A Multidisciplinary Inspection of Dental Photography: What Do Dentist Think and What Can Designer Do?

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Abstract: Dental photography, which is used in various stages of orthodontic treatment processes, is an overall system containing several components such as a camera and various retractors, mirrors or contrasts and other products. To provide an efficient photography procedure, usually more than one attendant -and sometimes even the patient himself- are required to take part. The relevant literature mostly focuses on equipment-based problems and their affects in the quality of final pictures; however, no prior research has been identified regarding the ergonomics and human factors aspects, as well as its emotional influences on the patients. In this paper, 12 professionals with at least two years of experience in dental photography are observed during the digital dental photography procedure, and semi-structured interviews are conducted with them. The identified shortcomings provide hints for possible areas of improvement regarding the equipment used in the process and the overall system.

Keywords: Human-centered design, Patient-centered design, Dental photography

1. Introduction

The influences of the advances in digital recording technologies could be seen in different sectors. Dentistry is one of the important examples with its “digital dental photography” (DDP) and it has become an essential part of orthodontic treatments and used in its different stages (Sandler, 2001). DDP enables clinicians to record and document the key-stages of the treatment (Sandler, 2001; Ogodescu et al, 2010; Fahim & Takur, 2014), as well as contributes to orthodontics discipline in a variety of aspects from communication with patients, self-check of the specialists, planning of the
treatment, provision of the materials for clinical research/education and marketing purposes in an effort to increase patient's motivation and cooperation during the process (Bengel, 2006; Morse et al, 2010). Medico-legal concerns is also another aspect that DDP protects both patients’ and dentists’ rights in possible problematic circumstances (Wander, 2014).

Dental photography allows clinicians to document both intra-oral and extra-oral close up, portrait and profile views of the patients (Bengel, 2006; Endodontics Journal, 2011). Also, “a high quality clinical photography will ‘show’ features such as cracks, surface characteristics, pits, fissures and discoloration translucencies and opacities, saving on an enormous amount of written and possibly inaccurate descriptions” (Wander, 2014, pp. 207). As it is a common argument that ‘one picture tells a thousand words’, the quality of the picture taken is utmost importance during the procedure, however, in DDP there are several components affecting picture quality. Although in some cases clinicians use compact “point and shoot” cameras, generally digital SLR cameras are preferred due to their durability and flexibility in providing a variety of lenses and external flash option to fit in different purposes (Desai & Bumb, 2013; Agarwal et al., 2014; Fahim ve Thakur, 2014). There are also examples of dentists using smart phones who do not want to allocate a budget for a digital SLR camera, and several additional equipment used during DDP, such as, dental mirrors, retractors, contrasts and reflectors (Figure 1).

Regarding the procedure, in many cases more than one attendant, even the patient himself, are required to work in cooperation in order to get high quality pictures. For this reason, when researching into DDP it is necessary to adopt a system perspective, which also covers the working environment. However, it is found that the relevant literature mainly focuses on the technological aspects of the procedure and its possible influences on picture quality (Sandler, 2001; Bister et al., 2006; Machado, 2010; Ogodescu et al., 2010; Meneghini & Biondi, 2012; Fahim, & Thakur, 2014; Agarwal et al., 2014), and no prior research has been found from a human centred design perspective in an effort to shed a light on qualitative aspects affecting both patients' and clinicians' experiences and satisfaction.

This research is supported by the Scientific Research Projects Unit of Mimar Sinan Fine Arts University. It is also organised in collaboration with the Department of Orthodontics of Istanbul University and the Department of Industrial Design of Mimar Sinan Fine Arts University; therefore, it is unique in providing both clinical and design perspectives and synthesises this information to provide better patient and clinician centred solutions for the future.
2. Study Method

This research adopts a qualitative approach. Contextual inquiry (Jordan, 2002) was used as the research method, in which 12 professionals (i.e. 11 dentists and 1 technician in charge of taking dental photographs) are observed while taking dental photographs in their own working environments, using their own equipment and practicing in their own way. During the process they were asked to express their considerations and were also video recorded during the task with the prior consent taken beforehand.

Afterwards the participants were interviewed (by using of semi-structured interviews) with respect to their personal views and interpretations on DDP. Purposive sampling was used as the sampling method (Robson, 2011) because all the participants were expected to have at least two years of experience in DDP.

The complete field research was carried out in the Faculty of Dentistry of Istanbul University and approved by their ethics committee. Regarding the analysis of the data, all the interviews were transcribed verbatim and thematic analysis was applied. In order to facilitate this process, QSR NVivo 11 Software was utilized.

3. Results

Table 1: DDP process and identified problems from observations

| Requirement of many attendants in the process in order to control many equipment at the same time. In some cases even 3 people is needed. | In certain cases the patient himself is also required to take an active role to take high quality pictures. The clinicians may avoid using a ring flash in order to hold the heavy camera with one hand. | The environment and even the dentistry unit may limit clinicians’ movements and make it harder to take good pictures | Coordination between the peers is important to effectively position the equipment used in the process. Also the environment could be crowded with other clinicians and patients during the process. |
Clinicians frequently adopt uncomfortable postures while taking pictures. There is a need to keep unsterilized camera somewhere before and after the procedure. Saliva accumulation interferes the process. Clinicians have very limited time to decide on the picture quality from the small screen of the camera.

The observations enabled identification of hidden problems in DDP procedure and other environmental problems. It was found that although participants followed a very similar task structure during the procedure, they adopted different approaches. However, a number of common problems are identified and summarised in Table 1.

As can be seen from the several pictures presented in Table 1, although DDP is a simple and straightforward procedure, in many cases clinicians needed extra attendants to help them in the process. This is considered to be due to the variety of equipment used in order to take high quality pictures. It was also observed that this variety bears coordination problems between the peers. In some cases the patient himself was also asked to take an active role-for example to hold and pull the retractor in an effort to position the mirror correctly, which is likely to extend procedure time due to communication problems between the clinician and patient. In addition, postural problems/body strains are commonly observed due to the environmental limitations and the heavy weight of the SLR Camera as well as the heavy ring flash attached on it. For this reason, it was also seen that some clinicians simply avoid using a ring flash (second picture in table 1) with a trade off of dropped shadow on teeth in the picture taken.

During the interviews, the participants highlighted certain important problems regarding the equipment used in the process. Most of the problems are indicated with respect to mirrors, retractors, camera and ring flash respectively (Figure 2).
The problems expressed for each equipment are presented in Figure 2 with the number of references coded. As can be seen from the results that dental mirrors are mentioned as the most problematic equipment due to its fog problem on the surface and its cause of pain on patients. Particularly, the buccal mirror is expressed to be the most problematic equipment due to its edges which stretches lips and compresses on the gingival tissues of the patients during the process. It is also highlighted that commonly used mirrors (both metal and glass) does not have a place to hold which results in fingerprints over them and gets damaged when trying to clean these frequently.

"Even when you respirate from your nose, it sometimes causes fog on the mirror. We are trying to cope with it by using air-water jet or suction. Fog and saliva decreases picture quality and causes repetitive shooting." (P9)

"...it is really hard to get the very rear teeth inside the mirror. To do this, you need to push the mirror but this time it causes pain on patients. For example the sides of the buccal mirror cuts patient's lips and if you are tired, while dealing with the mirror with one hand, your other hand holding the camera starts shaking." (P3)

Similarly, the retractors are found to be causing pain on patients. Participants also mentioned that in certain cases these products are insufficient in functionality. Products of universal sizes are not always usable on different types of patients. In addition, commonly used retractors are found to be mostly insufficient to retract the upper and lower lips and result in their interferences in the view while shooting.

"...it is a fact that the equipment we use, in particular the retractors, causes pain on patients. If the procedure gets a bit longer than usual, let's say you do not have someone to help you out, then it gets harder." (P4)

"Retractors are generally produced in standard sizes, or maybe I haven’t seen the others. These could be developed in a way so that you could set them up from the smallest size to the biggest." (P6)
Figure 2: Problems identified with mirrors and retractors

All the participants used a Digital SLR camera during the observations. Except one, all the participants also used a ring flash during the shooting procedure. The problems stated regarding camera and ring flash are summarised in Figure 3. It was expressed that the camera with a ring flash attached, is heavy to carry with one hand and at the same time deal with other equipment with the other hand. For this reason, getting help from other colleagues or, in some cases, from the patients is common. Moreover, in order to get good pictures, the dentists are required to obtain a certain level of knowledge on photography.

Figure 3: Problems identified with camera and ring flash

If the camera is a professional one, then it is heavy. I don't know, if there would be a system, maybe a hydraulic arm dangling from the ceiling which holds the camera, then this would facilitate positioning the other equipment. (P4)

I do not use professional cameras very often. Maybe because you need some training about how to use them. You should know their settings. I also use my iphone for this. It is automatic and gets clean pictures without any blur. (P5)

Also it is highlighted that low battery on ring flash turns into a significant problem for cameras in share in a clinic.
The biggest problem we have is the battery; battery of the ring flash. (P8)

Other problems are also stated regarding contrasts, saliva suction machine, sterilization liquid, densistry unit and air-water compressor.

4. Discussion and Conclusions

In this research, DDP procedure has been investigated from a human centred design perspective and as a whole system including several equipment used in the process, its actors including patients, the task and also the environment. Observation and semi-structured interviews are carried out with clinicians in their own work environment. It has been found that, although DDP is a simple and straightforward procedure, it is also very challenging when the aim is to obtain high quality pictures owing to many factors which are likely to affect the quality of the final outcome.

The results showed that postural problems and body strains are important issues in the DDP. In addition due to the variety of equipment used, often clinicians require help from their colleagues, and/or in some cases from the patient as well. This bears coordination problems while positioning the equipment correctly, extends the procedure time, causes repetitive shoots and makes crowd inside the working environment. It was also observed that clinicians have very limited time to decide on the quality of the picture from the very small screen of the camera.

Regarding the equipment used, mirrors are expressed as the most problematic product, because of the fog issue and the pain that it causes on patients during the procedure. Retractors are reported as insufficient in functionality due to not being capable of retracting the lip tissue sufficiently and incompatibility of standard sized retractors for different patients. The heavy weight of the camera with an extra ring flash attached is also another significant issue which is frequently highlighted by the participants. Battery and its charge related problems are indicated for both the ring flash and the camera, in particular for shared clinics.

From a designer perspective, it could be inferred from the results that commonly used products in DDP are designed in a function-oriented but not a human centred manner. In addition, their compatibility with other products used in the procedure is considered to be poor which prevents clinicians to carry out the task individually.

From a clinician perspective, intraoral photography is a challenging procedure due to insufficient retraction of the surrounding tissues and the bulkiness of the camera–flash complexity. If professional cameras are used for the procedure, adjustments in the required settings may be needed for different environment conditions, which could also be challenging and time consuming for clinicians. Sterilisation of an electronic device which is not particularly designed for clinical use is also a problem for clinicians. Apart from these, cooperation of the patient is mostly required for a better quality image.

Using of professional cameras are recommended in the literature in DDP; however, the results suggested that they are inappropriate for clinical settings due to their complexity, big sizes and sterilization problems. It is considered that new practical solutions are necessary to be developed for this purpose. Although intra-oral cameras provide new opportunities in the sector, they are still insufficient to be an alternative to DDP, because they are not portable, require extra work on computers and does not provide same quality level of pictures (Endodontics Journal, 2011).
As a result of this research, a number of design recommendations are made below and it is believed that the outcomes of this research may contribute in the design and provision of new equipment for DDP, in an effort to provide better solutions for the future.

- Different types of products used in DDP should be considered as a part of the whole system of DDP and their compatibility should be ensured.
- Adaptability of the equipment for different patients should be taken into consideration.
- The number of clinicians needed during the procedure should be decreased by providing products facilitating their own control and positioning.
- Postural problems and body strains are needed to be prevented by providing a lightweight yet appropriate technology for taking photographs.
- The whole system including all the components should be designed friendly for both clinician and patient.

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