THE CURRENT USE OF SOFT TISSUE LASERS IN ORTHODONTIC PRACTICES

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THE CURRENT USE OF SOFT TISSUE LASERS IN ORTHODONTIC PRACTICES

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ABSTRACT

This study investigated the use of soft tissue lasers in orthodontic practices, specifically whether the orthodontist demographics and practice characteristics influenced the use of soft tissue laser within an office. The study also examined whether the use of soft tissue laser had an impact on the number of referrals out of the office to other specialists for soft tissue procedures. A survey was sent to members of the American Association of Orthodontists (AAO) to collect this data.

Based on the results of this survey, there were no significant associations between orthodontist demographics and soft tissue laser use, practice characteristics and soft tissue laser use, or soft tissue laser use and the number of referrals out of the office to other providers. This study did find, however, that individuals who were trained on laser use by sales staff or manufacturers or who had attended continuing education courses regarding soft tissue laser use were significantly more likely to utilize lasers. Similarly, orthodontists with no training on soft tissue laser use were significantly less likely to use a laser in their practice. The results of this study also suggested that while many orthodontists believe that there are benefits to using soft tissue lasers in orthodontic settings, many still have not incorporated this technology into their own offices.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the School of Dentistry, have examined a thesis titled "The Current Use of Soft Tissue Lasers in Orthodontic Practices," presented by Aliah Fueller, candidate for the Master of Science degree in Oral and Craniofacial Sciences, and hereby certify that in their opinion it is worthy of acceptance.

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CONTENTS

ILLUSTRATIONS

Figure Page

TABLES

Table Page

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CHAPTER 1

INTRODUCTION

Early History of Lasers

Light is a type of electromagnetic energy that behaves as both a particle and a wave, and it is divided into units of energy known as photons (Prabha and Shreshtha 2017). Light energy can result in atoms being excited from their stable state to a higher energy level in a process known as stimulated absorption. The atoms then attempt to return to their original stable state via emission of energy, or spontaneous emission. In a process referred to as stimulated emission, a photon that is the same size as the excited atom is released, and this photon contacts adjacent atoms to begin a chain reaction of photon release (Elavarasu et al. 2012). This cascade effect eventually results in a beam of laser light being formed. The word laser is an acronym for light amplification by stimulated emission of radiation (Ganapathi and Jeevanandan 2019). Laser light is both monochromatic, meaning that all of the light within the beam is of the same wavelength, and coherent, meaning that the waves are in a particular phase relationship in space and time to one another (Elavarasu et al. 2012). The light from a laser can also be described as directional or collimated, meaning that the light is emitted in parallel rays that have little divergence from the source (Elavarasu et al. 2012; Convissar 2020).

Laser technology is based on Albert Einstein's 1917 theory of spontaneous and stimulated emission of radiation (Shah et al. 2018). Prior to its application to light energy, this principle of stimulated emission was first applied to microwaves. In 1954, the first microwave amplification by stimulated emission of radiation, or maser, was created (Peng et al. 2008). In 1958, physicists Arthur Schawlow and Charles Townes published an article

suggesting that the theory of stimulated emission could be directed toward infrared and visible regions of the light spectrum, and the race to construct the first working laser began (Peng et al. 2008). In 1960, 43 years after the publication of Einstein's quantum theory paper and only two years following Townes and Schawlow's proposal, Theodore H. Maiman was credited with the invention of the world's first functioning laser: the ruby laser (Gross and Herrmann 2007).

In general, lasers operate by exciting atoms and passing those atoms through another medium (Peng et al. 2008). Maiman's laser was a solid-state laser that utilized a ruby crystal for this medium (Gross and Herrmann 2007). Solid-state simply means that the medium is a solid, such as a crystal or glass. Other examples of solid-state lasers include neodymium-doped yttrium aluminum garnet (Nd:YAG) and erbium-doped yttrium aluminum garnet (Er:YAG) lasers, as well as the subset of semiconductor diode lasers (Peng et al. 2008). Following the invention of the ruby laser, most other first-generation lasers used various gases, such as helium, argon, or carbon dioxide, as their mediums (Gross and Herrmann 2007). Later, lasers were developed that incorporated liquid mediums consisting of organic dyes (Gross and Herrmann 2007).

Lasers in Healthcare

Almost immediately following the invention of the ruby laser, the potential for the use of lasers in numerous healthcare fields was recognized. In 1961, only one year after Maiman's ruby laser was created, ophthalmologists utilized ruby laser technology for a retinal repair procedure in animal subjects (Gross and Herrmann 2007). Two years later, the first successful photocoagulation of a torn human retina was completed using a ruby laser (Peng et al. 2008). In the 1970s, lasers began being used by physicians for surgical

procedures such as ablation of plaques in cardiovascular surgery and removal of skin lesions in dermatology (Peng et al. 2008; Gupta and Kumar 2011). Today, lasers continue to be useful in surgical treatment procedures in healthcare fields including, but not limited to, dermatology, urology, neurosurgery, orthopedics, and ophthalmology (Gross and Herrmann 2007; Peng et al. 2008). In general, benefits of lasers in medical healthcare include the ability to operate with increased speed and precision, while at the same time allowing procedures to be accomplished in a way that is less invasive to the patient when compared to traditional techniques (Peng et al. 2008). Along with their efficacy in the medical field, lasers are also considered to be quite safe for patient treatment; however, as with any healthcare technology, standard precautions should be taken to minimize risks (Verma et al. 2012).

Within healthcare, there are numerous types of lasers with unique abilities to impact different tissue types within the body. Lasers function via energy absorption into particular tissues, and whether or not a tissue will absorb the laser energy is dependent on the chromophores within that tissue (Convissar 2020). A chromophore is a molecule that only absorbs certain wavelengths of light; shorter wavelengths tend to interact with blood elements and melanin in soft tissues, while longer wavelengths are generally absorbed by hard tissue substances like hydroxyapatite, which is found in teeth and bones (Gupta and Kumar 2011; Convissar 2020). Depending on the procedures a healthcare provider is completing, different types of lasers, which emit unique wavelengths of light energy, can be utilized to ensure that the provider's procedure goals are being accomplished. For example, a gynecologist treating a patient with cervical cancer may find a carbon dioxide laser to be useful in treatment since this type of laser is capable of tissue vaporization (Peng et al. 2008).

Lasers in Dental Fields

Much like any other healthcare field, the field of dentistry has also experienced significant advances in technology, and many patients have begun to expect more modern and innovative care at the dental office. The potential for utilization of lasers in dentistry began being explored in the 1960s, almost immediately following the invention of the ruby laser (Ganapathi and Jeevanandan 2019). Today, many dental providers are incorporating lasers into their daily workflow to improve the patient experience within their offices.

Advantages of the use of lasers for dental procedures are similar to the benefits provided by lasers in other healthcare fields. First, lasers provide a less invasive experience for the patient (Ganapathi and Jeevanandan 2019). The patient can avoid the mental stress of seeing the sharp dental tools, scalpels, and burs, and thus, may be more at ease in the dental chair (Ganapathi and Jeevanandan 2019). The laser can also result in less physical pain than typical cutting instruments and less noise and vibration than the use of a dental handpiece (Ganapathi and Jeevanandan 2019). Simpler procedures can decrease chair time and increase profits for the dental provider, and a more comfortable experience for the patient may lead to a greater population of patients desiring treatment in that office.

Several procedures on both the dentition and the surrounding oral soft tissues can be aided and enhanced by the incorporation of a laser. Similarl to lasers in other healthcare professions, different types of lasers will work best for different dental procedures. It is important for the dental provider to understand the various lasers that are available for intraoral hard tissue or soft tissue procedures so they can incorporate the laser type that will be most beneficial for their particular needs.

Hard Tissue Applications of Lasers

The main laser types that are utilized for cutting hard tissues in dentistry and the dental specialties are Nd:YAG and Er:YAG lasers. While Nd:YAG lasers are mainly used for cutting soft tissues, they are also able to remove incipient caries from the teeth (Gupta and Kumar 2011). Er:YAG lasers are the typical laser of choice for hard tissue applications in dental fields. These lasers have an affinity for hydroxyapatite, though they can also ablate soft tissue and should be used with caution to avoid adjacent soft tissue damage (Verma et al. 2012).

Laser use can provide many benefits during procedures on dental hard tissues. For example, lasers can cut hard tissue without the need for local anesthetic, meaning that a syringe needle and the associated pain of the injection are eliminated (Fornaini et al. 2013). Lasers also lack the noise, vibration, and water spray of the dental handpiece, and the absence of these elements can be calming to an anxious patient (Elavarasu et al. 2012). Studies have also suggested that procedures on the dentition may be able to be completed more quickly with a laser, and the decrease in chair time can be helpful to both the patient and the provider (Chmura and Convissar 2020). Some studies indicate that lasers can have bactericidal effects against periodontal pathogens including Porphyromonas gingivalis and Aggregatibacter actinomycetemcomitans, which can lead to the loss of bone around the teeth (Elavarasu et al. 2012). Patients may also find the laser to be quieter and thus more acceptable than ultrasonic instruments that can be used to remove plaque and calculus from the tooth surface (Seyyedi et al. 2012).

General dentists and pediatric dentists may find lasers helpful in dental restorative procedures such as caries removal and tooth preparation, removal of restorative material, and

light curing of newly placed dental resins (Gupta and Kumar 2011; Verma et al. 2012). Lasers can also be utilized for esthetic dental purposes, such as tooth bleaching (Verma et al. 2012). Periodontists and oral surgeons can implement lasers in procedures such as osseous resection or recontouring, implant placement, bone grafting, and uncovering of bony-impacted teeth (Seyyedi et al. 2012; Tachmatzidis and Dabarakis 2016; Shah et al. 2018). Finally, lasers can aid in the detection and removal of calculus from the tooth surface during scaling and debridement procedures in the periodontist's or general dentist's office (Seyyedi et al. 2012).

Soft Tissue Applications of Lasers

The most common lasers used for oral soft tissue procedures are the carbon dioxide laser, the Nd:YAG laser, and the diode laser. Carbon dioxide lasers have a high affinity for water and therefore are drawn to the high water content of the oral soft tissues (Verma et al. 2012). However, the wavelengths of these lasers are also interactive with dental hard tissues, so care must be used to avoid adjacent hard tissue damage during their use (Verma et al. 2012). The Nd:YAG laser is not attracted to water, but instead is absorbed by pigments in soft tissue, such as melanin and hemoglobin (Verma et al. 2012). Diode lasers work similarly to Nd:YAG via the absorption by soft tissue pigments, but their wavelength is not absorbed by oral hard tissues, so there is minimal potential for hard tissue collateral damage (Verma et al. 2012). Thus, they are often considered the ideal laser for oral soft tissue surgical procedures (Verma et al. 2012).

In traditional oral soft tissue surgeries, the dentist, periodontist, or oral surgeon would typically utilize scalpels and hand instruments to manipulate the tissue. However, both topical and local anesthesia are required when a scalpel is used, and intraoperative bleeding

and post-operative pain and scarring may occur (Tirumalasetty et al. 2019). In addition, the use of the scalpel typically requires sutures to close the surgical site (Parhad et al. 2015). In contrast, the laser may require either no anesthetic or topical anesthetic only, which saves the provider time and saves the patient from the anxiety and pain of the injection (Prabha and Shreshtha 2017). The laser also coagulates as it cuts, resulting in minimal bleeding and a clear, dry visual field for the practitioner (Magid and Strauss 2007; Tirumalasetty et al. 2019). The laser results in minimal tissue shrinkage, decreased swelling, more rapid healing, and less scarring relative to the scalpel, and oftentimes post-operative analgesics are not needed (Parhad et al. 2015; Prabha and Shreshtha 2017; Tirumalasetty et al. 2019). Finally, unlike a scalpel, the laser results in a more sterile field due to its bactericidal effects during cutting (Magid and Strauss 2007).

General dentists and dental specialists alike can take advantage of the benefits of lasers for multiple soft tissue applications. Common soft tissue procedures that could be performed by a general dentist, pediatric dentist, periodontist, or oral surgeon include treatment of aphthous ulcers, incisional and excisional biopsies of lesions, gingivectomies, frenectomies, and operculectomies (Verma et al. 2012; Parhad et al. 2015; Tachmatzidis and Dabarakis 2016). Periodontists or oral surgeons may also utilize lasers for treatments such as second stage implant surgery, free gingival grafts, and coagulation at extraction sites (Elavarasu et al. 2012; Seyyedi et al. 2012; Tirumalasetty et al. 2019). Lastly, a relatively recent periodontal procedure known as laser-assisted new attachment procedure, or LANAP, utilizes laser technology to allow a periodontist to attempt to regenerate new attachment apparatus (Elavarasu et al. 2012).

Lasers in Orthodontics

Laser technology appears promising within the specialty of orthodontics as well. Lasers have been used for a variety of non-soft tissue orthodontic applications, and while results are not consistent across all studies, various reports have given moderate evidence that low-level laser irradiation can lead to faster orthodontic tooth movement and better pain reduction during orthodontic treatment (Cruz et al. 2004; Ren et al. 2015; AlSayed Hasan et al. 2020; Mistry et al. 2020). Bonding to tooth structure and restorative material such as zirconia crowns may be improved with laser pretreatment (Mirhashemi et al. 2020a; Mirhashemi et al. 2020b). Laser use has also been proposed at the end of treatment to debond the brackets and remove bonding material residue left on the tooth surface without risking damage to the enamel (Heidari and Torkan 2013). While these reports appear favorable, more research in this area is needed to produce conclusive evidence regarding the use of lasers to manipulate dentition in the field of orthodontics.

However, more evidence has been gathered regarding the use of lasers for soft tissue procedures in dentistry and specifically in orthodontics. Therefore, it is generally believed that soft tissue lasers are the type of laser that is best suited for use within the orthodontic field. Soft tissue laser procedures in orthodontic practice can provide functional and esthetic benefits. For example, in the case of a low maxillary frenum attachment resulting in diastema and gingival recession, the orthodontist can use a laser to perform a frenectomy to aid in space closure and reduction of tension on the marginal gingiva that could eventually result in gingival recession (Magid and Strauss 2007; Fornaini et al. 2013). In the mandible, abnormal lingual frenum attachment can result in ankyloglossia, or a “tongue tie” (Genovese and Olivi 2010). Ankyloglossia can negatively affect speech and can also result in alterations to

skeletal growth that lead to incorrect tooth position in the lower arch (Sbricoli et al. 2019). An orthodontist can resolve this problem by completing a lingual frenectomy with a soft tissue laser. In patients with poor esthetics due to excessive gingival display, or a "gummy smile," the orthodontist can complete a gingivectomy procedure with a laser to improve the esthetic outcome (Chmura and Convissar 2020). Gingivectomy can also be beneficial in cases where poor oral hygiene has resulted in enlarged gingival tissues, if the proportions of the gingiva relative to the tooth do not allow for proper bracket placement, or when intrusion or extrusion of teeth during orthodontic treatment has led to uneven gingival levels (Chmura 2020; Lione et al. 2020). Soft tissue impacted teeth, such as impacted maxillary canines, can be difficult to treat and can result in lengthy orthodontic treatment times. However, these teeth can be exposed using a soft tissue laser and subsequently bonded (Sarver and Yanosky 2005a). Lasers can also be used to treat painful aphthous ulcers, to eliminate redundant tissue following space closure, and to remove an operculum from an erupting second molar (Sarver and Yanosky 2005a; Chmura and Convissar 2020).

Along with the wide array of soft tissue procedures that can be accomplished in-office, there are many other benefits to incorporating a soft tissue laser into the orthodontic practice. These benefits can impact both the patient and the provider. First, these procedures are relatively simple, quick, safe, and minimally invasive when compared to other techniques, such as the use of a scalpel (Genovese and Olivi 2010). Local anesthesia and sutures are typically not necessary, and intraoperative pain and bleeding are decreased (Fornaini et al. 2013; Ize-Iyamu et al. 2013). Because there is coagulation during cutting, the orthodontist has a better visual field during the procedure (Borzabadi-Farahani 2017). The laser also sterilizes while it cuts, and studies have found more rapid healing and

improvements in gingival health following soft tissue laser procedures (To et al. 2013; Borzabadi-Farahani 2017). Patients are generally very accepting of the laser, and it can especially be useful in the treatment of pediatric patients due to its efficiency and lack of pain and sharp instruments that might be particularly frightening to a younger patient (Voller 2010; Sbricoli et al. 2019).

While these soft tissue procedures are typically performed at a periodontist or oral surgeon specialist's practice, there are benefits to being treated at the orthodontic office. First, patients may find that their overall orthodontic treatment time is shortened when their orthodontist uses the laser in his or her office. If orthodontists can perform laser procedures in-office rather than referring to a periodontist or an oral surgeon, the patient does not have to wait to be appointed with the second provider for a consult, the actual surgery, and potentially multiple follow up appointments. The orthodontist can instead complete the procedure and perhaps have the orthodontic brackets placed or removed on the same day in a single appointment (Sarver and Yanosky 2005a). Patients in more rural areas with fewer specialists may also avoid having to travel long distances to visit a periodontist or oral surgeon if the orthodontist can provide the same treatments. Finally, undergoing a procedure at the orthodontist's office rather than being referred to another specialist may result in lower treatment costs for the patient (Seifi and Matini 2017). While most outside providers would charge an extra fee for a consult and soft tissue procedure, some orthodontists refrain from charging their own patients or charge a lower price for the same treatments when performed in-house.

According to Chmura, "orthodontists who strive to deliver the highest level of care should consider adding a soft tissue laser to their armamentarium" (2020). If the use of a soft

tissue laser can decrease chair time, lower treatment time, reduce costs, and enhance the final results of orthodontic treatment, it would seem likely that most orthodontists would want to utilize this technology in their practices (Sarver and Yanosky 2005b; Kravitz and Kusnoto 2008). However, few orthodontic offices use lasers. In a 2012 study, Burke et al. found that while 93% of orthodontists believed that soft tissue laser use within the orthodontic practice was appropriate, only 26% of orthodontists surveyed actually used soft tissue lasers in their practices (Burke et al. 2012). While that study explored the frequency of laser use among orthodontists, factors that might explain the discrepancy between interest and actual application were not addressed. Some potential factors that might impact the decision to implement a soft tissue laser include the purchase price of the laser, the cost of maintenance, and the time and money needed for training on laser use. Laser purchase prices vary greatly by laser type. For example, some diode lasers are available for $3,000, while carbon dioxide lasers may cost anywhere from $25,000 to $50,000 (Levine 2016). The cost of disposable tips for the laser can also add up over time (Convissar 2020). Proper training and continuing education courses on laser use for multiple procedures as well as laser safety precautions for laser operation can also be expensive and time consuming.

Problem Statement

The use of technology within the field of dentistry and the various dental specialties is rapidly evolving. No research since a 2012 survey has investigated the use of soft tissue laser technology in orthodontics or the impacts that soft tissue laser use can have on the orthodontic practice (Burke et al. 2012). To date, factors influencing the interest in and the use of soft tissue lasers in orthodontic practices have not been evaluated. The purpose of this study is to survey practicing orthodontists to determine the prevalence of soft tissue laser use

within the field of orthodontics and to understand what procedures are most commonly completed in an orthodontic practice using a soft tissue laser. Additionally, this study seeks to understand what clinician demographic factors and practice characteristics influence the orthodontist's decision to utilize soft tissue lasers within his or her office. Finally, while a 2012 study by Burke et al. addressed referrals into the orthodontic practice, it did not examine referrals out of the orthodontist's office. Therefore, this survey also aims to assess whether the use of soft tissue lasers within the orthodontic practice impacts patient referrals from that office to other providers for the completion of minor soft tissue surgical procedures.

Hypotheses

1. The demographics of the orthodontist will be associated with whether or not that practitioner utilizes soft tissue lasers in their practice.
2. The practice characteristics will be associated with whether or not the provider uses soft tissue lasers in their office.
3. The use of soft tissue lasers within an orthodontic practice will be associated with the percentage of referrals out of the office to general dentists and dental specialists for soft tissue procedures.

CHAPTER 2

METHODS

Construction and Aim of Survey

A survey consisting of 19 questions was developed to gather information regarding soft tissue laser use in private and corporate-owned orthodontic practices in the United States. The frequency of utilization of soft tissue lasers and the types of soft tissue lasers owned were examined within the survey. The orthodontists' preferred procedures for soft tissue laser use and the perceived benefits of soft tissue lasers were also assessed.

The survey had three domains. The first was the orthodontist demographics, including questions regarding age, gender, race/ethnicity, and year of orthodontic residency graduation. The second domain of the study was the orthodontic practice characteristics, which involved questions regarding the number of office locations, regional location of the primary orthodontic office, and the number of active patients treated. The third domain of the study focused on whether the use of soft tissue lasers impacted referrals out of the orthodontic office to general dentists and other dental specialists such as periodontists or oral surgeons. This section contained additional questions about laser use, training, and the roles of the soft tissue laser within the practice as well.

Following a review of the survey during an Oral and Craniofacial Sciences (OCS) Master of Science (MS) committee meeting, some survey updates were made in response to committee suggestions. The updated survey was then reviewed by two faculty members and one resident in the University of Missouri-Kansas City (UMKC) Advanced Orthodontics and Dentofacial Orthopedics program to evaluate the content, order, and clarity of the survey

questions. After these evaluators were given a paper copy of the survey, they received an evaluation form to provide feedback on the survey contents. The feedback evaluation form is located in Appendix A. The comments from these evaluation forms were utilized when revising the survey for final distribution. The final survey was constructed and securely stored in Research Electronic Data Capture (REDCap) software, which is hosted by The Center for Health Insights of UMKC (Harris et al. 2009; Harris et al. 2019).

A copy of the final survey can be found in Appendix B. It was decided to distribute the survey in an electronic format via email mainly due to convenience and cost. The electronic survey provided the option for branching questions, which could aid in the avoidance of survey fatigue for respondents. After the survey was initially entered into REDCap, several committee members were asked to take the survey to test for any errors. Minor edits to the survey were also completed at the request of the American Association of Orthodontists (AAO) Partners in Research program prior to distribution.

Survey Distribution and Data Collection

The final survey was distributed electronically through the AAO Partners in Research program following completion of an agreement and payment of a $275 fee. The survey was intended for practicing orthodontists in private or corporate-owned practices who were currently members of the AAO. Exclusion criteria included orthodontists working in a full-time academic setting or those who were not currently practicing. The survey was sent via email to 2,152 U.S. orthodontists, who were randomly selected by the AAO. The email with the survey request is located in Appendix C. Approximately three weeks after the initial email was sent, the same email was sent to the same recipients asking them to complete the survey if they had not already done so. No further communication took place with the

recipients of the survey. Before distributing the survey, the survey and proposed distribution protocol were reviewed by the UMKC Institutional Review Board (IRB). The IRB approval letter is available in Appendix D.

Experimental Design

This study was a cross-sectional, non-experimental design. There were eleven independent variables and two dependent variables in this study. The first four independent variables fell under the domain of orthodontist demographics, six independent variables fell under the domain of orthodontic practice characteristics, and the last independent variable was utilization of soft tissue lasers within the orthodontic practice. Associations between utilization of soft tissue lasers and orthodontist demographics and orthodontic practice characteristics were examined. Associations between the utilization of soft tissue lasers and the percentage of referrals out of the orthodontic practice were also evaluated. The study design is outlined (table 1).

TABLE 1

EXPERIMENTAL DESIGN

Independent variables	Specific questions	Dependent variables
Orthodontist demographics	• Year of graduation from orthodontic residency (Q1) • Gender (Q2) • Age (Q3) • Race/ethnicity (Q4)	Utilization of soft tissue laser in the orthodontic practice (Q11)
Orthodontic practice characteristics	• Current practice setting (Q5) • Number of office locations (Q6) • Population type of area being served (Q7) • Office location by region (Q8) • Number of current active patients (Q9) • Percentage of soft tissue surgery referrals out (Q10)	
Utilization of soft tissue laser in the orthodontic practice (Q11)		Percentage of referrals out (Q10)
Sample size (n) = 71		

Data Analysis

Twelve responses were excluded from the data analysis for this study. Six individuals indicated that they worked full-time in an academic setting, which was one of the exclusion criteria. Four respondents were determined to be missing too much data, and two others were excluded because they did not answer the question regarding laser use.

Some of variable categories were combined to assist in organization, data analysis, and statistical testing. Graduation year from orthodontic residency was condensed into three groups by combining data from the "1980-1989" and "1990-1999" groups into a single "prior to 2000 group," because the first group only included 8.9% of the respondents. The race/ethnicity variable initially included several groups; however, the responses for most minority categories were sparse, so this variable was re-grouped into two categories: "white" and "non-white." The majority of respondents were owners of private practices, with only a few people choosing other categories for the primary practice setting variable. Because of this, the variable was re-grouped into "owner of a private practice" and "other" categories. For the number of office locations, only three respondents stated that their practice network included four locations, and five individuals had five or more office locations, so these two groups were combined. Office location regions were also combined into new groups: West (including Pacific, Rocky Mountain, Southwest, and Noncontiguous), Midwest, and East (including Southeast and Northeast). Finally, the percentage of patients referred for soft tissue laser procedures was mostly under 10%, and only one person referred more than 30% of their patients for these procedures. As a result, it was decided to condense this data into two groups: "0-10%" and "11% or more."

For all variables from the survey data, descriptive statistics including percentages and counts were calculated. To evaluate the hypotheses of the study, Chi-square and Fisher's Exact tests were utilized within a statistical software program[1]. Significance for all testing was set at $p \leq 0.05$.

[1] SPSS Statistics for Windows, Version 26.0. IBM Corp., Armonk, NY 10504

CHAPTER 3

RESULTS

Orthodontist Demographics

Only 71 orthodontists of the 2,152 to whom the survey was sent completed the survey, for a response rate of approximately 3%. The sample of survey respondents, as well as their utilization of soft tissue lasers, is summarized (table 2). The majority of those who responded were male (79%), age 45-64 (65%), identified as White/Caucasian (79%), and graduated prior to 2010 (76%). There were no statistically significant associations between orthodontist demographics and soft tissue laser use.

TABLE 2

ORTHODONTIST DEMOGRAPHIC VARIABLES ASSOCIATED WITH SOFT TISSUE LASER USE

	Sample N = 71 N (Col. %)	Laser Use No N = 32 N (Row %)	Yes N = 39 N (Row %)	p-value*
Gender				0.47
Male	56 (79%)	24 (43%)	32 (57%)	
Female	15 (21%)	8 (53%)	7 (47%)	
Age				0.43**
Younger than 25	0 (0%)	0 (0%)	0 (0%)	
25-34	7 (10%)	5 (71%)	2 (29%)	
35-44	17 (24%)	6 (35%)	11 (65%)	
45-54	22 (31%)	11 (50%)	11 (50%)	
55-64	24 (34%)	10 (42%)	14 (58%)	
65 or older	0 (0%)	0 (0%)	0 (0%)	
Missing***	1 (1%)			
Race/Ethnicity				0.89
White/Caucasian	56 (79%)	25 (45%)	31 (55%)	
Other/Multi-race	15 (21%)	7 (47%)	8 (53%)	
Graduation Year				0.37
Prior to 2000	27 (38%)	12 (44%)	15 (56%)	
2000-2009	27 (38%)	10 (37%)	17 (63%)	
2010 or after	17 (24%)	10 (59%)	7 (41%)	

*Calculated using a Chi-square test or **Fisher's Exact Test
***Missing data excluded from tests of association

Orthodontic Practice Characteristics, Referral Patterns, and Laser Training

The orthodontic practice characteristics associated with soft tissue laser use of the orthodontists who responded to the survey is summarized (table 3). Most respondents were private practice owners (82%), worked in a single office location (48%), served patients from suburban areas (73%), and had between 251-750 active patients (49%). The respondents were fairly evenly dispersed among the West, Midwest, and Eastern regions of the United

States (38%, 27%, and 35%, respectively). There were no statistically significant associations between orthodontic practice characteristics and soft tissue laser use.

TABLE 3

PRACTICE CHARACTERISTICS ASSOCIATED
WITH SOFT TISSUE LASER USE

	Sample N = 71 N (Col. %)	Laser Use No N = 32 N (Row %)	Yes N = 39 N (Row %)	p-value*
Current Practice Setting				0.19
Owner of private practice	58 (82%)	24 (41%)	34 (59%)	
Other	13 (18%)	8 (62%)	5 (39%)	
Number Office Locations				0.55**
1	34 (48%)	16 (47%)	18 (53%)	
2	15 (21%)	8 (53%)	7 (47%)	
3	14 (20%)	4 (29%)	10 (71%)	
4 or greater	8 (11%)	4 (50%)	4 (50%)	
Population Served				0.13**
Rural	10 (14%)	2 (20%)	8 (80%)	
Suburban	52 (73%)	24 (46%)	28 (54%)	
Urban	9 (13%)	6 (67%)	3 (33%)	
Active Patients				0.61**
250 or less	9 (13%)	4 (44%)	5 (56%)	
251-500	17 (24%)	9 (53%)	8 (47%)	
501-750	18 (25%)	10 (56%)	8 (44%)	
751-1000	14 (20%)	5 (36%)	9 (64%)	
Greater than 1000	13 (18%)	4 (31%)	9 (69%)	
Office Location Region				0.54**
West	27 (38%)	10 (37%)	17 (63%)	
Midwest	19 (27%)	10 (53%)	9 (47%)	
East	25 (35%)	12 (48%)	13 (52%)	

*Calculated using a Chi-square test or **Fisher's Exact Test

The orthodontic practice referral patterns associated with soft tissue laser use of the orthodontists who responded to the survey is summarized (table 4). The majority of orthodontists surveyed refer 10% or less of their patients for soft tissue surgical procedures

(73%). There was not a statistically significant association between soft tissue laser use and the percentage of referrals out of the practice to general dentists and other dental specialists for soft tissue procedures.

TABLE 4

REFERRALS ASSOCIATED WITH SOFT TISSUE LASER USE

	Sample N = 70 N (Col. %)	Laser Use No N = 32 N (Row %)	Yes N = 38 N (Row %)	p-value*
Percentage of Patients Referred for Soft Tissue Surgical Procedures				0.13
10% or less	52 (73%)	21 (40%)	31 (60%)	
11% or more	18 (25%)	11 (61%)	7 (39%)	

*Calculated using a Chi-square test

Most respondents had been trained on laser use (table 5). The majority of this training was via sales staff or manufacturers (38%) or in continuing education courses (37%).

TABLE 5

TRAINING FOR SOFT TISSUE LASERS

	Sample N = 71 N (%)	Laser Use No N = 32 N (%)	Yes N = 39 N (%)	p-value*
Have You Been Trained on Laser Use?* **				
Yes via sales staff or manufacturer	27 (38%)	7 (22%)	20 (51%)	0.01
Yes in continuing education course	26 (37%)	5 (16%)	21 (54%)	<0.01
Yes in advanced dental program/residency	14 (20%)	4 (13%)	10 (26%)	0.17
Yes via practice colleague	12 (17%)	5 (16%)	7 (18%)	0.80
Yes in dental school	9 (13%)	3 (9%)	6 (15%)	0.50**
No	18 (25%)	16 (50%)	2 (5%)	<0.01

*Calculated using Chi-square tests or **Fisher's Exact Test
***Multiple answers were selected. Will not sum to 100%.

The main perceived benefit of soft tissue laser use was enhanced treatment efficiency (79%) followed by improved orthodontic treatment results and increased patient satisfaction (58% for both) (fig. 1).

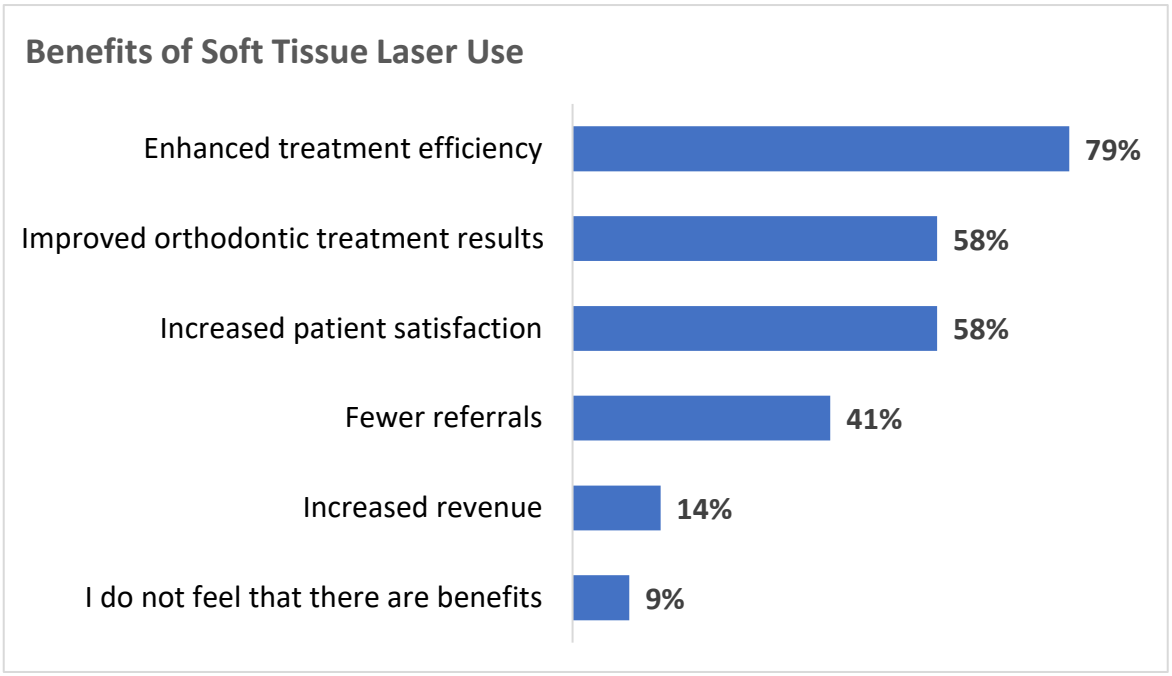

Figure 1: Benefits of Soft Tissue Laser Use.

Respondents Who Utilize Soft Tissue Lasers

Of the 39 respondents who reported using a soft tissue laser, almost all utilized a diode laser (97%) (table 6). The majority reported only using the laser "occasionally" (87%) and stated that they did not believe that laser use impacted their referrals to other dental specialists (62%).

TABLE 6

LASER USE CHARACTERISTICS FOR RESPONDENTS
WHO USED LASER (N=39)

	N (%)
Type of Laser Used*	
Diode laser	38 (97%)
Carbon dioxide laser	1 (3%)
Nd:YAG laser	0 (0%)
How Often is Laser Used	
Occasionally (≤ 1-2 times per week)	34 (87%)
Often (3-5 times per week)	3 (8%)
Regularly (6-10 times per week)	2 (5%)
Very regularly (≥ 11-15 times per week)	0 (0%)
Do You Believe Laser Use Has Impacted Referrals	
Yes – I refer fewer	15 (39%)
No – referrals not impacted	24 (62%)

*Multiple answers were selected. Will not sum to 100%.

Of the types of procedures performed with the laser, gingivectomy to enhance esthetics, removal of keratinized gingiva for bracket placement, and removal of keratinized gingiva to expose unerupted teeth were the most frequently performed (80%, 75%, and 75%, respectively) (data not shown). When asked to choose the single most common procedure performed with the laser, gingivectomy to enhance esthetics and removal of keratinized gingiva to expose unerupted teeth were the most common (31% for both choices) (data not shown).

Respondents Who Do Not Utilize Soft Tissue Lasers

Of the 32 respondents who did not use soft tissue lasers, the main barriers to using a laser were lack of training and the belief that the laser would not be beneficial to the practice (44% and 31%, respectively) (fig. 2).

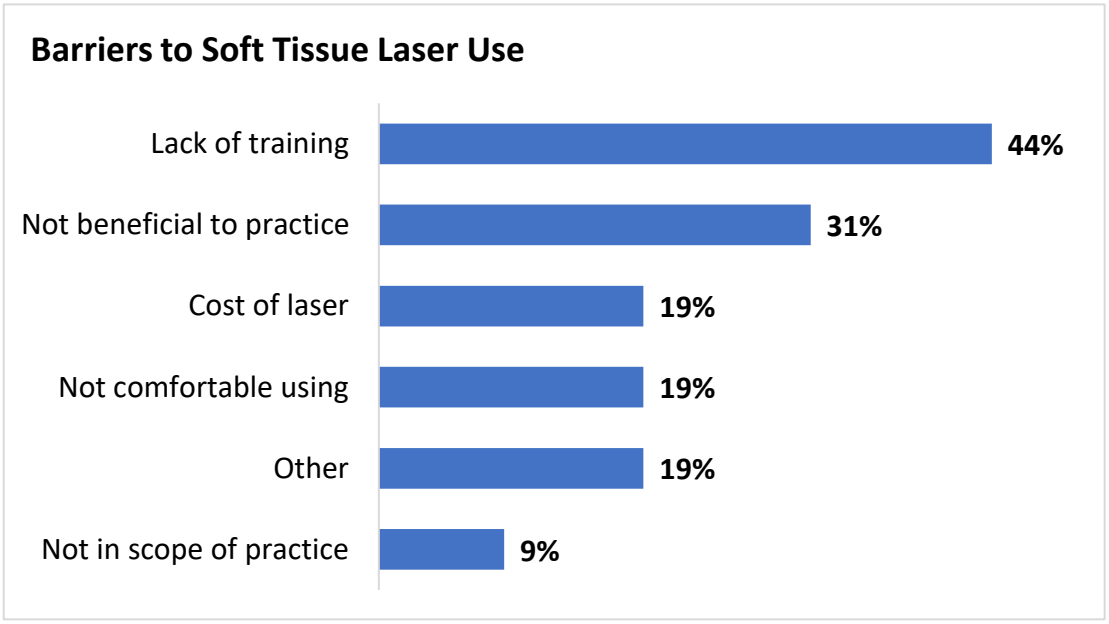

Figure 2: Barriers to Soft Tissue Laser Use.

CHAPTER 4

DISCUSSION

A total of 71 orthodontists participated in this survey. Of those respondents, 55% stated that they used a soft tissue laser within their practice. Compared to a 2012 study, while 93% of orthodontists who responded said that soft tissue lasers were appropriate for use within an orthodontic practice, only 26% of those surveyed actually used a soft tissue laser (Burke et al. 2012). It is reasonable to assume that during the past ten years since that study, usage of soft tissue lasers would have become more common in orthodontic practices as providers have adopted more technologies into their practices.

Orthodontist demographics were not associated with soft tissue laser use in this study. The majority (79%) of the respondents to this survey were male. This is not surprising, as approximately 72% of active orthodontists are men (AAO 2018). Also unsurprising was that 79% of participants identified as white/Caucasian, which aligns with the fact that around 70% of dental providers in the United States are white (ADA 2021). A finding that was more unexpected was that there was no significant difference among age groups or graduation years in relation to soft tissue laser usage. It would seem likely that younger orthodontists or those who had graduated more recently may have more interest or more exposure to newer technologies such as lasers and therefore be more inclined to implement these technologies in their practices; however, this was not supported by the data from this survey.

Practice characteristics did not have a significant effect on soft tissue laser use, either. Most respondents were owners of a private practice and worked in single office locations in suburban settings. It was predicted that perhaps those in rural locations may be more likely to

utilize a laser in order to prevent their patients having to travel longer distances to see periodontists or oral surgeons for simple soft tissue procedures. On the other hand, it could also be assumed that it would be more probable to see laser use dominate in urban settings where orthodontists may feel the need to incorporate more technologies in order to set their practices apart and be more competitive. However, neither of these trends were seen in this study.

It was hypothesized that referrals to outside providers would be impacted if the orthodontist used a soft tissue laser in his or her office, but this did not seem to be the case. Most respondents (73%) stated that they referred 10% or fewer of their patients for soft tissue laser procedures, but 62% believed that those referrals were not impacted by whether or not they used a laser. While this study examined the referrals out of the practice to other dental providers, this finding is somewhat similar to a 2012 study which found that most orthodontists surveyed (82%) believed that referrals into the practice would not be affected by their use of a laser, either (Burke et al. 2012).

When asked about procedures completed using a soft tissue laser, gingivectomy to improve esthetics, removal of keratinized gingiva for bracket placement, and removal of keratinized gingiva to expose an unerupted tooth were the most commonly selected in this study (80%, 75%, and 75%, respectively). These results are similar to a 2012 study, in which removal of gingiva to expose unerupted teeth and gingivectomy for bracket placement were also two of the top three choices (91% and 90%, respectively) (Burke et al. 2012). This finding is not surprising, as these procedures could be performed relatively easily in an orthodontic office and would assist the orthodontist in delivering more efficient care to patients.

When asked about potential benefits, 79% of orthodontists surveyed stated that they believe that enhanced treatment efficiency is a benefit of utilizing a soft tissue laser. Regarding barriers to soft tissue laser use, lack of training was the most reported issue for respondents (44%). Approximately 25% of the sample had never been trained on soft tissue laser use, and these individuals were statistically significantly less likely to use a laser in their practice. Another significant finding in this study was that those who received training from sales staff or a manufacturer or in a continuing education course were more likely to own a laser. This makes sense, because someone receiving training from a sales staff member or manufacturer of a laser has likely already purchased, or is at least seriously considering purchasing, a soft tissue laser. An individual taking time to take specific continuing education courses on laser use is also probably someone who has a laser or is interested in acquiring one. This finding is similar to a 2012 study, in which continuing education courses were the most common form of training (61%) among participants (Burke et al. 2012).

Clinical Implications

The current study demonstrated that only 55% of orthodontists surveyed utilized soft tissue lasers in their practices. However, it seems that most orthodontists believe that there are benefits to using a soft tissue laser in the treatment of orthodontic patients. Lasers can be used to complete procedures that improve orthodontic treatment results and reduce orthodontic treatment time, and these procedures would benefit both the patient and the provider. It appears that the main barrier to laser use in orthodontics is a lack of training. If more focus can be directed toward training orthodontic specialists on the use of soft tissue lasers, perhaps more orthodontists would utilize this technology in their practices.

Study Limitations

The main limitation of this study was a small sample size. Despite being sent to over 2,000 orthodontists, only 71 orthodontists responded to the survey. It is possible then that the results of this survey may not reflect the views of the entire orthodontic practitioner population. Nonresponse bias may also be a factor in that those who are not interested in laser use may have been less likely to participate in the study, while orthodontists who are more involved with laser use may have been more willing to respond. If this were the case, the results of the study could be skewed. Finally, recall bias could play a role. Several of the items in the survey asked the participant to reflect on the frequency of laser use, the percentage of referrals, and other questions that would require the respondent to remember accurately numerical values from their practice. If these estimations were not correctly reported, the data could be a misrepresentation of what is truly happening in these practices.

Future Investigations

Utilizing the AAO Partners in Research program alone for survey distribution did not result in a substantial number of responses. However, it is possible that adding an incentive, such as an entry into a raffle for a prize or gift card, could increase the survey response rate. It could also be beneficial to examine certain aspects of this survey in more depth. For example, this study showed a statistically significant association between training and soft tissue laser utilization in practice, but a cause-and-effect relationship between training and laser use cannot be determined from this survey. A future study, therefore, could involve a prospective study on training vs. laser use. A survey of current orthodontic residents could also be beneficial to further examine the current curriculum on soft tissue lasers within orthodontic residency programs.

CHAPTER 5

CONCLUSIONS

1. In general, the demographics of the orthodontist were not significantly associated with whether that practitioner utilized soft tissue lasers in their practice. However, orthodontists who had received training from sales staff or manufacturers or in continuing education courses were more likely to utilize lasers. A lack of training on soft tissue laser use was also associated with a respondent being less likely to utilize a soft tissue laser in their practice.
2. The practice characteristics were not associated with whether the provider used soft tissue lasers in their office.
3. The use of soft tissue lasers within an orthodontic practice was not associated with the percentage of referrals out of the office to general dentists and dental specialists for soft tissue procedures.

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APPENDIX A

SURVEY EVALUATION FEEDBACK REQUEST

Dear Dr. (XXXXX),

Thank you for agreeing to take time to review my survey. Please **evaluate the attached survey for clarity and content**.

This survey is part of my UMKC thesis project to evaluate the use of soft tissue lasers within private and corporate-owned orthodontic practices. The survey is intended for practicing orthodontists who are members of the American Association of Orthodontists. The final survey will be distributed electronically.

Please note that in the paper format I have provided to you, some questions will have prompts in parentheses such as, "(Skip if answered "yes" to Q7)." Therefore, the survey will be shorter for some participants based on their specific responses.

You do not need to complete the survey. Instead, please examine each question critically, and leave comments in the margins where you feel necessary. Your comments will help me improve the survey prior to its final distribution to AAO members throughout the United States.

Thank you again for your assistance and feedback. I appreciate your time and willingness to help with my project.

Respectfully,

Aliah Fueller, DMD
UMKC School of Dentistry
Resident, Dept. of Orthodontics & Dentofacial Orthopedics
MS Candidate, Dept. of Oral and Craniofacial Sciences

APPENDIX B

SURVEY

Orthodontist Demographics

1. What year did you graduate from orthodontic residency?
    a. Prior to 1980
    b. 1980-1989
    c. 1990-1999
    d. 2000-2009
    e. 2010 or after
2. What is your gender?
    a. Male
    b. Female
    c. Other/prefer to self-describe: please specify
3. What is your age?
    a. Younger than 25
    b. 25-34
    c. 35-44
    d. 45-54
    e. 55-64
    f. 65 or older
4. What is your race/ethnicity? Select all that apply.
    a. Asian
    b. Black/African American
    c. Hispanic/Latino
    d. Native American Indian or Alaska Native
    e. Native Hawaiian/Pacific Islander
    f. White/Caucasian
    g. Other/prefer to self-describe: please specify

Practice Characteristics

5. What is your current primary practice setting?
    a. Owner of a private practice
    b. Associate in a private practice
    c. Employee of a corporate-owned practice
    d. Employed in a full-time academic position
    e. Other: please specify
6. How many office locations belong to the practice in which you work (your practice network)?
    a. 1
    b. 2
    c. 3
    d. 4
    e. 5 or greater
7. How would you describe the population of the area that your primary office is serving?
    a. Rural
    b. Suburban
    c. Urban

8. Based on the map, in which region is your <u>primary</u> office located?
    a. Pacific
    b. Rocky Mountains
    c. Southwest
    d. Midwest
    e. Southeast
    f. Northeast
    g. Noncontiguous

9. Approximately how many active patients are currently being treated at your primary office? This includes all comprehensive, limited, and phase I patients but does NOT include patients in retention.
    a. 250 or less
    b. 251-500
    c. 501-750
    d. 751-1000
    e. Greater than 1000
10. In the past 5 years, approximately what percentage of your active patients treated at your primary office have you referred to a general dentist or dental specialist (periodontist, oral surgeon, etc.) for a soft tissue surgical procedure (gingivectomy, frenectomy, tooth exposure, etc.)?
    a. 0-10%
    b. 11-20%
    c. 21-30%
    d. More than 30%

Laser Use

11. Do you utilize a soft tissue laser within your primary office?
    a. Yes
    b. No
12. What type of soft tissue laser do you utilize in your primary office? Select all that apply:
    a. Carbon dioxide laser
    b. Nd:YAG laser
    c. Diode laser
    d. Other: please specify

13. In an average work week, how often is the soft tissue laser utilized in your primary office?
    a. Occasionally (for example ≤ 1-2 times per week)
    b. Often (for example, 3-5 times per week)
    c. Regularly (for example, 6-10 times per week)
    d. Very regularly (for example, ≥ 11-15 times per week)
14. Which of the following are procedures you have performed using a soft tissue laser in your primary office? **Select all that apply.**
    a. Gingivectomy to improve hygiene around brackets or bands
    b. Gingivectomy to enhance esthetics
    c. Operculectomy
    d. Uncovering temporary anchorage devices (TADs) due to overgrowth of mucosa
    e. Removal of keratinized gingiva for proper bracket placement on incompletely erupted teeth
    f. Removal of keratinized gingiva to expose unerupted teeth
    g. Frenectomy
    h. Ablation of aphthous ulcers
    i. Other: please specify

15. Which most closely represents the most common procedure performed with a soft tissue laser in your primary office? **Select only one.**
    a. Gingivectomy to improve hygiene around brackets or bands
    b. Gingivectomy to enhance esthetics
    c. Operculectomy
    d. Uncovering temporary anchorage devices (TADs) due to overgrowth of mucosa
    e. Removal of keratinized gingiva for proper bracket placement on incompletely erupted teeth
    f. Removal of keratinized gingiva to expose unerupted teeth
    g. Frenectomy
    h. Ablation of aphthous ulcers
    i. Other: please specify
16. Do you believe that soft tissue laser use in your practice has impacted your referrals out of your office to general dentists or dental specialists (periodontists, oral surgeons, etc.)?
    a. Yes – I refer fewer patients to general dentists and specialists
    b. No – my referrals have not been impacted
17. What prevents you from utilizing a soft tissue laser in your practice? Select all that apply.
    a. Cost of laser purchase
    b. Lack of training on laser use
    c. I do not feel that laser use is within the scope of practice of the orthodontist
    d. I do not feel that it would be beneficial to my practice
    e. I am not comfortable using a laser for any procedure in my practice
    f. Other: please specify

18. Have you ever been trained on soft tissue laser use? Select all that apply.
    a. Yes, within dental school training
    b. Yes, within a formal advanced dental program or dental specialty/residency program
    c. Yes, within a continuing education course
    d. Yes, via instruction from sales staff or manufacturer (printed or audio-visual materials or hands-on training)
    e. Yes, via instruction from a practice colleague
    f. No, I have not been trained on soft tissue laser use
19. Which of the following do you feel are benefits of soft tissue laser use in an orthodontic practice? Select all that apply.
    a. Fewer referrals to general dentists and dental specialists for soft tissue procedures
    b. Enhanced treatment efficiency
    c. Improved orthodontic treatment results
    d. Increased patient satisfaction
    e. Increased revenue within the orthodontic practice
    f. Other: please specify
    g. I do not feel that there are benefits of soft tissue laser use in an orthodontic practice

APPENDIX C

AAO SURVEY INITIAL EMAIL AND REMINDER EMAIL

Dear AAO Member,

My name is Aliah Fueller, and I am an orthodontic resident and Master of Science candidate in the Oral and Craniofacial Sciences program at the University of Missouri-Kansas City School of Dentistry. I am working on a thesis project focused on educational research related to the use of soft tissue lasers in orthodontics. Specifically, the goal of my project is to better understand how the use of a laser for soft tissue procedures in a private or corporate-owned practice might be influenced by orthodontist demographics and practice characteristics. Additionally, I hope to evaluate whether the use of a soft tissue laser impacts referrals out of the orthodontic office to other dental providers. To accomplish my goals, I am requesting that you complete a short research survey, which can be accessed via the link provided below.

This 19-question survey should take approximately 5-10 minutes to complete. All survey responses are anonymous with no identifying markers linked to your responses.

Please complete this survey within 10 days of receiving it from the AAO.

If you decide to participate in this survey, your participation is voluntary. If you choose not to participate or to withdraw from the study at any time, you may do so without penalty or loss of benefit to yourself. If you wish to not participate, simply do not fill in any of the information and exit the survey. Your identity will not be collected nor shared. The results of the survey may be published.

Any survey responses you provide will be a valued contribution to this project, and I thank you in advance for your time.

If you have any questions concerning this study, please contact the student investigator: Aliah Fueller at: aliah.fueller@umkc.edu. If you have any questions regarding your rights as a research participant, you may contact the UMKC IRB at 816-235-5927.

Sincerely,

Aliah Fueller, DMD

APPENDIX D

IRB APPROVAL LETTER

UMKC Institutional Review Board
University of Missouri-Kansas City

5319 Rockhill Road
Kansas City, MO 64110
816-235-5927
umkcirb@umkc.edu

June 28, 2021

Principal Investigator: Mary P Walker
Department: Dean, School of Dentistry

Your IRB Application to project entitled "THE CURRENT USE OF SOFT TISSUE LASERS IN ORTHODONTIC PRACTICES--Walker/Fueller" was reviewed and determined to qualify for IRB exemption according to the terms and conditions described below:

IRB Project Number	2062482
IRB Review Number	324393
Initial Application Approval Date	June 28, 2021
IRB Expiration Date	N/A Revised Common Rule
Level of Review	Exempt
Project Status	Active - Exempt
Exempt Categories	45 CFR 46.104(d)(2)
Risk Level	Minimal Risk
HIPAA Category	No HIPAA

Approved Documents
- informed_script_v1.0_324393_06-17-21.docx
- survey_questions_324393_06-17-21.docx

The principal investigator (PI) is responsible for all aspects and conduct of this study. The PI must comply with the following conditions of the determination:

1. No subjects may be involved in any study procedure prior to the determination date.
2. Changes that may affect the exempt determination must be submitted for confirmation prior to implementation utilizing the Exempt Amendment Form.
3. The Annual Exempt Form must be submitted 30 days prior to the determination anniversary date to keep the study active or to close it.
4. Maintain all research records for a period of seven years from the project completion date.

If you are offering subject payments and would like more information about research participant payments, please click here to view the UM system Policy on Research Subject Payments: https://www.umsystem.edu/oei/sharedservices/apss/nonpo_vouchers/research_subject_payments

If you have any questions, please contact the IRB at 816-235-5927 or umkcirb@umkc.edu.

Thank you,
UMKC Institutional Review Board

VITA

NAME: Aliah Fueller

DATE AND PLACE OF BIRTH: October 30, 1994; Rugby, North Dakota

EDUCATION:

5/2013	Diploma	Muhlenberg County High School Greenville, KY
5/2017	B.S. Human Health Sciences	University of Kentucky Lexington, KY
6/2020	D.M.D	University of Kentucky College of Dentistry Lexington, KY
12/2022 In Process	M.S. Oral and Craniofacial Sciences	University of Missouri-Kansas City School of Dentistry Kansas City, MO
12/2022 In Process	Orthodontics and Dentofacial Orthopedics	University of Missouri-Kansas City School of Dentistry Kansas City, MO

PROFESSIONAL ORGANIZATIONS:

2016-Present	American Dental Association
2020-Present	American Association of Orthodontists

HONORS:

2013	National Merit Scholar
2013-2017	University of Kentucky Patterson Scholar
2016-2020	University of Kentucky College of Dentistry Dean's Scholarship
2018-2020	University of Kentucky Academic Excellence Scholarship
2020	University of Kentucky College of Dentistry Occlusion Award