F. Wilbur Gingrich Library
Special Collections Department
Albright College

Release of Senior Thesis

I hereby grant to the Special Collections Department of the F. Wilbur Gingrich Library at Albright College the nonexclusive right and privilege to reproduce, disseminate, or otherwise preserve the Senior Honors Thesis described below in any noncommercial manner that furthers the educational, research or public service purposes of Albright College. Copyright privileges remain with me, the author.

Title: The Development of the Novel Utilization of Dental Lasers for Soft and Hard Tissue Procedures

Signature of Author: _____ Date: 4/19/2020

Printed Name of Author: Linden Bennetch

Street Address: 301 Valley View Rd.

City, State, Zip Code: Myerstown PA, 17067

The Development of the Novel Utilization of Dental Lasers for Soft and Hard Tissue Procedures

Linden Bennetch

Candidate for the degree

Bachelor of Sciences

Submitted in partial fulfilment of the requirements for

College Honors

Replace with name of Thesis Advisor plus academic degree, e.g. Joseph Harris, Ph.D.

Replace with name of Departmental Reader here including academic degree

Replace with name of College Reader here including academic degree

The Development of the Novel Utilization of Dental Lasers for Soft and Hard Tissue Procedures

By: Linden Bennetch

Studying history is a useful way to build on previous knowledge to create advancements for the future. Dentistry is a profession that has been around for centuries, but in the past 150 years there have been many technological developments that have propelled the vocation forward. Dental history is an extensive topic that can be broken down into subspecialties that exist in the occupation. Endodontics is one such specialty that studies the preservation of teeth by extracting infected pulp and sealing the tooth with medicinal cement. The typical procedure for a root canal uses an anesthetic and then a drill to complete the treatment. However, with the creation of dental lasers, there has been an opportunity for novel methods of remedying dental diseases. This paper focuses particularly on the idea of lasers in dentistry, and how those technological developments have been altered and received by experts and practitioners in the field of dentistry. There are many benefits of using lasers in dentistry, but some drawbacks exist as well. Dentists are beginning to realize the advantages of using lasers in their practice, and public perception of dental lasers is becoming more positive. Therefore, as dental technology continues to advance, more procedures, such as tissue clearance, and cavity and root canal preparation, will be completed using a laser, so as the public becomes more aware and knowledgeable about the benefits of lasers, more dentists will purchase them for their practice.

History of Dentistry and the Development of the Specialty of Endodontics

The history of dentistry is a broad, but important topic that can be looked at from many different angles. Dentistry is the medicinal science that is “concerned with the embryology, anatomy, physiology, pathology of oral-facial complex, and with the prevention, diagnosis and treatment of deformities, diseases and traumatic injuries” (Majumdar 2002). Dental care is a

crucial part of overall body health. The teeth and mouth "are the gateway to the inside of the body" (Majumdar 2002). People who have poor oral health are susceptible to coronary heart disease, diabetes, and cancer (Joshipura *et al.* 1996). Dental diseases have been around for as long as *Homo sapiens* have existed on earth. Thus, every tribe, every country, every culture, and all different types of people, through their own experiences have helped shape the development of dental sciences throughout the centuries (Majumdar 2002).

The practice of dentistry goes back to the Egyptians, where dental decay was discovered on mummies' teeth that were preserved since 4000 B.C. (Majumdar 2002). There were teeth found in a jar, during the Bronze Age (2500 B.C. to 1500 B.C.) that had some unusual brownish tarter which formed a ring around the teeth. Utilizing ultraviolet emission spectroscopic examination, scientists found that the ring was copper residue, indicating that a dental professional during that time period used copper strings for periodontal splintage to aid in keeping the loose teeth anchored to the intact teeth, so the person could use their teeth effectively to consume food (Majumdar 2002). Galen (130-200 A.D.), known as the "medical dictator," referenced "pruritus of the gums" which in modern terms would be gingivitis. There are also references to teeth extraction in Greek writings by Hippocrates (460-377 B.C.), but he believed only loose teeth could be extracted (Majumdar 2002). Other writings from Abulcasis (936-1013 A.D) and Gerard (1114-1187 A.D.) were translated in 13th century Europe, and that re-awakening of information allowed the Europeans to develop dental instruments to treat dental diseases (Majumdar 2002).

The history of endodontics began a few centuries later in the 17th century when Charles Allen, a dentist in England, wrote a book describing new techniques for dental transplants (Castellucci 2004). Endodontics was developed to "relieve pain, maintain exposed pulp, and

preserve teeth" (Castellucci 2004). The advances in endodontics occurred after Pierre Fauchard, a French physician (1678-1761), wrote a textbook called "*Le chirurgien dentiste*", which explained dental pulp, dispelling the myth of a "tooth worm" heretofore blamed for tooth cavities and toothaches. In 1725, Lazare Riviere, a French medical professor, isolated an oil from cloves that could be used for its sedative properties, so patients did not have to be in a lot of pain when dentists were performing work on their teeth (Castellucci 2004). Later in 1746, Pierre Fauchard explained the process of removing pulp tissue from teeth. By 1820, Leonard Koecker, an American dentist, had cauterized exposed pulp tissue with an instrument that could heat the pulp followed by putting lead foil over the tooth to protect the tooth from further infection. Edward Maynard, an American inventor, created the first root canal instrument, in the late 1830s, after he filed down a watch spring to create a sharp tip capable of penetrating an infected tooth (Castellucci 2004). In 1867, Dr. Magitot, a British dentist, suggested that an electric current could be used to test pulp vitality. The late 19th century, into the early 20th century saw numerous beneficial improvements in dental medicine focusing particularly on endodontic treatments. Otto Walkhoff, a German dentist, was the first to take a dental radiograph, just 14 days after Wilhelm Roentgen, a German engineer, discovered that X-rays could be utilized to detect undesirable changes in exposed tissues (Sansare *et al.* 2011). Walkhoff took the first dental radiograph on himself. It took 25 minutes and hurt tremendously. However, after the invention of anesthetics, the X-ray is probably the most important invention for the field of dentistry (Sansare *et al.* 2011). The pictures produced by the X-ray allow dentists to see areas of decay on the patient's tooth, and if the decay is too deep having already reached the nerve of the tooth, then the dentist knows to perform a root canal treatment to remove the infected pulp in the patient's tooth.

One of the most important developments in the history of endodontics was anesthesia. The use of local anesthetics began in 1859, after Dr. Albert Niemann, a German chemist, isolated cocaine (Singh 2012). Karl Kollar, an ophthalmologist, was the first to use cocaine as a topical anesthesia during an eye surgery. Then William Halsted became the first surgeon to use cocaine as an anesthetic during a wisdom tooth extraction. Neither patient complained about pain, but after "a number of adverse effects were observed with the clinical use of cocaine … other local anesthetic agents had to be developed" (Singh 2012). Other dental anesthetics that were used in the late 19th into the early 20th century were nitrous oxide, ether, and chloroform. Ether and chloroform use has diminished because of the harmful side effects, but nitrous oxide is still utilized as a general anesthetic (Weaver 2013). In 1905, Alfred Einhorn, a German chemist, created procaine, which was the first kind of ester-type anesthetic agent (Singh 2012). This anesthetic was used for over 4 decades, but in 1943, Nils Lofgren, a Swedish chemist, created lidocaine, the "first modern local anesthetic agent, since it is an amide-derivate of diethylamino acetic acid" (Singh 2012). Lidocaine was introduced to the global market in 1948 and is currently the most widely used local anesthetic in dentistry. The utilization of reversible local anesthetic chemical agents is the most prevalent way to get pain control in a dental practice (Singh 2012).

There are three main ways to get the anesthetic into a patient's mouth, specifically at the infected area. The treatments consist of using topical anesthesia, local anesthesia, or regional anesthesia and all of these treatments contain lidocaine. Topical anesthesia is a gel that is rubbed from a Q-tip onto the area of the patient's mouth that needs to be numbed. The topical gel allows for the mucosal layer to become insensitive (Castellucci 2004). This treatment tends to come before the local or regional anesthetic treatments so getting the needle inserted into the gum does

not hurt the patient as much. Local infiltration is described "as a technique by which an anesthetic solution is deposited within the treatment area" (Castellucci 2004). The local treatment provides fast and efficient use of the anesthetic for the maxillary teeth and mandibular incisors. The needle is inserted vestibularly at the mucogingival junction in the area of the infected tooth. Usually, 2 ml of anesthetic solution is enough to numb the tooth area so the patient can be treated comfortably (Castellucci 2004). Regional anesthesia involves blocking feeling from an entire facial nerve, such as the inferior alveolar nerve. The dentist must apply a local anesthetic near the trunk of the major nerve, which then blocks the afferent impulses from traveling proximally to the area where the dentist is drilling on the tooth (Castellucci 2004). For this procedure, more anesthetic is needed because finding the area where the nerve is located is difficult so the dentist normally needs to insert the needle more than once to get the nerve blocked.

Once the anesthetic takes effect, the dentist can begin working on the patient's infected tooth; however, reliable tools are necessary to perform the complex procedures. Edward Maynard created the first endodontic hand instrument in 1845 by notching a round wire from piano wires utilizing small needles to extract the infected pulp tissue (Hulsmann *et al.* 2005). By 1885, the Gates Glidden drill was invented and was considered the best drill to form regularly shaped canals, which allowed a standard of care to be set for dentists. When dentists used a Gates Glidden drill, they knew how large the canal they created should be, so the new drill helped to standardize root canal instruments and lowered the possibility for error (Hulsmann *et al.* 2005). In 1889, a dentist named William Rollins "developed the first endodontic hand-piece for automated root canal preparation. He used specially designed needles, which were mounted into a dental hand-piece with a 360° rotation. To avoid instrument fractures rotational speed was

limited to 100 r.p.m" (Hulsmann *et al.* 2005). This was a giant step forward because the previous endodontic instruments were powered by a pulley system, which was not only inefficient but the drill did not spin as fast, so the procedure would take longer. A few years later, Dr. Oltramere found a way to put an endodontic drilling file onto a dental hand piece, which allowed more dentists to perform root canals since they already had the necessary equipment in their offices. All they needed to purchase was an endodontic file (Hulsmann *et al.* 2005). By 1928, an Australian company (W&H) created a hand-piece that could rotationally and vertically move the endodontic file, giving dentists more freedom of movement when trying to generate the right canal size in the damaged tooth (Hulsmann *et al.* 2005). During the late 1960s, the Racer hand-piece was developed and it worked with vertical motion and a reciprocal 90° rotation. In the early 2000s, the nickel-titanium (NiTi) instrument was invented by an endodontics company called SynbronEndo. This instrument is the most common type of root canal tool used presently by endodontists globally, because of its vertical rotation and 360° rotational abilities, it is harder to break compared to the traditional endodontic instruments (Hulsmann *et al.* 2005). These endodontic tools are important for cleaning the tooth canals of infected teeth, and there are many reasons why those canals need to be disinfected.

The main goals of root canal preparation are to prevent periradicular (composed of the root cementum, periodontal ligament, and the alveolar bone) disease and promote healing in cases where the infection already exists (Hulsmann *et al.* 2005). Dentists need to take out the vital and necrotic tissue from the root canals in the infected tooth. They have to create enough space for irrigation and medication. Additionally, the dentist needs to preserve the stability and location of the apical canal anatomy (Hulsmann *et al.* 2005). The canal should also be filled with gutta-percha, a rubber like material that can get wet, be exposed to other types of chemicals and

enzymes, and still be cemented in the tooth, blocking more bacteria from going down the canal of the tooth. This helps to prevent further irritation or infection of the periradicular tissues too. By following all of these steps, that will ensure the "preservation of sound root dentine to allow long-term function of the tooth" (Hulsmann *et al.* 2005). There are many techniques associated with root canal preparation; they include manual preparation, automated root canal preparation, ultrasonic preparation, and the utilization of lasers (Hulsmann *et al.* 2005). Lasers are a relatively new form of endodontic preparation. There is much debate about whether lasers are an advantageous preparation method and if they are actually going to be used by dentists.

After the development of the ruby laser by Theodore Maiman in 1960, scientists have been researching ways to get lasers involved in dental care (Kimura *et al.* 2000). A laser "is a device which transforms light of various frequencies into a chromatic radiation in the visible, infrared, and ultraviolet regions with all the waves in phase capable of mobilizing immense heat and power when focused at close range" (Kimura *et al.* 2000). Dr. Stone and Dr. Sognnaes were the first people to research the potential uses of the ruby laser in the dental field. They wanted to investigate the ruby laser's ability to reduce subsurface demineralization on hard dental tissues. Their tests were successful, and they found that the laser decreased the tooth enamel's permeability to acid demineralization after laser irradiation (Kimura *et al.* 2000). With the success of the experiments by Dr. Stone and Dr. Sognnaes, researchers started to investigate other lasers on enamel materials. The lasers' depth of penetration is controlled by "the wavelength, power, and the irradiation time" (Timimi and Alhabeel 2019). The dentists can select a particular wavelength that is released from the laser, and they can control how long the laser penetrates a certain area to make sure the laser is working effectively on the patient's teeth (Timimi and Alhabeel 2019). Those lasers included "argon (Ar), carbon dioxide (CO_2),

neodymium: yttrium-aluminum-garnet (Nd:YAG), and erbium (Er): YAG lasers" (Kimura *et al.* 2000). The purpose of lasers in endodontics is to reduce dental hypersensitivity, treat pulp in an infected tooth, modify and sterilize root canal walls, and recently lasers have been used in full root canal treatments (Kimura *et al.* 2000). Dentists have many options for lasers they can purchase to use in their offices.

Three of the most popular dental lasers include gas lasers, solid-state crystal lasers, and semiconductor lasers. One of the most common gas lasers is carbon dioxide (CO_2) driven dental laser. It involves a gas mixture of carbon dioxide, nitrogen, and helium (Coluzzi and Parker 2018). Nitrogen aids in the "excitation process and ultimately transfers that energy to the carbon dioxide molecules" (Coluzzi and Parker 2018). Once the carbon dioxide molecules are excited they can produce a light energy wavelength that is at 10,600 nm. The light energy is "delivered through a hollow tube-like waveguide" and gives the "CO_2 laser the ability to provide the required power in continuous and gated modes using focused … hand-pieces giving this instrument the versatility and precision required for soft tissue surgical procedures" (Garg *et al.* 2015). CO_2 lasers alone are only used for soft tissue procedures, such as gum repair. However, when the CO_2 laser is combined with an active medium of isotopic gas, it can perform hard tissue procedures like repairing cavities and creating sterilized root canals (Spector 2017). Following CO_2 laser irradiation, dentine permeability was reduced, which "caused surface fusion and inhibition of subsequent lesion progression in dentine and improved bonding strength of a composite resin to dentine" (Kimura *et al.* 2000). The CO_2 laser's ability to create strength between the composite and dentin of a root canal greatly helps in securing a successful root canal treatment.

Solid-state crystal lasers contain a host material of yttrium aluminum garnet (YAG) that can then be treated with multiple different elements. The most popular is neodymium (Nd). Combining the YAG and Nd creates a laser called the Nd:YAG laser (Coluzzi and Parker 2018). The Nd:YAG laser has a wavelength of 1064 nm, and the laser is "fiber-optically delivered … and generates a free-running pulsed beam of energy" (Julian 2016). The laser "exhibits minimal surface tissue absorption and maximal penetration; this property allows for coagulation of tissue in depth" (Sawisch 2016). Since the Nd:YAG laser can penetrate up to 4 mm into the tissue, it is effective at generating coagulation and hemostasis (Julian 2016). Additionally, scientists have found that the Nd:YAG laser can be "used successfully for intraoral soft tissue applications without anesthesia and with minimal bleeding" (Sawisch *et al.* 2016). This is a large step forward because most patients complain about having to receive anesthetic for dental procedures as the needle hurts their mouth, so eliminating that discomfort will make more patients appreciative of the laser treatment. As advancements were made to the Nd:YAG laser, its use was investigated for endodontic treatment. Clinical examinations of the Nd:YAG laser were undertaken by researchers to find out potential endodontic uses for the laser. There was a control group that had root canals completed in a regular fashion with a root canal file and drill, and a second group that had lasers used to aid in finishing the root canal treatment (Kimura *et al.* 2000). The patients were then asked 3 months later what their pain level was on a scale of 1-10 and same thing 6 months later, and the researchers found that "infected teeth at 3 to 6 months after laser irradiation and root canal filling revealed that postoperative discomfort or pain in the laser-treated group was significantly reduced compared to the non-laser-treated group" (Kimura *et al.* 2000). Successful completion of a root canal with the help of an Nd:YAG laser is a notable step forward for a laser that is usually utilized for soft tissue procedures.

The semiconductor lasers can also be used in endodontic treatment, mainly for pulp disinfection. Semiconductor lasers "utilizes the basic positive-negative junction of everyday electronic circuits – the diode: that is, a two pole oppositely charged wafer. The flow of negatively charged electrons into the positively charged holes diffuses across the junction" (Coluzzi and Parker 2018). The lasing action occurs between the charged layers, referred to as the depletion region. This small rectangle will release a monochromatic light that is then aligned with an external lens (Coluzzi and Parker 2018). An example of a semiconductor laser is the gallium arsenide (GaAs) laser which can be used "for dental pulp repair, and has bactericidal properties that are mainly related to photo-thermal effects" (Su *et al.* 2017). Dental pulp that is infected causes pain in the tooth, so it needs to be cleaned during a root canal. The semiconductor laser can remove the bacteria from the pulp because of its affinity for targeting bacterial cells (Su *et al.* 2017). The "laser irradiation can penetrate the dentinal tubules in depth, as it is not absorbed by the hard tissue of the teeth and has reached a 63% reduction in bacterial population at a depth of 750 μm" (Su *et al.* 2017). The ability of the semiconductor laser to kill bacteria, but not harm the hard dentine of the tooth is essential for an effective root canal treatment. If bacteria are left in the root canal then they will cause another infection. If the laser degrades the dentine of the tooth then the tooth could be perforated and may cause the tooth to be non-viable. Thus, the semiconductor laser does a balancing act between removing the harmful bacteria, but not damaging the structure of the tooth. Researchers found that "after conventional root canal preparation, semiconductor laser irradiation in root canals may help to reduce microleakage and improve root canal closure for a success of root canal therapy" (Su *et al.* 2017). Reducing microleakage and improving root canal closure makes the root canal procedure

viable for a longer period of time, making the patient happy and improves the dentist's skills as a clinician.

The benefits of using a laser in dentistry are numerous, and revolve around providing the patient with quality care with less pain. Over time, dentists and inventors have developed improvements in dental tools that can provide higher quality treatment for patients. Lasers in dentistry "can transform a patient who was previously resistant to conventional treatment plans into a more relaxed and certainly cooperative one" (Coluzzi and Parker 2018). People feel more comfortable when they believe their dentist is experienced while keeping up with the latest technology. Lasers allow the dentist to show they are up to date on the newest procedures. Dentists have found that "lasers are especially helpful in geriatric patients as it makes the procedure more tolerable and helps them overcome some of the barriers in providing dental care to them, including severe dental complexity, multiple medical conditions, and diminished functional status" (Coluzzi and Parker 2018). More specifically, the advantages of lasers extend into soft and hard tissue treatments. Soft tissue treatments such as exposure of unerupted and partially erupted teeth allow the dentist to clear away the unwanted gum tissue and place a bracket on the tooth so it can be pulled up into a satisfactory position (Verma *et al.* 2012). Also, lasers, at low doses, can activate tissue proliferation (at higher doses the laser destroys the tissue). The laser "affects fibroblast maturation and locomotion, and this in turn may contribute to the higher tensile strength reported for healing wounds" (Verma *et al.* 2012). If a patient walks into a dental office with an ulcer, and the dentist owns a laser, the treatment would be quick and basically painless for the patient, which would make them more likely to come back to the office in the future. Hard tissue applications include cavity preparation and restorative removal. The lasers can clean off cavities in the dentine and enamel by ablation, without harming the

underlying pulp tissue (Verma *et al.* 2012). One of the most common complaints in dentistry is dentinal hypersensitivity; lasers can desensitize exposed hypersensitive dentine, and maintain that desensitization longer compared to other agents (Verma *et al.* 2012). The possibilities of utilizing lasers in dentistry are limitless, and they focus on providing less invasive, more precise, and less painful procedures which gives the patient a positive dental experience (Coluzzi and Parker 2018).

Unfortunately, there are some drawbacks to lasers in dentistry. One of the main concerns is education. Occasionally, dentists will purchase a laser and watch a YouTube video or attend one continuing education (CE) class and think they can use the laser effectively. This is not the case and can be detrimental to the patient's health. The dentist should have an "understanding of the fundamentals of laser physics, tissue interactions, and the safe use of the device" (Coluzzi and Parker 2018). Comprehending all of those points requires a lot of time, effort, and money. The lasers themselves are expensive, and maintaining the laser is costly as well. Thus, a lot of dentists, especially older dentists, do not see the advantage of bringing one into their practice. Another drawback of some lasers is their "inability to remove defective metallic and cast porcelain restorations… due to a combination of too much power or the laser beam moving too slowly" (Coluzzi and Parker 2018). Furthermore, the laser produces a plume consisting of vaporized water, carbon, and other harmful molecular particles that need to be suctioned up immediately after they are produced. If the dentist is working with an inexperienced assistant, then that plume may go down the patient's throat causing pain an infection, or an asthmatic reaction (Coluzzi and Parker 2018). Thankfully, if there is a proficient dentist using the laser, there are many beneficial possibilities for creating treatment options.

The number of dentists utilizing lasers in their dental offices are growing. A recent survey discovered “that 28 percent of orthodontists, periodontists, and general dentists surveyed said they used a soft tissue laser,” in 2013, compared to 2 percent in 2004 (Dansie *et al.* 2013) (Jameson 2004). Despite this small percentage, many dentists who use a laser have positive feedback for its application in dentistry. Dr. Christopher Owens explains that lasers have been “approved to do hard tissue, soft tissue, osseous, perio, and endo procedures and just about anything else you would want to do with a laser in the mouth” by the Food and Drug Administration (FDA) (Jameson 2004). Dentists have found that lasers are good for bread-and-butter procedures, such as crown lengthening and removing excess gum tissue. The lasers can also be used in “class 1 to class 6 cavity preps, endodontics, periodontics, and osseous procedures” which allows dentists, like Dr. Owens, to get a large return on investment (ROI) for the laser because it can be used in a broad range of procedures (Jameson 2004). There are some dentists that “started calling their lasers the "ATM machine" in their hygiene rooms” because the dentist can train the hygienist to do laser procedures, which will increase the profits for the practice (Jameson 2004). Additionally, dentists like that procedures can be completed without an anesthetic, because patients feel better after the treatment, and give the dentist more positive reviews. Endodontists, in particular, are appreciative of dental lasers because of the laser’s “effect at the cell level to prevent the signal transmission of pain from peripheral to central parts as well as blocking of the depolarization of sensory C fibers” (Asnaashari and Safavi 2013). People who get root canals are usually afraid of pain, and if dentists and endodontists who perform root canals can find an effective way to take away that pain, it will make the procedure go much smoother. Lasers can also repair nerve damage that occurs to an adjacent tooth while the root canal is being performed; the use of a “laser resulted in stimulation of damaged fiber’s

axon growth" (Asnaashari and Safavi 2013). This permits clinicians (dentists or endodontists) to save teeth that otherwise may have been harmed in the root canal treatment. Dentists are beginning to realize the value of lasers in dentistry, especially in the field of endodontics.

The public perception of lasers in dentistry is closely tied to how people view oral health generally. Oral health is "the state of the mouth and associated structures where disease is contained, future disease is inhibited, the occlusion is sufficient to masticate food, and the teeth are of a socially acceptable appearance" (Baiju *et al.* 2017). People are beginning to understand that oral health is tied to their overall physical and mental health. Oral diseases have been connected to heart disease and diabetes, so the public is taking oral hygiene more seriously (Joshipura *et al.* 1996). Studies have found that "the social and aesthetic impact of poor oral health will be related to the expectations of the individual and the society around them, or on the value placed on beauty, and the effect of facial appearance on life chances in their particular culture" (Nassani *et al.* 2015). In the United States, there is a large push for proper oral health and white teeth. There are many tooth whitening products on the market, and they are inexpensive, so now everyone can have the chance for the "Hollywood Smile." Lasers have the ability to whiten teeth, so people are seeing them in dental offices far more commonly for aesthetic uses, and that is getting them more comfortable being treated with a laser (Verma *et al.* 2012). However, now that lasers have been technologically advanced, they can provide patients, who have more complex procedures, a new tool for tooth care. For example, in 2017, Dr. Yooson Kim, the owner of Family Dentistry of Morgantown in Pennsylvania, saw a patient named Tina Cressman (Kulsrud 2017). Mrs. Cressman was a new patient at Dr. Kim's office. Previously, Mrs. Cressman had gone to a different dentist that diagnosed her with multiple cavities and performed several root canals on her teeth. She was in a significant amount of pain

from those procedures and did not want to go back to the dentist. However, after hearing from friends about Dr. Kim's dental office, Mrs. Cressman decided to check out the new technology that Dr. Kim had that performed painless dental care. When Mrs. Cressman arrived at the office, Dr. Kim offered to use a new laser on Mrs. Cressman to alleviate her fears. After using the dental laser to fill her remaining cavities, Mrs. Cressman "felt a huge sense of relief – and I had no pain" she also mentioned that her "kids will never have to experience those needles or that type of pain again" for a regular cavity or root canal treatment (Kulsrud 2017). Lasers have risen in popularity and functionality to help the public get a more positive view of dentistry. About "one-third of patients surveyed by the American Dental Association … thought it was very important that their dentists have lasers, which could put pressure on dentists to invest in this tool to attract patients" (Dederich and Bushick 2004). There is a good chance that lasers will become commonplace in dental practices as soon as the cost of lasers goes down and the consumer desire for dental laser operations goes up.

The progression of technological advancements in dentistry has allowed lasers to become a tool to perform soft and hard tissue procedures, and their rise in popularity has driven dentists to purchase lasers for their practice. The rise of laser popularity in the public started with the James Bond film *Goldfinger* produced in 1964, coinciding with development of lasers in dentistry that started in 1960. Lasers are a useful tool to provide quality care to the patient, sometimes foregoing the need for anesthetic. Dental lasers can be used in every subfield of dentistry, but their use in endodontics is growing rapidly because the lasers can numb the operatory field, and be used to file and sterilize the walls of the root canals. Endodontics describes a strategy where clinicians try to preserve a tooth by drilling into it and filling it with medicinal material. Analyzing the history of dentistry and endodontics allows people to see the

progression of the technological developments made in the dental profession, and where the future techniques are headed. The utilization of the past to influence growth in the future is why focusing on historical progression is so invaluable.

Works Cited

Asnaashari, Mohammad, and Nassimeh Safavi. “Application of Low Level Lasers in Dentistry (Endodontic).” *Journal of Lasers in Medical Science* , vol. 4, no. 2, 2013, pp. 57–66.

Baiju, Rm, et al. “Oral Health and Quality of Life: Current Concepts.” *Journal Of Clinical And Diagnostic Research*, vol. 11, no. 6, June 2017, pp. 21–26., doi:10.7860/jcdr/2017/25866.10110.

Castellucci, Arnoldo. “A Brief History of Endodontics.” *Endodontics*, vol. 1, 2004, pp. 2–5.

Coluzzi, Donald, and Steven Parker. *Lasers in Dentistry - Current Concepts*. Springer, 2018.

Dansie, Chase O, et al. “Training and Use of Lasers in Postgraduate Orthodontic Programs in the United States and Canada.” *Journal of Dental Education*, vol. 77, no. 6, June 2013, pp. 773–781.

Dederich, Douglas N., and Ronald D. Bushick. “Lasers in Dentistry.” *The Journal of the American Dental Association*, vol. 135, no. 2, 2004, pp. 204–212., doi:10.14219/jada.archive.2004.0153.

Garg, Nimit, et al. “Use of Carbon Dioxide Laser in Oral Soft Tissue Procedures.” *National Journal of Maxillofacial Surgery*, vol. 6, no. 1, 2015, pp. 84–88., doi:10.4103/0975-5950.168218.

Hulsmann, Michael, et al. “Mechanical Preparation of Root Canals: Shaping Goals, Techniques and Means.” *Endodontic Topics*, vol. 10, no. 1, 2005, pp. 30–76., doi:10.1111/j.1601-1546.2005.00152.x.

Jameson, John H. “How Have Lasers Advanced Dentistry as We Know It?” *Dental Education*, Oct. 2004, www.dentaleconomics.com/science-tech/article/16393024/how-have-lasers-advanced-dentistry-as-we-know-it.

Joshipura, K.j., et al. “Poor Oral Health and Coronary Heart Disease.” *Journal of Dental Research*, vol. 75, no. 9, 1996, pp. 1631–1636., doi:10.1177/00220345960750090301.

Julian, Jon. “Lasers in Implant Dentistry.” *Principles and Practice of Laser Dentistry*, 2016, pp. 107–130., doi:10.1016/b978-0-323-29762-2.00007-3.

Kimura, Y., et al. “Lasers in Endodontics: a Review.” *International Endodontic Journal*, vol. 33, no. 3, Apr. 2000, pp. 173–185., doi:10.1046/j.1365-2591.2000.00280.x.

Kulsrud, Zachary. “Laser Dentistry: A Patient's Perspective on Pain-Free Treatment.” *Dentistry IQ*, Oct. 2017, www.dentistryiq.com/practicemanagement/industry/article/16366821/laser-dentistry-a-patients-perspective-on-painfree-treatment.

Majumdar, Sisir K. “History of Dentistry: An Overview.” *Bull.Ind.Inst.Hist.Med.*, vol. 32, 2002, pp. 31–42.

Nassani, MZ, et al. “Is the Value of Oral Health Related to Culture and Environment, or Function and Aesthetics?” *Community Dental Health* , vol. 32, no. 4, Dec. 2015, pp. 204–208.

Sansare, K, et al. “Early Victims of X-Rays: a Tribute and Current Perception.” *Dentomaxillofacial Radiology*, vol. 40, no. 2, 2011, pp. 123–125., doi:10.1259/dmfr/73488299.

Sawisch, Todd J., et al. “Use of Lasers for Minor Oral Surgery in General Practice.” *Principles and Practice of Laser Dentistry*, 2016, pp. 131–151., doi:10.1016/b978-0-323-29762-2.00008-5.

Singh, Preetinder. “An Emphasis on the Wide Usage and Important Role of Local Anesthesia in Dentistry: A Strategic Review.” *Dental Research Journal*, vol. 9, no. 2, Mar. 2012, pp. 127–132., doi:10.4103/1735-3327.95224.

Spector, Andrew M. “The Benefits of Using a CO2 All-Tissue Laser in Dentistry.” *Dentistry Today*, Dec. 2017, www.dentistrytoday.com/news/todays-dental-news/item/2689-the-benefits-of-using-a-co2-all-tissue-laser-in-dentistry.

Su, Dandan, et al. “Semiconductor Laser Irradiation Improves Root Canal Sealing during Routine Root Canal Therapy.” *Plos One*, vol. 12, no. 9, 2017, doi:10.1371/journal.pone.0185512.

Timimi, Zahra, and Mohammed Alhabeel. “Laser Dental Treatment Techniques.” *Prevention, Detection and Management of Oral Cancer*, 2019, doi:10.5772/intechopen.80029.

Verma, Sanjeevkumar, et al. “Laser in Dentistry: An Innovative Tool in Modern Dental Practice.” *National Journal of Maxillofacial Surgery*, vol. 3, no. 2, 2012, pp. 124–132., doi:10.4103/0975-5950.111342.

Weaver, Joel M. “New evidence of enhanced safety of nitrous oxide in general anesthesia.” *Anesthesia progress* vol. 60,4 (2013): 143-4. doi:10.2344/0003-3006-60.4.143