structure and surrounding bone structure. The image receptor (IR) is placed within the oral cavity and positioned parallel with the adjacent teeth while the x-ray beam is directed perpendicular or at an angle towards the intraoral image receptor from the outside of the mouth [1]. However, to achieve this ideal positioning, patient may feel discomfort relate to gag reflex due to the placement of IR, technique and variation of oral space in human [2].

Gagging reflex is a behavioral response towards any foreign body taken into the oral cavity based on the biological mechanism called pharyngeal reflex to prevent choking. Generally, it is related with dental care or oral health care but until today there is little information regarding to the epidemiology of gagging during dental examination. The possibility of a gag reflex was higher when a person had greater dental care related fear and fear of pain [3]. In intraoral radiography, the image receptor (IR) acts as a stimulus which can cause gag reflex. The IR requirements to be placed as close as possible to the mouth floor or roof such as the hard palate soft palate and the tongue to cover the entire root of the teeth in PA radiography[3]. When stimulation occurs, the afferent fibres of the trigeminal, vagus and glossopharyngeal nerves pass to medulla oblongata which then give rise to efferent impulse affect the spasmodic and uncoordinated muscle movement inducing the gagging. Five intraoral regions which label as the "trigger zones" are the palatogossal and palatopharyngeal folds, base of tongue, palate, uvula, and the posterior pharyngeal wall [30]. Therefore, patient will have sensation to vomit and discomfort within oral cavity during the PA technique [4,5].

The digital sensor use as IR is based on the charge-coupled device (CCD) or photostimulable phosphor (PSP) material which is able to capture the x-ray photon and digitized to be view on a monitor compared with the conventional x-ray film whereby the image is captured on the radiographic film and printed by an image processor [6]. In recent years, the

conventional dental x-ray film has been surpassed by the usage of digital intraoral sensor as the IR [7,8]. It provides a good image quality which increases the specificity and sensitivity of detection for many oral pathologies, offers quicker image acquisition and has better image storage selections [9]. However, the digital intraoral sensor is generally thicker and bigger in size and stiffer as compared to the x-ray film hence causing discomfort feeling to the patients [10]. Goncalves et al (2009) adds that sharp edges that pressing on the oral cavity also lead to discomfort. Alternative methods such as additional sleeve and sensor cover are suggested to improve on this issue [11].

In order to improve these limitations, many vendors initiating a more practical design for the sensor based on ergonomics shape such as curve edges, rounded design and optimizing the thickness based on the electronic component in the sensor. Current design by most of the vendors highlighted the need of utilizing ergonomics design with optimum thickness applied to minimize the discomfort [12, 13]. However, these criteria were focusing on the physical effect of the sensor towards discomfort feeling. Referring to psychiatric principle, the comfort can be based on physical and psychological factors. Shape, colours and appearances of the sensor affect the psychology. Wright (2017) suggests there is a connection between colours and emotions, blue colour relate with calmness while warm colours related with aroused feelings, however specific association was not described [14]. Current colour of digital sensor available in practice is black and dark colours. However, the justification on discomfort level with the used of different colour was not well justified and whether initiating different colours will help in reducing discomfort. The aim of this study was to evaluate discomfort level with different sensor colours and different cable connection location on the digital sensor.

2. MATERIALS AND METHODS

This study is an experimental study using the pre and post intervention technique to evaluate the discomfort level with the use of different colours and cable connection location on the digital sensor. The sample of the study was the students of Faculty of Health Science with the population of 1465 students. The sample size was calculated by using the G.Power software and n= 47 was estimated. A systemic random sampling was used to ensure the selection not bias and reliable to represent the population. This was based on sample size calculation with 95% confidence level, 5% confidence interval using the G.Power software. The sample taken from both gender to avoid bias since male and female had different tolerance and acceptance on discomfort [11]. The range of age between 18 to 25 years old was used to ensure only mature adult will be involved and to limit for only student of Faculty of Health Science involved. Besides, all the students those have current oral trauma, oral mechanical disorder like temperomandibular joint dysfunction and wearing cosmetic implant such as braces were excluded from this study.

The feedback on discomfort level was translated on the NRS based on scale of 1 to 10 (lowest to highest pain/discomfort) [15]. A simulation area was design at the Medical Imaging Laboratory, Universiti Teknologi MARA (UiTM) Selangor, Kampus Puncak Alam to resemble the clinical setting so all of the respondents experienced the PA technique using digital sensor with different colours and position of cable connection and comparison of discomfort level can be made. Participants were selected and divided into two groups before they were explained about the study to seek for agreement and consent. For the first group, they were requested to place different colours of digital intraoral sensor inside their oral cavity. The suggested colours are black (C1) and dark blue (C2); a PA dental radiography procedure simulation was done for the posterior teeth. These sensors were constructed from 3D printer based on the dimension of one of the current digital intraoral sensor produced by vendor then wrap with colour paper depends on the colour wanted to be test. Then the material was wrapped with a plastic sheet for infection control before the simulation begins. Parallel technique without using film holder was used during placing of the intraoral sensor in the oral cavity of the student. The duration of the sensor inside the oral cavity was based on the standard procedure time during an actual intraoral dental procedure which was 10 seconds. This gave the students enough time to experience the sensor inside their mouth [11].

After the simulation had ended, the students were required to reflect their discomfort experienced regarding the simulation with different colours of the intraoral sensor on the Numeric Rating Scale (NRS). NRS was preferred because it is easy to understand and simple to manage. It is also dependable and valid since it has similarly sensitivity as the Visual Analog Scoring (VAS) in assessing the pain or discomfort level and more prefer to be used in time-constrain study [16]. This was done right after the simulation has ended so that the students still have the discomfort sensation in their oral cavity so that the NRS was accurate. The simulation was done for the posterior teeth and there was no radiation exposed during the simulation.

For the second group, the students who participated were required to place the sensor in their oral cavity with different position of cable connection. The cable was connected to the centre (D1) and corner (D2) of the digital intraoral sensor body. Parallel technique was used during placing of the intraoral sensor in the oral cavity of the student during a PA simulation procedure for the posterior teeth. The duration of the sensor inside the oral cavity was based on the standard procedure time during an actual intraoral dental procedure which is 10 seconds. This gave the students enough time to experience the sensor inside their mouth [11]. The simulation steps were repeated as before for the different position of cable connection used. After the simulation had ended, the students required to reflect their discomfort experienced regarding the simulation with different position of cable connection of the digital intraoral sensor on the NRS. There was no radiation exposure involved during the simulation of PA radiograph be done on the student. In order to avoid bias during data collection process, a single-blinded study was used where all the students participated did not know the difference between the digital sensors used.

The Wilcoxon matched pair signed rank test which was a non-parametric test that equivalent to a dependent t-test was used because the NRS score used in this study was not normally distributed although it is in ordinal form [17].

3. RESULTS AND DISCUSSION

The respondents consist of students from different programs. Majority of the respondents were female at 53.2%, while male was 46.8%. From this figure, the highest from the Medical Imaging Programs, while the lowest was from Environmental Health Program. Although majority were from Medical Imaging Program, the respondents did not receive initial idea about the discomfort issue with the use of intraoral sensor.

3.1 Sensors' Colour

Table 1 shows the descriptive data for the black and dark blue colour of the digital intraoral sensor evaluated by the 47 respondents underwent PA dental radiography simulation for the posterior teeth. The median value for the black colour of the sensor was 7.00 and for the dark blue colour was 8.00. Majority of the respondents score 7 for the black sensor. While for the dark blue sensor, the NRS score that most frequent chosen among the respondents was 8. The higher score on the NRS implied more discomfort experienced by the respondent. Therefore when comparing the result of descriptive analysis of both colours black and dark blue sensor, the score picked among the respondents for the black sensor was tend to be on the lower score region of the NRS. In contrast, the score picked among the respondents for the dark blue colour of digital intraoral sensor tend to be on higher score of the NRS. The sensor with black colour was less discomfort as compared with the dark blue sensor.

Table 1: Descriptive data of NRS for different sensor colours

	Mean	Std. Deviation	Min	Max	Percentiles		
					25th	50th	75th
Black	6.45	1.282	4	9	4.00	7.00	8.00
Dark Blue	7.23	1.355	5	9	4.00	8.00	9.00

The Wilcoxon signed ranked test indicated that NRS score of the black colour sensor was significantly lower than the dark blue colour of digital sensor ($Z= -4.062$, $p < 0.001$). This shows that the black colour sensor had less impact on the discomfort level of respondents when used in the simulation of PA radiography as compared to dark blue colour of digital sensor. It proved that darker colour of a digital intraoral sensor had better impact on comfortable feeling during the PA radiography procedure. Hence, most of the respondents in this study were more comfort when using a black colour of digital intraoral sensor than the dark blue colour of the digital sensor.

According to Angela Wright (2017), the effect of colours on us is caused by the energy emitted entering our eyes. The psychological properties of the eleven basic colours were done in this study [18]. For the black colour, it gave the feeling of security, emotional safety and efficiency but also coldness menace and heaviness. Meanwhile dark blue gave the effect of the efficiency, calm and intelligence but also coldness, lack of emotion and unfriendliness. Thus, in relation to current study, black gave feeling of security and efficiency made the respondent felt less discomfort compare to dark blue sensor.

In contrary, blue colour elicited a high number of positive emotional responses which includes relaxation, calmness, happiness and comfort [19]. Blue also give some negative value like sadness and depression but in low percentage. Meanwhile for black colour, the colour reminded the respondents of funeral or related with power. However, this study was done in Western cultures. In some countries, black represent wedding and white is considered as colour of death in China [17]. Thus, in present study, it showed that black colour can reduce the discomfort during the PA radiography.

A study from Oner Ozdas & Kazak, (2017) stated using the colour preference as the main variable in their study as they believed nature of the colour can influence the psychology of people and have controlling effect on individuals [20]. Hulshof (2013) found that the colour and scent as two environmental factors that can affect one's comfortable. It is showed cool colour gives positive impact on people's mood in meeting room as cool colour has fewer distracting characteristics [21]. Thus, it was in accordance with the presented findings that some colours give less discomfort feelings to participants in experiencing the intraoral digital.

3.2 Cable connection

When comparing both position of the cable connection at the sensor, the NRS score picked among the respondents for the digital intraoral sensor with cable connection connected at the corner tend to be higher (median = 7) as compared to centre position (median = 6) as shown in in Table 2. Cable connected to the centre of digital intraoral sensor is less discomfort as compared with the cable connected at the corner of digital intraoral sensor.

Table 2: NRS score with different cable location

	Mean	Std. Deviation	Min	Max	Percentiles		
					25th	50th	75th
Centre	6.60	1.056	5	9	4.00	6.00	8.00
Corner	7.43	1.078	5	8	4.00	7.00	8.00

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It can be suggested that, as the respondent felt less discomfort when using the sensor with cable connection connected to the centre of the sensor in the simulation as compared to sensor with cable connection attached at the corner of the sensor body. This was because the median

score of the cable connection connected at the centre of sensor body was lower compare to the sensor with cable connection connected at the corner.

The Wilcoxon signed ranked test indicated that NRS score of the corner position of the cable connection sensor was statistically significantly higher than the centre position of the cable connection of digital sensor ($Z= -4.135$, $p < 0.001$). Thus, this suggested that the cable connection located at the corner of digital sensor had greater impact on the discomfort level of respondents when used in the simulation of PA radiography as compared to cable connection position at the centre of digital sensor. The different design of the cable connection of a digital intraoral sensor had influenced on discomfort feeling during the PA radiography procedure.

In the research made by Al-Rawi (2013), comparison of various sensors with different physical design was made. There was no sensor that had the best physical design among the sensor had been tested [2]. However, the present of cable do affect the discomfort. [22]. But, the position of cable connection does not include in the physical design tested in the study. Thus, the finding in current study may improve the current knowledge in designing digital sensor for better comfort during the PA procedure.

Other than cable location, the present of the cable itself leads to discomfort feelings [8, 23]. Patients face difficulty in maintaining the sensor position due to the cable attached to the sensor. This can be worsened if the sensor is used for bitewing procedure [24]. Maintaining the sensor position is very important either by biting the biting tab or using the finger technique. This is the reason most of the respondents agreed that the cable lead to discomfort as majority of the respondents indicated 6 and 7 for the NRS scoring. Study by Farman and Farman (2005) indicated that wireless sensor lead to less discomfort, however, other condition such as thickness and dimension may on the other hand lead to higher discomfort [13].

4. CONCLUSION

In the colour group, the dark blue colour has higher discomfort level than black colour sensor. On the hand, the cable connection group can be concluded that corner position produces more discomfort level as compared to centre position. Thus, different types of intraoral sensor colour and cable location could affect the discomfort level during PA dental radiography, however, a variety of colours and cable location should be assessed in order to explore more options for sensor design.

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