Prospectus

Improving the Digital X-Ray Sensor Positioning Device for Improved Images and Reduced discomfort

(Technical Topic)

Integration of Dental and Medical care through Co-Locations

(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Improving the digital sensor positioning device would allow for improved images. Our design will force the sensor into the correct position both angularity and distance. A common problem in bitewing X-rays is that the teeth are overlapped in the image and the dentist is not able to view any cavities on the interproximal surfaces of the teeth. Our advisor has been a dentist for 25+ years and has been taking digital X-rays for even longer. Even with all of her experience, she only gets the X-ray right 30% of the time.

Digital dental bitewing X-rays are taken once a year and full mouth images are taken about every 5 years unless there is a specific problem. The X-ray sensors are held in place with a plastic positioning device that the patient bites in order to keep stationary. This device has not been upgraded since it's invention, there have been changes in the way x-rays are taken but they are all expensive to integrate and very different systems. This makes our design a better option for dental offices.

X-rays in dentistry are mainly used as a diagnostic method to locate tooth decay in early stages and prevent problems from becoming exacerbated. Across the healthcare industries, preventative care is the future, but insurances do not have policies that support that. Dentists are not treated the same as other medical doctors; they are not compensated for consultations or fixing patient's broken restorations within specific time limits. There has been a division between dentistry and other medical professions since the start of dental schools, this has led to the insurances forming separately and preventing people from getting the care they need. A proposed plan to integrate the industries is through co-locations. I will explore this idea in this paper.

Technical Topic

The current procedure for taking bitewing X-rays is not a very intuitive procedure, it uses the red positioning device in Figures 1 (Patterson) to hold the sensor behind the teeth and the hoop to line up the camera. Figure 2 shows how the dental professional places the positioning device in the patient's mouth, a small cutout on the red piece is there to line-up the sensor parallel with gaps in teeth, this is to produce an ideal bitewing X-ray with no teeth overlap, Figure 3 shows a X-ray that is diagnostic. The green line in Figure 2 points to the ideal position of the X-ray sensor. Dental radiographs are the best diagnostic tool readily available to dental offices. However, they are useless if the sensor and X-ray machine are not aligned parallel to the teeth, because this will produce an image with overlap, a common occurrence, shown in Figure 4. This device insufficiently produces high-quality X-rays consistently due to the poor alignment mechanism on the current piece. While extensive research has not been conducted on the efficacy of the current device, experts in the field have cited that >50% of bitewing

Figure 1: Denstply Digital Sensor Positioning Device

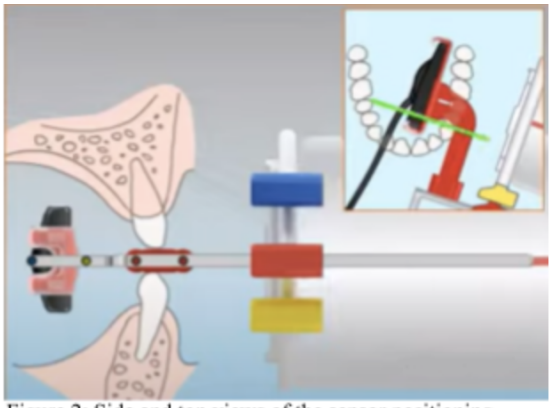

Figure 2: Side and top views of the sensor positioning device taking a bitewing X-ray

X-rays are unsatisfactory on the first attempt (A. Galina 2020).

My capstone team is redesigning the digital X-ray sensor positioning device. Our goal is to redesign the plastic positioning piece so that it will align more easily and be more comfortable for the patient. A better positioning system will save dentists time and money by taking high-quality X-rays on the first attempt. For patients, if an X-ray is not sufficient the first time, they will be exposed to

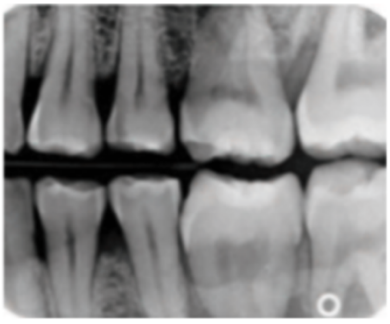

Figure 3: An exemplary bitewing X-ray, showing the gaps in molars and premolars

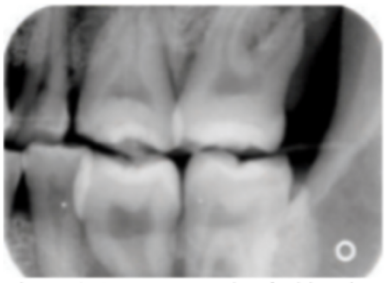

Figure 4: A poor example of a bitewing X-ray, showing how sensor misalignment can lead to teeth overlap

unnecessary dental radiation, which has been linked to adverse health outcomes, especially brain tumors and thyroid cancers (Hwang, S. Y., Choi, E. S., Kim, Y. S., Gim, B. E., Ha, M., & Kim, H. Y. 2018). The current sensor positioning device is uncomfortable and painful for patients, sometimes resulting in abrasions on the lingual surfaces of the gum tissue and palate. Patients can have tori, benign bone growth in the mouth, making X-rays incredibly painful due to the positioning of the senor in this device. By reconfiguring the plastic piece that the patient bites down on, we will allow for a minimal change and no new major equipment necessary, making it incredibly easy and cost efficient to integrate into dental offices.

Our positioning device design will place the sensor further behind the teeth and lined up at the correct angle so the teeth don’t overlap in the image, preventing the visibility of cavities. To aid in the orienting of the sensor, we will add

a ridge on the biting surface of the X-ray holder to help the technician place the device properly. We are also making the device adjustable to allow the sensor to sit further back from the teeth in different sized mouths and making the X-ray camera be able to line up on the top, middle, or bottom of the mouth. The device will have curved sides to allow the patient more comfort. Overall, an improved X-ray image would allow for cavities to be found earlier and less likely to result in root canals or extractions.

STS Topic

An apple a day keeps the doctor away, but brushing your teeth twice a day keeps death away. Global Burden of Diseases declared that oral diseases are the number 1 problem, affecting 3.9 billion people (E. Mertz 2016). According to recent studies (cf.Mayo Clinic Staff 2017; Marshfield Clinic Health System), dental health is more important than ever thought before and people are now arguing that dental care should be included in federal medical insurance plans. Studies have shown a strong link between gum disease and an increased risk of developing heart disease or having a stroke. Plaque buildup in the mouth can get into the bloodstream causing inflammation and making blood more likely to clot.

Despite the immense amount of research and conclusive results that good dental care is vital to good overall health, oral care is still both separate and underappreciated compared to other medical care. By incorporating the mouth into general health, many illnesses and problems can be prevented/cured much easier.

Separation

The separation of dental and medical care started when medical schools were established and dentistry was excluded (K. A. Atchison & J. A. Weintraub, 2017).

Insurance companies used this divide to their advantage by creating two separate types of insurances. Insurance companies discovered that people would buy dental insurance but rarely use it, this benefits the companies because then they make a lot more money versus medical insurance which is used regularly: "The presence of dental coverage does not automatically result in the use of dental service" (K. A. Atchison & J. A. Weintraub, 2017). The exclusion of a body part and the separation of health care was an intentional ploy to take advantage of civilians and exacerbated by greedy insurance companies. In recent years oral health has become more important to people and they are seeing that oral and medical health is one and the same (K. A. Atchison & J. A. Weintraub, 2017).

Congresswoman Alexandria Ocasio-Cortez is a big advocate for dental care, sharing her own experiences and struggle to get dental care before becoming a United States Congresswoman (A. Werner 2020): "DENTAL HEALTHCARE IS HEALTHCARE". AOC struggles with getting orthodontic care and wasn't able to until she became a Congress woman. She is pushing for dental care to become part of medical care because it is not for aesthetics, "not having your bite lined up correctly can be painful and contribute to other health problems" (Alexandria Ocasio-Cortez, Instagram 2020).

Currently Medicaid mostly provides only children with dental insurance (Medicaid), and while that is a great start and allows children to develop good habits while young, it excludes all other ages from receiving the dental care they need. The care of oral care is something that has to be instilled at the age of children,

this is why it is so important to have programs directed at providing dental care for children (Kleinberger, J. A., and Strickhouser, S. M. 2014)

There is a connection between sociology and dentistry that has not been explored (Catherine Exley 2009). The inequality in dentistry is linked to poor medical and dental care in most countries, so it is the lower class people who suffer from illnesses that can be easily prevented or advanced. This is important because it is a fundamentally racist system that was designed with this intent (Catherine Exley 2009). Co-locations aim to combat this problem by making general care more accessible for people.

Integration

The lack of comprehensive medical insurance can be solved by bridging the gap between dental and medical care through integration. A proposed method of integrating is co-locations. In the North Carolina Medical Journal Co-location and Closer Integration of Medical and Dental Providers was discussed (K.A. Atchison & J.A. Weintraub 2017), their plan is to put multiple preventative care procedures in the same facility, allowing the patient easy access to care and integrating electronic health records (EHR). Co-locations are a way to make preventative care more accessible by providing mammograms, flu shots, colonoscopies, and dental hygiene check-ups all in the same building. The American Dental Association has declared that the dentist's "expertise and network" qualifies (K.A. Atchison & J.A. Weintraub 2017) them to provide medical screenings while the patient is in their chair. Over the past couple of years there has been a push to have dentists provide medical care for smokers and diabetics during their annual dental appointments.

The co-location integration theory has been implemented around the country and has been successful. The clinics had different methods from each other but all had "coordination of services within comprehensive systems of care" (McKernan, S. C., DMD MS PhD, Kuthy, R. A., DDS MPH, Reynolds, J. C., DDS MS, Tuggle, L., MPH, & García, D. T., PhD MPH. 2018). Numerous clinics accomplished this through EHR to "facilitate bidirectional referrals and flagging records of dental patients who have chronic conditions" (McKernan, S. C., DMD MS PhD, Kuthy, R. A., DDS MPH, Reynolds, J. C., DDS MS, Tuggle, L., MPH, & García, D. T., PhD MPH. 2018) and many clinics implemented a referral system where a primary care physician would perform oral examinations and would refer their patient for oral care if necessary. Integrating these medical professions under one roof streamlined the collaboration between a patient's doctors and limited mistakes . The clinics that participated in this study mainly focused on diabetes, EHR alleviates the pressure on the patient to confirm that all of their doctors know about their medical conditions and medications because they all had access to their file (McKernan, S. C., DMD MS PhD, Kuthy, R. A., DDS MPH, Reynolds, J. C., DDS MS, Tuggle, L., MPH, & García, D. T., PhD MPH. 2018). I could see this as a great way to lower the risk of being given conflicting medication that could cause life-threatening side effects. Along with dentists being able to provide chairside medical evaluations, a program was started in North Carolina called *Into the Mouths of Babes (IMB)*. This "program trains medical providers to deliver preventive oral health services to young children insured by NC Medicaid" until the child is 42 months old (Oral Health 2020). The medical profession provides basic oral care: oral evaluation and risk assessment,

counseling with primary caregivers and application of topical fluoride varnish (Oral Health 2020).

Preventative Care

Preventative health care is the way to save lives, countless illnesses can be cured just by "catching it early" and the best way to implement preventative care is through the integration of medical care. Some people only go to medical visits and some only go to dental appointments, this could be because of insurance or lack of funds, but frankly insurance companies are often too focused on money instead of the well-being of their client. New York State passed a law mandating that dentists must offer voluntary HIV screenings (K. A. Atchison, R. G. Rozier, & J. A. Weintraub 2018), this is a huge step! By legally allowing qualified doctors to counsel their patients on general medical care, people would be able to take better care of themselves. When COVID-19 hit America in March 2020, there was a severe lack of doctors around the country, all hands were called on deck except for dentists. Dentists go through the same schooling required for a medical doctor and yet they are often disregarded. To integrate these industries would forever change the way healthcare is in this country.

Next Steps

My next step is to look at the ethical implications of integrating medicine and dentistry. The patriarchal system of dentistry and how it formed on the macro level may be a good start into some of the ethical problems that surround this field in general (Kleinberger, J. A., and Strickhouser, S. M. 2014). Who will be in charge of

this new institution, the American Dental Association or American Medical Association? There could be a power component here, a fight for who creates the new rules. Another concern to explore is how people will react, will they be skeptical or accepting?

In terms of my next steps for my technical project: my partner and I will have our CAD designs finished by the end of the semester and hopefully start production and testing next semester.

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