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Practicing orthodontists' use and perceived efficacy of self-ligating brackets

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PRACTICING ORTHODONTISTS' USE AND PERCEIVED EFFICACY OF SELF-LIGATING BRACKETS

By

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Abstract

Introduction. The purpose of this study was to compare perceptions of efficacy and efficiency of Self-Ligating Brackets vs. conventional brackets between practicing Orthodontists and Orthodontic Residents. *Methods*. Cross-sectional survey research using a three-wave emailing of addresses from the current American Association of Orthodontists directory. The directors of all orthodontic residency programs in the US were asked to also distribute to all residents. The survey included five sections: 1) respondents' experience, 2) factors that influence, 3) positive or negative factors, 4) the perceived efficiency/efficacy, and 5) demographics. A 39% response rate (N=707) was obtained. *Results.* Over half (51.8%) stated using self-ligation in their practice. Non-board certified orthodontist (57.1%) reported using self-ligation more often than board certified orthodontists at 46.2%. The two most common systems used were *GAC Innovation-R* (52.7%) and *Damon* (50.3%). Of the advantages cited, the most common was decreased chair time (64.3%). Most (71.7%) felt negatively about the price of self - ligating brackets, and increased difficulty finishing cases (62.4%). Due to low response rate from residents, no comparison could be made between orthodontists and orthodontic residents. *Conclusion.* While this project answered questions about use of self-ligating brackets, it is still uncertain the motivating factors of orthodontists of their use of self-ligation. Self-ligation has seen a growth in the number of products available, and the amount of doctors using this technology in the last two decades. While there are still an increasing number of practitioners that are using self-ligation, there are still many practitioners who choose conventional brackets over self-ligation.

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Chapter 1: Introduction

Self-Ligating brackets have been in existence in orthodontics for close to 85 years (Harradine, 2003, 2008). Originally designed to be a more efficient method of ligating archwires during appointments, self-ligation has seen a shift towards focusing more on the biomechanical aspects of the system. These brackets, referred to as "low-friction" brackets tout utilizing lighter forces to move teeth because there is much less friction in the system to overcome (Harradine, 2003, 2008). Self-Ligating brackets allow the orthodontist to choose the type of wire and ideal force levels that will be most efficient in the early stages of a patient's treatment, most notably for leveling and aligning, as well as correcting rotations. The design of the self-ligating brackets is based on the principal that the force used to reposition teeth should not overwhelm the specialized tissues surrounding and supporting the teeth (Harradine, 2003, 2008). Self-ligating brackets come in a variety of designs, with either "active" or "passive" ligation mechanisms. During the last ten years there has been a surge in the utilization, as well as an increase, in the number of manufacturers producing these brackets.

Orthodontists have previously been surveyed about their use of self-ligating brackets (Mosby, 2009, Keim 2002). In 2002, Keim et al., found that only 8.7% of practitioners surveyed indicated that they used at least one system during the year (Keim, 2002). However, in 2008 the percentage of respondents who reported using at least one system during the year jumped to 42%, which is a significant increase in use (Keim, 2008). Manufacturers have been able to improve the self-ligating bracket systems to exhibit major advances in strength and ease of use which has aided in their

boost in popularity. However, this technology still merits scrutiny and it is unclear why there has been such a rapid increase in utilization in the past decade. More specifically, is there any evidence supporting the advantages of self-ligation in clinical practice?

The first self-ligation bracket system was patented by Charles E Boyd in 1933 (Graber, 2005). Since then, there have been multiple systems of varying designs that have been released to the orthodontic community. These brackets were classified as either active or passive. Most all of the systems released prior to 1995 are not on the market today. A more complete history of self-ligating systems is discussed in chapter 2.

With every major manufacturer now producing their version of a self-ligating bracket, there are several new brackets entering the market. With these new products, there is little empirical research on their effectiveness. Many of these new systems have been researched and funded by their respective commercial producer to provide data to support the effectiveness of their product. However, data published by the manufacturer of a product is open to criticism.

The purpose of this study was to compare perceptions of efficacy and efficiency of self-ligating brackets vs. conventional brackets between practicing Orthodontists and Orthodontic Residents. This paper is not aimed at determining true merits or effectiveness of self-ligation, but rather determining *if* and *why* practitioners are choosing self-ligation systems over conventional mechanics.

Research Questions

Below are the research questions that have been posed in this thesis project.

Research Question 1

What are the characteristics and practices of orthodontic practitioners using self-ligating brackets in their practice?

Research Question 2

Which factors identified in the literature influence orthodontic practitioners' decision to use self-ligating brackets over conventional brackets?

Null Hypothesis.

Orthodontic practitioner did not select all identified factors as very influential or extremely influential in their decision to use self-ligating brackets over conventional brackets.

Alternative Hypothesis.

Orthodontic practitioner will select all identified factors as very influential or extremely influential in their decision to use self-ligating brackets over conventional brackets.

Research Question 3

Which of the self-ligating bracket systems on the market do orthodontic practitioners report greatest satisfaction in use? The literature suggests that Damon system is the most popular system being used.

Null Hypothesis,

There is no difference in the level of satisfaction reported by orthodontic practitioners' using Damon system as compared to other brands.

Alternative Hypothesis.

There is a difference in the level of satisfaction reported by orthodontic practitioners' using Damon system as compared to other systems.

Research Question 4

Is there a difference between orthodontic residents and orthodontists in their perception of efficacy and efficiency of self-ligating brackets?

Null Hypothesis.

There is no difference between orthodontic residents and orthodontists perceptions of efficacy and efficiency of self-ligating brackets.

Alternative Hypothesis.

There is a difference between orthodontic residents and orthodontists in the perception of efficacy and efficiency of self-ligating brackets.

Basic Assumptions

There is a basic assumption that respondents will respond honestly to the survey items. In addition, there is an assumption that orthodontic practitioners will have been exposed to the use of and have sufficient experience using self-ligating brackets.

Limitations

Limitations of this study include:

1. Achieving sufficient sample size of orthodontists and orthodontic residents to draw comparisons.

2. Use of survey research can lead to low response rates and potential for respondents to answer in a manner that is expected rather than honest.
3. Because this survey will be web-based, it is limited to those practitioners with internet access.

Definition of Key Terms

1. Self-ligating Brackets – A bracket, which utilizes a permanently installed, moveable component to entrap the arch wire (Graber, 2005)
2. Active Clip Self-ligating Brackets - A bracket which uses a flexible component to entrap the archwire. This flexible component has the ability to store and release energy through elastic deformation (Graber, 2005).
3. Passive Slide Self-ligating Brackets - A bracket which uses a rigid, moveable component to entrap the archwire. This component exerts no force on the archwire, and effectively forms an archwire tube (Graber, 2005).
4. Archwire Engagement - The act of inserting and retaining an orthodontic archwire into the bracket slot (Proffit, 2007)
5. Frictional Resistance – When one moving object contacts another, friction at their interface produces resistance to the direction of movement (Proffit, 2007)

Summary

When choosing between new bracket systems, there is a lack of research describing orthodontists' opinions as to which systems are being utilized the most, as well as perceived advantages and disadvantages of various systems. There is also little evidence indicating if these systems are being used to replace conventional

brackets, or being used as an adjunct to systems already in place. This paper aims to determine factors influencing the orthodontic professionals' current utilization of self-ligation brackets.

Chapter 2: Literature Review

During recent years there has been a dramatic increase in the use of self-ligating brackets by practitioners. This chapter begins with a brief history of self-ligating brackets, followed by a discussion of the various types and uses of brackets used by orthodontists today. Thereafter, manufacturer's claims (both advantages and disadvantages) are presented. Also included in this chapter is a discussion of the confounding variables that may affect the decisions to use specific brackets along with a review of the published treatment outcomes.

History of Self-ligating Brackets

Self-ligating brackets have been in existence for use in orthodontic practices for many years (Harradine, 2003, 2008). Self-ligating brackets are appliances with specially designed closure mechanisms that do not need ligatures (the small bands that hold the wire in place). They are sometimes referred to as "speed braces" (Harradine, 2003, 2008). Rather than using ligatures or metal ties, the brackets have a door that holds the archwire in place. Self-ligating brackets allow the orthodontist to choose the type of wire and ideal force levels that are most efficient in the early stages for "rotating, tipping, and leveling" in the patient's treatment. The teeth are allowed to move in a rapid and efficient manner with low forces, allowing the most effective treatment. These systems were first introduced in the literature by Stolzenberg who described the Russell Lock edgewise attachment as early as 1935 (Stolzenberg, 1935). Since that time many different designs have been developed and

patented. This chapter reviewed the history of those that have become commercially available for use by orthodontists.

Early Development of Self-ligating Systems

The first patent filed for a self-ligating attachment was by Charles E Boyd in 1933 (Graber 2005). The intended goal of this type of self-ligating bracket was to decrease chair time needed for archwire changes. There have been many designs that have been developed throughout the years, however only a very small proportion have been commercially available (Harradine, 2003, 2008, Graber, 2005). The major disadvantages associated with many of these self-ligating systems were that they were either too expensive or too bulky to be commercially viable (Graber, 2005). However, all the designs shared a common ligation method that was built into the bracket. Many inventors were attempting to produce this type of self-ligating system with the hope of decreasing chairside time by expediting the archwire change process. It was subsequently discovered that with these ligation mechanisms there was less frictional resistance associated with sliding wires through the engagement mechanism, and thus they were used to optimize the associated biomechanics (Graber, 2005). The effort to develop self-ligating orthodontic brackets was fueled by the wish to create a bracket that would be more efficient while still effectively moving teeth. Thus patients would have the benefit of quicker treatment in the office and hopefully less discomfort in tooth movement. Additionally, there was an attempt to reduce the number of office visits with fewer archwire changes while ensuring quality treatment results (Harradine, 2006).

After the Boyd band bracket, there were a number of other designs with varying ligation methods that were introduce to the market. See Figure 1 for a listing of these brackets.

In 1972, an entirely new type of bracket was introduced by G.H. Hanson called the SPEED bracket. In 1980 it was introduced to the market, and presently still has a group of devoted users (Harradine, 2003, Graber, 2005). The SPEED bracket is different because it features an active spring clip (Graber, 2005). As opposed to the previous systems that used a rigid door to hold the archwire in place, the SPEED bracket uses a flexible component to accomplish this outcome. The flexible component has the ability to store and subsequently release energy through elastic deflection. The release of this energy imparts a light and continuous force on the tooth and supporting structures (Graber, 2005). Theoretically if a tooth is out of position with the archwire, the spring clip ligation will direct force upon the tooth until the archwire is fully engaged in the archwire slot. This bracket's innovative method of ligating the wire to the bracket introduced the first "active" self-ligating bracket (Harradine, 2006). The concepts of active and passive self-ligating brackets are discussed later in this literature review.

The In-Ovation bracket was the only active bracket system introduced in the 20 years following the SPEED bracket. It is unique in that it is a mix between active and passive designs. In a smaller archwire, the bracket acts much like a passive bracket, with very low levels of friction. Once the archwire exceeds a certain dimension, the active spring clip will engage the wire and create a more secure bond enabling more finite movements (Roth, 2005).

One of the more popular self-ligating brackets in use today, the Damon SL bracket, was introduced in 1995 (Harradine, 2006). These have tie-wings and a self-ligating slide and superseded the Activa bracket. The newer Damon "Q" bracket is more advanced and further developed the concept of tie-wings, now with a new slide mechanism created from composite resin to help improve the aesthetics. The Damon brackets are made of a combination of clear material and stainless steel, thus making the brackets appear smaller than previous versions. Today aesthetic brackets are entirely made from composite polymers (Oyster and Opal) (Harradine, 2006). The 3M Unitek SmartClip bracket has wire-retaining spring clips to either side of the conventional bracket. This internal structure helps hold the archwire stay in place, and thus claims to allow for an easier and faster means for changing the archwire.

Advancements in Self-Ligating Systems

Various advancements have been discovered in self-ligating Systems. These include: secure full archwire engagement, low friction between bracket and archwire, ease of use, and faster archwire removal and ligation.

Secure, Full Archwire Engagement

In self-ligating systems, full engagement is a positive feature because it prevents any unintentional partial engagement (Harradine, 2003). Additionally, there is no problem associated with decay of the ligature seen in elastic ligatures. Wire ligatures do not stretch to the extent that elastomeres do and therefore meet the requirement of full engagement, but they are time intensive in their application. This secure, full engagement helps to maximize the archwire's effect upon the tooth.

Low Friction

There have been numerous studies that show self-ligating brackets have less friction when sliding a wire through the bracket slot (Shivapuja, 1994, Sims, 1993, Berger, 1990). Theoretically, if friction was decreased drastically, much lower force levels would be necessary, and it would be easier to maintain optimal force levels through treatment. However, it is difficult to be certain how accurately any laboratory simulation of friction reproduces the true level of friction that is present intra-orally. The design of the self-ligating brackets is based on the principal that the force used to reposition teeth should not overwhelm the specialized tissues surrounding and supporting the teeth (Harradine, 2003, 2008, 2006). Instead, minimal force should be used to stimulate the cellular activity required for tooth movement. By having forces in the optimal range, teeth can avoid movement by undermining resorption.

According to developers and manufacturers self-ligation systems create less friction between the wire and the bracket. The elastic bands used with traditional braces act like a bungee cord that places friction and pressure on the teeth. Additional pressure slows down the movement of the teeth. Self-ligating brackets use the built in doors on the bracket to secure the archwire and are nearly frictionless when using early stage small diameter archwires. These brackets allow the wire to move more freely and are smaller in appearance than standard braces. There is less resistance between the bracket and archwire, so only a small wire is required to gently move teeth into place. Supporters say that self-ligating systems reduce discomfort and treatment time an average of six months (Harradine, 2003, 2008, 2006).

Ease of Use

Prior to the 1970's archwires needed to be secured to the bracket via use of steel ties. These steel wire ligatures are labor intensive to place and the principle reason for the decline in their use (Harradine, 2003). In the 1970's, elastomeric ligatures were released and have since become the standard ligation method (Harradine, 2008, Graber, 2005). The advantages of this new ligation system were that elastomeric ligatures were simple, cheap, and an effective method of ligating archwires to orthodontic brackets. The major disadvantages of these ligatures are potential for increased bacteria, and an increased amount of friction from tightly binding the wire to the bracket. In addition, elastomeric rings have an association with a high rate of decay and deformation, limiting their effectiveness. In instances when ligation deformation will be an issue, steel ties are still preferred over elastomeric ligation. Self-ligating brackets solve these problems of deformation, secure engagement, and bacteria by having the ligation method built into the bracket.

Active Clip vs. Passive Slide Self-ligating Systems

Self-ligating brackets come in a variety of designs and from different manufacturers. Overall these designs can be categorized as either active or passive designs. Active and passive systems have been introduced to allow for more efficient sliding mechanisms to reduce the force and increase the rate of tooth movement (Pandis, 2010). This has been a topic of controversy because most of the original claims were published by the manufacturer and not evidence-based.

Active Clip Designs

Active clip designs such as the SPEED bracket have an element in the bracket that depresses and makes contact with the archwire when the wire is engaged (Pandis, 2010). In many designs nickel-titanium is used to exert force onto the wire when it is engaged. In reality active systems are a mix of both passive and conventional systems. This means they have low friction in small round archwires when there is room in the slot to allow for easy sliding of the archwire. As the wire size increases, the spring clip engages the wire and causes the bracket to act similar to a conventional bracket. This allows for more three-dimensional control expressed in larger archwire. In addition, these spring clips will exert their own force upon the archwire giving a greater and longer activation range. Smaller archwires that do not completely fill the bracket slot can still exert more control. Arguments against use of the spring clips on active brackets are that they change the direction of force in a less desirable direction. This can result in unwanted side effects on the tooth and can throw off finite finishing movements.

Passive Slide Designs

As opposed to active clip designs, passive slide designs do not have an "active" element that exerts force on the wire when the bracket door is closed. Instead, passive slide designs have a "door" that closes around the wire effectively making a tube. Ideally there would be no pressure exerted upon the archwire, although this is likely possible only when the tooth is in ideal alignment. Passive slide brackets are used when the orthodontist inserts a smaller wire to create less friction

early on in treatment, which is very good for freedom of movement (Harradine, 2006). The advantage of a passive slide system is the extremely low level of friction, while the disadvantage is that many practitioners feel there is a lack of finite control during the finishing stages. The same large bracket slot that provides low friction levels during initial stages of treatment diminish "slot-fill" and therefore control of tip and torque on the tooth is compromised in later stages of treatment. During the initial stages of treatment, low friction is advantageous. In the middle and final stages of treatment, low friction is a disadvantage (Roth, 2005).

Conclusions of Evidence-based Literature

Most published studies do not support superior efficacy in the self-ligating brackets regardless of type (active clip or passive slide) (Harradine 2003, Shivapuja 1994, Harradine 2001, Miles 2006). In a study in 1997, researchers studied the reduction in the amount of frictional resistance for various bracket types (Vourdouris, 1997). They concluded that active self-ligating brackets exhibited 56.7% less friction than conventional twin brackets, while passive self-ligating brackets exhibited 99.5% less friction than active self-ligating and 99.8% less than conventionally ligated twins.

However, in a more recent clinical trial (Pandis, 2010), researchers agreed with several studies in the literature by concluding that there was no difference in treatment duration between conventional and various self-ligating brackets regardless of whether they used active clips or passive slide mechanisms.

Manufacturers' Claims

This section discusses the manufacturers' claims regarding self-ligating systems, both the advantages and disadvantages.

Advantages of Self-ligating Brackets

Over the past few years, practitioner utilization of self-ligating brackets has increased. These brackets carry a significantly higher price tag over conventional brackets, giving the impression that there is some major advantage to their use. One of the most compelling reasons manufacturers market the use of self-ligation is the belief that they reduce the treatment time over the conventional brackets. Overall chair time is said to be reduced through quicker treatment in the office, and reduction in the number of office visits with fewer archwire changes (Harradine, 2006). Other reasons these brackets have gained popularity is because of a supposed reduction in patient discomfort through the use of lighter "gentler" forces, which theoretically should result in better periodontal health of the patient.

Disadvantages of Self-ligating Brackets

One of the largest and practical disadvantages to self-ligation systems are the increased cost per bracket. Individual brackets can cost upwards of five times the amount of conventional brackets. Considering the average patient case uses 24-28 brackets (not including lost or broken brackets), the added expense can be significant.

Notwithstanding the cost of these brackets, other clinical disadvantages have been reported. Because of their low friction design, some practitioners feel they have trouble expressing the minor tooth movements necessary to finish cases (Harradine, 2006). The increased size of self-ligating brackets can also cause occlusal interferences, particularly in the lower anterior position. There is a lack of evidence to support these claims (Pandis, 2010). Claims that the brackets promote better oral hygiene, increased patient comfort, less treatment and chair time, and greater patient

acceptance have not been reported in the literature. Unfortunately, many continuing education programs provided to practitioners on the self-ligating systems are vendor-driven and contain unfounded opinions supported only by testimonials rather than clinical research.

Confounding Variables

Beyond the ligation system used, there are many other confounding variables that affect the role of the orthodontic force system including, but not limited to: wire size and shape, bracket size and shape, archwire material, inter-bracket distance, masticatory forces, saliva, oral function, periodontal ligament function, temperature, and tooth irregularity (Harradine, 2003). Studies that only examine the frictional resistance of a bracket sliding along an archwire have not taken all these confounding factors into consideration when conducting their clinical research. Additionally it is difficult to reproduce the clinical finding in-vitro. Other studies investigate bracket movement along a wire that occurs significantly faster than the clinically observed 1mm per month. Many studies show how self-ligating brackets provide excellent low friction sliding of small early stage wires, but as wire size progresses, friction levels increase to levels comparable to conventional brackets (Harradine, 2003, 2008, Pandis, 2010). Practitioners are cautioned in extrapolating in-vitro findings to in-vivo clinical performance.

Published Treatment Outcomes

Miles et al compared the two bracket systems (Damon self-ligating, and conventional twin) in a split mouth study (Miles, 2006). Irregularities were measured at baseline, ten weeks, and twenty weeks. The archwires were changed at the ten

week visit. The study found that conventional brackets achieved better correction (not significant though), less bracket failure, less pain, and better patient aesthetic acceptance. Despite the attempt to use a split mouth study to control for fewer variables, it was proposed the mechanics of conventional brackets on one side can affect the self-ligating side.

In another study, Miles investigated the efficacy of space closure differences between conventional and self-ligating brackets (Miles, 2007). This was a split mouth study that used en-masse retraction of anterior teeth with NiTi coil springs and sliding mechanics on self-ligating brackets to close extraction space. Miles studied nineteen consecutive patients who had bilateral extraction of first premolars, and used symmetric mechanics on each side. For each patient on one side the posterior teeth had self-ligating brackets, and the other posterior teeth had conventional brackets. After aligning all teeth, and consolidating the six anterior teeth, NiTi coil springs were activated from the molar to the canine. Space between the premolar and canine was measured with a digital caliper to the nearest 0.1 mm, and was recorded at five week intervals until the space closed. The rate of movement in millimeters per month was calculated for each patient and bracket system and averaged. The closure rates of 1.1mm/month for SmartClip, and 1.2mm/month for conventional twin brackets were not significantly different. It should be noted that this study only investigated a system of two posterior self-ligating brackets, and that one of the two brackets on the conventional side was a ligature free bracket. Closing space on a coil spring as opposed to other methods is another way to decrease friction in a system.

Summary

Self-ligating bracket systems have not been perfected, as there are more design features that can be adjusted, including an active as well as passive element in the design of the bracket that has yet to be considered. Currently manufacturers can design different brackets for use in different situations, such as passive brackets for the posterior, and active for the anterior but have not combined them.

The decision to use self-ligating or conventional brackets rests with the practitioner. It needs to be determined if the use of self-ligation would be beneficial to a patient's specific case, and if those benefits warrant the added cost of self-ligating brackets. Thus the purpose of this study is to compare perceptions of efficacy and efficiency of self-ligating brackets versus conventional brackets between practicing Orthodontists and Orthodontic Residents.

Chapter 3: Methods

This chapter discusses the methodology used for this study. The first section reviews the study design and sample/sample side. This is followed by a detailed explanation of the survey instrument and how it was developed and validated. Finally, the explanation of the data collection and data analyses for each of the research questions is provided.

Study Design

Surveys represent one of the most common types of quantitative, social science research. In survey research, a sample of respondents thought to be representative of some population is selected and administered a standardized questionnaire. Through survey research, it is possible to efficiently collect data from larger populations in a cost-effective manner amenable to administration in person, by telephone, and over the Internet. This study used cross-sectional survey research to assess the perceptions of orthodontic practitioners and orthodontic residents regarding the treatment efficacy and use of self-ligating brackets. A Web-based survey was distributed to a sample of orthodontists and orthodontic residents in the United States. This study was deemed exempt by UNLV's institutional review board for the protection of human subjects' research (Protocol #1105-3818) (Appendix A).

Sample and Sample Size

This study included two different populations: 1) a cross-section of orthodontic practitioners who practice in the United States, and 2) a cross-section of orthodontic residents currently attending residency programs in the United States.

A systematically generated email list of practicing orthodontists was obtained using the member registry from The American Association of Orthodontists in the United States. In an attempt to obtain a sample that would represent practicing Orthodontists throughout the United States, members were selected from every state. A systematic approach selected every tenth name on the list from each state. Of those selected, the email address was added to an excel database and uploaded into the Zoomerang® web-based survey account. A mass email was sent to those on the email list (Appendix B). This included a letter of introduction explaining the purpose of the study. They were asked to participate in this survey. An embedded link to the survey was included in the email. This link took the respondents directly to the Web-based survey on Zoomerang® (Appendix C).

According to the Bureau of Labor Statistics (2011), the population size of practicing Orthodontists is approximately 7,700 in the US. In order to achieve a power of 0.80, p=0.05, d=0.20, a total of 600 participants were targeted as the sample size from this population (Cohen, 1998). Over the past decade, the use of Web-based surveys has increased significantly over traditional mailings (Wright, 2005). Archer computed the response rates of 84 Web-based surveys deployed over 33 months (Archer, 2008). The response rate varied by survey type and ranged from less than 40% to over 60%. Understanding these response rates to Web-based surveys is critical in the selection of sample size. Therefore an email list of 1500-2000 names were requested to account for the potential of the lower response rates as outlined in the literature and defined as 40% of the identified representative population.

In addition to the above listing, Program Directors (or administrative staff) were contacted via email by the SDM Orthodontic Program Director via the listserv. The goal was to reach all the accredited orthodontic residency programs in the United States. There are currently 70 orthodontic residency programs in the US as of 2010. The email also included an explanation and the embedded link to the survey (Appendix D). The Program Directors were encouraged to distribute the email and associated link to all of their residents. After reviewing the potential resident pool, it was thought that the number of active residents currently enrolled was approximately 650. Based on this number, a power analysis was conducted and in order to achieve a power of 0.80, p=0.05, d=0.20, a total of 250 participants were targeted from this population (Cohen, 1988). Taking into consideration the potential for a low response rates to Web-based surveys, the hope was that the sample size would be adequate to obtain the necessary 250 responses (40%) from the population.

Instrumentation

The questionnaire entitled, "Perceptions of Orthodontists Compared to Orthodontic Residents Regarding the Efficiency and Efficacy of self-ligation versus Conventional Brackets," was constructed through information obtained from a comprehensive review of the scientific literature on related topics and in consultation with experts in Orthodontics. The survey instrument was a combination of selected-response questions (Likert-scale) and closed ended questions (yes/no, circle one, or check all the above) (Appendix C). The survey included five (5) sections that assess the respondents' use and perceptions of 1) factors that influence respondents decisions to use self-ligating Brackets, 2) experience in using self-ligating brackets,

3) positive or negative factors associated perceptions of efficacy in use of with self-ligating brackets, 4) the perceived efficiency/efficacy of self-ligating brackets, and 5) demographic information.

The first three items assessed the use and specific slot size of self-ligating brackets that were used in treatment. Item 4 assesses on a Likert-scale (1= not at all influential, 5= extremely influential) the level of influence that specific factors found in the literature have on respondent's decision to use self-ligating brackets. Item 5 requested that respondents indicate which systems they use in treatment and whether they had had positive or negative experience with these designs. Item 6 addressed the respondents' perception of the positive or negative factors associated with self-ligating brackets. Item 7 addressed the efficiency and/or efficacy of the various factors associated with self-ligating brackets. Item 8 asked respondents whether they had clinical experience with self-ligating brackets in their residency programs and whether that was a factor in deciding to use them in practice. The final section of the survey asks respondents to provide some demographic information to allow for comparison of groups.

Face validity was established by using information from the comprehensive literature search. Content validity was established by having three experts (survey research and orthodontics) review and provide feedback to the survey. Internal reliability was established using Cronbach's alpha. Table 1 details the results for the instrument and each defined sections. Stability-reliability was established through test-retest process. The survey was given to a select group (convenience sample) 10

days apart. Pearson Product Moment Correlation Coefficient was computed (r=0.70). All reliability coefficients were in acceptable ranges.

Data Collection

A three-wave emailing was be used to collect the data for the study. This procedure was used because it has been shown to increase the response rates (Easton, 1997, Oden, 2000). Obtaining a high survey response rate was critical to ensure that the study was robust. High response rates help ensure sufficient breadth and depth of respondent reactions. It is also desirable to ensure generalizibility of the findings in any survey to the entire potential respondent pool. However research has found that having responses from 40% or less of the potential respondents can still provide sufficient information to ensure robust study results (Oden, 2000). There are several reasons given for failing to complete a Web-based survey, including open-ended questions, questions arranged in tables, fancy or graphically complex designs, use of pull-down menus, unclear instructions, and the absence of navigation aids (Bosnjak, 2001). Methods found to increase response rates include: personalized email cover letters, follow-up reminders, pre-notification of the Web-based survey, and simple formats (Solomon 2001). In an effort to increase the response rate, the methods proposed above were employed as described above.

Data Analyses

Descriptive statistics were used to describe the demographics of the sample surveyed.

Data analysis for each hypothesis is defined below:

Research Question 1

What were the characteristics and practices of orthodontic practitioners using self-ligating Brackets in their practice? *Descriptive Statistics (number and percentages) was reported on select demographic variables collected in the study. Two variables of interest were gender differences and whether the respondents were board certified or not. Chi-square analyses were used to assess whether there were significant differences.*

Research Question 2

Of the factors identified in the literature, which factors were reported by orthodontic practitioners' as being "very influential" or "extremely influential" in their decision to use self-ligating brackets versus conventional brackets? The Likert-scale was collapsed into two categories, 1) not very influential [not at all influential, slightly influential, or somewhat influential] and 2) very influential [very influential and extremely influential]. *Descriptive Statistics were reported on various factors selected in these two groups. Data was collapsed into 'influential' and 'not influential for purposes of analyses. Chi-square statistics were computed to determine if there are significant differences between board certification and by region of practice in influence among the various factors reported in the literature.*

Research Question 3

Which of the self-ligating bracket systems on the market did orthodontic practitioners report greatest satisfaction in use? *Descriptive Statistics (number and percentages) were reported on the positive and negative experiences in the bracket systems. Chi-square analysis was used to assess if there are significant differences*

between those who had positive experiences versus those with negative experiences by whether board certified or not board certified.

Research Question 4

Was there a difference between orthodontic residents and orthodontists in their overall satisfaction and efficiency of self-ligating brackets? *The Mann-Whitney test was used to determine if there were significant difference between Orthodontic residents and practicing orthodontists.*

Threats to Validity

Non-response bias was a potential limitation in conducting this survey research. Non-response errors are the result of not all potential respondents completing the survey, and therefore creating non-response bias (Crawford, 2001).

Another potential limitation was the method of survey delivery and response. Web-based survey research has been associated with coverage bias or bias due to sampled people not having or choosing not to access the Internet (Crawford, 2001). Despite exponential growth of the Internet, there are still a large number of people who do not have access and/or choose not to use the Internet. There are also wide disparities in Internet access among ethnic and socioeconomic groups (Selwyn, 1998).

Conclusion

Chapter 3 described the methodology for this study. In Chapter 4 the results are presented and answer the four research questions outlined in Chapter 1 and 3. Chapter 5 concludes by discussing the interpretation and implications of the results of the study.

Chapter 4: Results

Chapter 4 presents the results of the study. The chapter begins by reviewing the survey response rate, followed by the demographic information of the sample. This is followed by presentation of the results by each of the four research questions:

1) What were the characteristics and practices of orthodontic practitioners using self-ligating Brackets in their practice?
2) Of the factors identified in the literature, which factors did orthodontic practitioners' report as being "very influential" or "extremely influential" in their decision to use self-ligating brackets versus conventional brackets?
3) Which of the self-ligating bracket systems on the market did orthodontic practitioners report greatest satisfaction in use?
4) Was there a difference between orthodontic residents and orthodontists in the perception of efficacy and efficiency of self-ligating brackets?

Survey Response Rate

This study included two different populations: 1) a cross-section of orthodontic practitioners who practice in the United States, and 2) a cross-section of orthodontic residents currently attending residency programs in the United States. There were two types of means to obtain the survey responses. The first was an email mailing to Orthodontic Practitioners practicing in the US who were currently members of the American Orthodontic Association. Initially a random sample email listing was going to be obtained through the association. However the professional association placed requested several changes to the survey that were felt would bias the results. Therefore, it was determined instead to use a systematic sampling using

the most current association member directory. The survey demographic information was divided by region rather than state; therefore rather than selecting a systematic sample from each state, it was selected by region. The following regions were included: Northeast, Southeast, Midwest, Southwest, and West. Within each region names were systematically selected (every tenth name) from the member list until the targeted number of 2000 was reached.

A three-wave emailing was used to collect the data for the study. This procedure was used because it has been shown to increase the response rates, and this was important to ensure generalizibility of the findings (Easton, 1997, Oden, 2000). However research has found that having responses from 40% or less of the potential respondents could still provide sufficient information to ensure robust study results (Oden, 2000). Of the 2000 emails that initially were sent out, 650 were bad email addresses (soft or hard bounce back) equally 1350 and 114 opted out of the survey.

In an effort to obtain the proposed sample size, an additional 1000 were sent. Of those 239 were bad email addresses (soft or hard bounce back) and 132 opted out of the survey. After removing those with bad email addresses and those who opted out, there were a total of 1865 possible responses. Seven hundred and seven (707) completed surveys were obtained (39% response rate). The total projected number of responses of orthodontists was 600; therefore while the response rate was not optimal, the projected number was obtained. However based on the response rate being on the lower end caution must be placed on the results when attempting to generalize.

However, this was not true of the response rate for the Orthodontic residents. Out of the potential resident pool, the targeted number of responses was 250. Only 27

responses were received from Orthodontic residents. This means that the anticipated comparisons between the practitioners and residents could not be completed with any validity.

Research Question 1: Demographic Information

A majority of all the respondents were male (n=592, 87.1%), with a relatively even distribution between ages 36-45 (n=188, 27.5%), 46-55 (n=148, 21.6%), and 56-65 (n=184, 26.9%). As previously stated an overwhelming majority were Orthodontic practitioners (n=664, 96%), with over half being board certified (n=416, 62%). The distribution of respondents was fairly even across the regions. Table 2 details the demographic information.

Descriptive Statistics were computed to look at gender differences and differences in those who were board certified and those who were not in their use and slot size preferences. Table 3 outlines the gender differences and Table 4 details the differences in those who were board certified and those who were not. Because there were so few women, Chi-square were not completed to assess gender differences, however Chi-Square was completed to assess if there were significant differences between those who were board certified and those who were not in their use and slot size preferences. Significant differences were found between their use of self-ligating brackets (χ^2= 7.58p<0.05), the slot size used (χ^2 = 12.11, p<0.05), and the slot sized preferred (χ^2=42.94, p<0.001).

When reviewing the difference between those professionals who were board certified versus those who were not board certified, there were more board certified orthodontists (53.8%) that did NOT use self-ligating brackets, and there were more

non-board certified orthodontists who DID use self-ligating brackets (57.1%). Regarding preferred slot size, the 0.022" slot size was the overall preference of all practitioners. There were significantly more non-board certified orthodontists who preferred the 0.022" slot size, and of those that preferred the 0.018" slot size a greater percentage were board certified orthodontists.

Research Question 2: Influencing Factors

In research question 2, the factors that were identified by the respondents as being influential in their decision to use self-ligating brackets were identified. Table 5 details the responses by each factor. The Likert-scale allowed respondents to select from not very influential, slightly influential, somewhat influential, very influential, and extremely influential.

To identify the differences between select demographic variables, Chi-square analyses were used to determine factors that were considered influential versus those that were not influential. To do this, the factors were collapsed into two categories: 1) not influential [not at all influential, slightly influential, or somewhat influential] and 2) influential [very influential and extremely influential] for the purposes of the analyses. Table 6 details the results of these analyses comparing board certified to non-board certified. Table 7 details the differences by region.

Significant differences were found in the factors that influenced the use of self-ligation between the board certified and non-board certified orthodontists. The largest significant differences were noted in opinions on quality of product, company reputation, past experience, rates of leveling and alignment, speed of treating cases, and advertising. Although advertising was ranked as being non-influential by most, it

should be noted that some practitioners might not admit that advertising played a role in their decision on using a particular bracket system. The majority of board certified orthodontists (63.5%) felt that the quality of the product (consistency) was influential, while only 38.1%of the non-board certified orthodontists felt it was influential. More board certified orthodontists felt that the rate of leveling and alignment was influential (55.8%), and only 38.1% felt that it was influential. More board certified orthodontists (55.8%) felt that the time savings chair-side was influential while only 41.3% of non-board certified orthodontists felt that was influential in their decision to use self-ligating brackets.

Research Question 3: Self-Reported Satisfaction

Research Question 3 looked at the orthodontic practitioners' self-reported satisfaction in the use of self-ligating brackets (Table 8).

The three bracket systems that respondents listed as having used the most were GAC Innovation R (52.7%), Damon system (50.3%), and Time 2 (47.3%). The system that had the fewest number of practitioners list their use was Smartclip with only 3.6% reporting having used the system.

The system that had the most responses indicating a positive experience with the bracket was the GAC Innovation R (64.8%). The Damon system had a slightly more negative response rate, and of those that rated it only 45% rated it positive. The system that had the highest amount and percentage of negative responses was the Time 2 bracket (N=248; 78.5%). Another bracket system that did not receive high positive reviews was Smartclip. Although Smartclip was the rated as the least used

bracket, it also received the least number of positive responses. Not a single responder rated the bracket system positively.

Two systems had significant differences when comparing the opinions of board certified orthodontists and non-board certified: RMO synergy ($\chi^2 = 15.32$, $p<0.05$) and Time 2 ($\chi^2 = 18.93$, $p<0.01$). RMO synergy had higher positive responses from non-board certified group and higher negative responses from the board certified group. With the Time 2, more non-board certified respondents responded overall as using this type, which likely explains why there were significantly more positive and negative responses than the board certified group.

Research Question 4: Perceived Satisfaction

Research question 4 was to look at the differences between orthodontic residents and orthodontists in the overall perceived satisfaction and efficiency of self-ligating brackets. Due to the small number of orthodontic resident responders, this research question could not be answered. However descriptive statistics were used to determine overall respondents' satisfaction and efficiency in self-ligating brackets (Table 8). It was further decided to assess the differences by board certification on the use and perceived efficacy of self-ligating Brackets (Table 9).

There was little to no difference in the reported efficacy of self-ligating brackets between board certified orthodontists and non-board certified orthodontists. Overall, a majority (62.3%) of practitioners felt that self-ligating brackets had no effect on overall treatment time, while one third thought it decreased treatment time. Only a small percentage (7.4%) thought it increased treatment time. While a majority of practitioners felt the overall treatment time was not affected, there was a strong

percentage (64.0%) that responded that chairside time was decreased. About one third (29.8%) felt there was no effect on the chairside time. Regarding the total number of visits needed per case, just over half (52.5%) responded that there was no effect as compared to conventional brackets, while one third (36.9%) felt there was a decrease in the total number of visits.

One of the largest criticisms of self-ligating brackets is that it is more difficult to finish cases. When asked if what affect the brackets had on finishing cases, a majority (63.4%) felt that finishing cases had an increased level of difficulty. This is contrasted by the fact that only 8.1% responded that it was easier to finish cases with self-ligating brackets. Just over a quarter (28.6%) of respondents felt there was no effect upon finishing a case.

Conclusion

This chapter outlined the results of the survey. These results are discussed in Chapter 5. In addition, Chapter 5 presents the limitations and strengths of the study. It concludes with clinical relevance of the study, and recommendations for future research.

Chapter 5: Discussion

As shown in the literature review, self-ligating brackets are not new to the orthodontic profession. Studies by Keim et al showed that their use has seen a great increase in the past decade, specifically in 2002 only 8.7% of practitioners used self-ligating brackets, and in 2008, 42% used self-ligating brackets. This study showed that 51.5% of practicing orthodontists and orthodontic residents use self-ligating brackets in their practice. While this is not as great a jump from 2002 to 2008, there is still an overall increase in their usage.

This study did not answer whether there were differences between orthodontic residents and practicing orthodontists in their views on self-ligating brackets. It did however show there was a significant difference between board and non-board certified orthodontists that used self-ligating brackets. More board certified practitioners did not use self-ligating in their practice, while more non-board certified practitioners used self-ligating. However, this could have been influenced by the inclusion of the resident sample in the calculations.

The satisfaction of practitioners with self-ligating brackets was evaluated by the price, plaque/hygiene, bulk of bracket, and difficulty finishing. Most (72.1%) felt either negatively, or very negatively about the price of the bracket systems.

Manufacturers typically claim that their self-ligating bracket system will decrease treatment, chair time, and total number of patient visits. These claims and the efficacy of self-ligating brackets were evaluated by investigating treatment time, chairside time, total number of patient visits and difficulty finishing a case. Evaluating the overall numbers revealed that most (2/3) feel there is no effect in

overall treatment time and about 1/3 feel there is a decrease in treatment time. There is a general feeling that chairside time is decreased (2/3 of responses), and 1/3 felt there was no effect. Evaluating the total number of patient visits revealed that about ½ felt there was no effect, 1/3 felt there was a decrease, and 10% felt there were more visits necessary to finish the case. The majority of practitioners felt it was more difficult to finish a case with self-ligating brackets, while 1/3 felt there was no effect, and only 8% felt that finishing a case was easier with self-ligating.

Strengths and Limitations

As with any survey research, a greater response rate from an even broader sampling of orthodontists would increase validity. More responses from residents would help give an answer to research question four, and establish if there is a difference in opinion on self-ligating brackets between practitioner and resident. Another limitation would be that it must be assumed that respondents answer in a truthful manner.

Recommendations for Future Research

This research highlighted some of the qualities that practitioners like and dislike about self-ligating brackets, but further research could be conducted as to what the exact motivating factor is when a practitioner decides to purchase and utilize self-ligating over conventional brackets. A question that could be asked in future research is what motivating factors were behind the purchase of self-ligating brackets as well as the use and satisfaction of specific brackets by manufacturer. In addition to asking for a positive or negative experience with the bracket, many different options could be given as to why a bracket is or is not satisfactory.

Conclusion

While this project answered questions about use of self-ligating brackets, it is still uncertain the motivating factors of orthodontists of their use of self-ligation. Self-ligation has seen a growth in the number of products available, and the amount of doctors using this technology in the last two decades. Are orthodontists going to continue to embrace this technology, or will there be a shift back towards conventional brackets? Because of the low response rate of residents, the researcher was unable to make comparisons to orthodontic practitioners this population should be surveyed in the future to see the potential trend for these upcoming practitioners. This research showed that while there are still an increasing number of practitioners that are using self-ligation, there are still many practitioners who choose conventional brackets over self-ligation.

Date	Bracket	Passive/Active	Available	Mechanism
1933	Boyd band	Passive	No	Rigid Sliding Bar
1933	Ford Lock	Passive	No	Rigid Rotational Lock
1952	Russel appliance	Passive	No	Rigid Sliding Lock
1953	Schurter	Passive	No	Rigid Locking Pin
1957	Rubin	Passive	No	Rigid Hinged Plate
1966	Branson	Passive	No	Rigid Rotational Screw
1972	SPEED	Active	Yes	Flexible Spring Clip
1972	Edgelok	Passive	No	Rigid Sliding Cap
1979	Mobil-Lock	Passive	Yes	Rigid Rotational Disk
1986	Activa	Passive	No	Rigid Rotational Arm
1995	Time	Passive	Yes	Rigid Rotational Arm
1996	Damon	Passive	Yes	Solid Indented Slide
1998	TwinLock	Passive	No	Solid Labial Slider
2000	In-Ovation	Active	Yes	Flexible Spring Clip
2004	Damon 3	Passive	Yes	Rigid Solid Slide

Figure 1. *Overview of the Various Types of Ligation Methods on the Market*

Table 1

Demographic Characteristics of Sample

Variable	Frequency	Percentage
Gender		
Male	592	87.1
Female	88	12.9
Age		
25-35	56	8.2
36-45	188	27.5
46-55	148	21.6
56-65	184	26.9
65+	108	15.8
Type of Practitioner		
Orthodontic Practitioner	664	96.1
Orthodontic Resident	27	3.9
Board Certification		
Currently Board Certified	416	62.3
Not Board Certified	252	37.7
Region Where Received Training		
Northeast	164	24.6
Southeast	128	19.2
Midwest	184	27.5
Southwest	84	12.6

West	108	16.2
Region Where Practice or Plan to Practice		
Northeast	124	19.0
Southeast	188	28.8
Midwest	120	18.4
Southwest	60	9.2
West	160	24.5

Note: N= 707; not all the responses equal 100% due to missing data.

Table 2

Gender Differences in the Use of Self-Ligating Brackets in Practice

	Do you use Self-Ligating Brackets in your practice	
	Yes N (%)	No N (%)
Male	304 (51.4)	288 (48.6)
Female	48 (54.5)	40 (45.5)

	What is the slot size that you USE?		
	0.018 N (%)	0.022 N (%)	Both N (%)
Male	152 (26.2)	384 (66.2)	44 (7.6)
Female	4 (4.8)	76 (90.5)	4 (4.8)

	What is the slot size you PREFER?		
	0.018 N (%)	0.022 N (%)	Both N (%)
Male	168 (28.8)	384 (65.8)	32 (5.5)
Female	8 (9.1)	76 (86.4)	4 (4.5)

N=707; not all equal 100% due to missing data.

Table 3

Differences in the Use of Self-Ligating Brackets between those who are Board Certified and those who are not Board Certified

	Do you use Self-Ligating Brackets in your practice		
	Yes N (%)	No N (%)	χ^2
Board Certified	192 (46.2)	224 (53.8)	7.58*
Not Board Certified*	144 (57.1)	108 (42.9)	

	What is the slot size that you USE?			
	0.018 N (%)	0.022 N (%)	Both N (%)	χ^2
Board Certified*	120 (29.7)	272 (67.2)	12 (3.0)	12.11*
Not Board Certified*	36 (14.5)	176 (71.0)	36 (14.5)	

	What is the slot size you PREFER?			
	0.018 N (%)	0.022 N (%)	Both N (%)	χ^2
Board Certified*	128 (31.4)	264 (64.7)	16 (3.9)	42.94**
Not Board Certified*	48 (19.0)	192 (76.2)	12 (4.8)	

N=707; not all equal 100% due to missing data. * $p<0.05$; ** $p<0.001$

Table 4

Factors that influence use of Self-Ligation

Variable	Not at all influential	Slightly influential	Somewhat influential	Very influential	Extremely influential	N/A
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Speed of treating cases	164 (23.2)	108 (15.3)	120 (17.0)	132 (18.7)	44 (6.2)	139 (19.7)
Time savings chair-side	96 (13.6)	92 (26.6)	160 (22.6)	128 (18.1)	92 (13.0)	139 (19.7)
Cost	252 (35.6)	72 (10.2)	112 (15.8)	68 (9.6)	68 (9.6)	135 (19.1)
Rate of leveling and alignment	132 (18.7)	68 (9.6)	156 (22.1)	148 (20.9)	56 (7.9)	147 (20.8)
Rate of Space Closure	148 (20.9)	88 (12.4)	148 (20.9)	140 (19.8)	40 (5.7)	143 (20.2)
Plaque indices	212 (30.0)	84 (11.9)	132 (18.7)	116 (16.4)	12 (1.7)	151 (21.4)
Periodontal health	216 (30.6)	92 (13.0)	116 (16.4)	112 (15.8)	16 (2.3)	155 (21.9)
Patient comfort	172 (24.3)	52 (7.4)	136 (19.2)	164 (23.2)	32 (4.5)	151 (21.4)
Lower level of friction	140 (19.8)	64 (9.1)	104 (14.7)	164 (23.2)	84 (11.9)	151 (21.4)
Sales rep/company reputation	212 (30.0)	100 (14.1)	128 (18.1)	88 (12.4)	20 (2.8)	159 (22.5)
Advertising	308 (43.6)	108 (15.3)	72 (10.2)	52 (7.4)	8 (1.1)	159 (22.5)
Quality of product (consistency)	108 (15.3)	76 (10.7)	140 (19.8)	148 (20.9)	76 (10.7)	159 (22.5)
Past experience	156 (22.1)	92 (13.0)	120 (17.0)	80 (11.3)	88 (12.4)	171 (24.2)
Colleague's experience	204 (28.9)	80 (11.3)	128 (18.1)	96 (13.6)	36 (5.1)	163 (23.1)
Employer's preference	280 (39.6)	28 (4.0)	52 (7.4)	20 (2.8)	24 (3.4)	303 (42.9)

Table 5

Factors that influence use of Self-Ligation by Board Certification

	Board Certified		Not Board Certified		
	NI	I	NI	I	
Variable	N (%)	N (%)	N (%)	N (%)	Chi-Square
Speed of treating cases	208 (50)	208 (50)	168 (66.7)	84 (33.3)	17.71**
Time savings chair-side	184 (44.2)	232 (55.8)	148 (58.7)	104 (41.3)	13.198**
Cost	264 (63.5)	152 (36.5)	260 (63.5)	92 (36.5)	0.000
Rate of leveling and alignment	184 (44.2)	232 (55.8)	156 (61.9)	96 (38.1)	19.62**
Rate of Space Closure	216 (51.9)	200 (48.1)	156 (61.9)1	96 (38.1)	6.336*
Plaque indices	236 (56.7)	180 (43.3)	176 (69.8)	76 (30.2)	11.41*
Periodontal health	240 (57.7)	176 (42.3)	168 (66.7)	84 (33.3)	5.32*
Patient comfort	200 (48.1)	216 (51.9)	144 (57.1)	108 (42.9)	5.16*
Lower level of friction	176 (42.3)	240 (57.7)	116 (46.0	136 (54.0)	0.885
Sales rep/company reputation	232 (55.8)	184 (44.2)	192 (76.2)	60 (23.8)	28.28**
Advertising	272 (65.4)	144 (34.6)	204 (81.0)	48 (19.0)	18.57**
Quality of product (consistency)	152 (36.5)	264 (63.5)	156 (61.9)	96 (38.1)	40.64**
Past experience	196 (47.1)	220 (52.9)	164 (65.1)	88 (34.9)	20.38**
Colleague's experience	268 (64.4)	148 (35.6)	132 (52.4)	120 (47.6)	9.47*
Employer's preference	228 (54.8)	188 (45.2)	116 (46.0)	136 (54.0)	4.839*

Note. NI=not influential; N=Influential; *P<0.05; **p<0,001

Table 6

Factors that influence use of Self-Ligation by Region

	Northeast		Southeast		Midwest		Southwest		West		
	NI	I	NI	I	NI	I	NI	I	NI	I	
Variable	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	χ^2
Speed of treating cases	96(58.5)	68(41.5)	56(43.8)	72(56.3)	120(65.2)	64(34.8)	60(71.4)	24(28.6)	52(48.1)	56(51.9)	25.0**
Time savings chair-side	100(61)	64(39)	44(34.4)	84(65.6)	104(56.5)	80(43.5)	40(47.6)	44(52.4)	48(44.4)	60(55.6)	25.0**
Cost	108(65.9)	56(34.1)	68(53.1)	60(46.9)	108(58.7)	76(41.3)	64(76.2)	20(23.8)	72(66.7)	36(33.3)	14.3*
Rate of leveling	84(51.2)	80(48.8)	48(37.5)	80(62.5)	116(63.0)	68(37.0)	52(61.9)	32(38.1)	56(51.9)	52(48.1)	22.7**
Rate of Space Closure	100(61.0)	64(39.0)	60(46.9)	68(53.1)	108(59.7)	76(41.3)	44(52.4)	40(47.6)	64(59.3)	44(40.7)	7.4
Plaque indices	92(56.1)	72(43.9)	76(59.4)	52(40.6)	116(63.0)	68(37)	56(66.7)	28*33.3)	76(70.4)	32(29.6)	6.8
Periodontal health	92(56.1)	72(43.9)	80(62.5)	48(37.5)	108(58.7)	76(41.3)	56(66.7)	28(33.3)	76(70.04)	32(29.6)	7.2
Patient comfort	84(51.2)	80(48.4)	68(53.1)	60(46.9)	108(58.7)	76(41.3)	52(61.9)	32(38.1)	44(40.7)	64(59.3)	11.8*
Lower level of friction	68(41.5)	96(58.5)	52(40.6)	76(59.4)	84(45.7)	100(54.3)	44(52.4)	40(47.6)	52(48.1)	56(51.9)	4.1
Company reputation	120(73.2)	44(26.8)	68(53.1)	60(46.9)	112(60.9)	72(39.1)	60(71.4)	24(28.5)	76(70.4)	32(29.6)	17.1*
Advertising	132(80.5)	32(19.5)	68(53.1)	60(46.0)	132(71.7)	52(28.3)	68(81.0)	16(10.0)	72(66.7)	36(33.3)	31.9**
Quality of product	76(46.3)	88(53.7)	64(50.0)	64(50.0)	84(45.7)	100(54.3)	56(66.7)	28(33.3)	36(33.3)	72(66.7)	21.7**
Past experience	96(58.5)	68(41.5)	52(40.6)	76(59.4)	104(56.5)	80(43.5)	60(71.4)	24(28.6)	48(44.4)	60(55.6)	25.3**
Colleague's experience	108(65.9)	56(34.1)	64(50.0)	64(50.0)	116(63,9(	68(37.0)	52(61.9)	32(38.1)	56(51.9)	52(48.1)	11.3*
Employer's preference	108(65.9)	56(34.1)	48(37.5)	80(62.5)	104(56.5)	80(43.5)	52(61.9)	32(38.1)	48(44.4)	60(38.1)	29.8**

Note. NI=not influential; N=Influential; *P<0.05; **p<0,001

Table 7

Self-reported use of and Satisfaction of Self-Ligating Brackets by Manufacturer

Type of Bracket	Total Use (answered yes)	Positive		Negative			Would Rather Not Answer or NA
	N (%)	BC	NBC	BC	NBC	Chi-Square	N (%)
Damon	336 (50.3)	88 (21.2)	64 (25.4)	124 (29.8)	60 (23.8)	3.39	332 (49.7)
"RMO" Synergy	68 (10.2)	12 (2.9)	24 (5.8)	24 (9.5)	8 (8)	15.32*	600 (89.8)
GAC Innovation R	352 (52.7)	148 (35.6)	80 (31.7)	72 (17.3)	52 (20.6)	1.62	316 (47.3)
Speed	148 (22.2)	36 (8.7)	20 (7.9)	60 (14.4)	32 (12.7)	0.56	520 (77.8)
Smartclip	24 (3.6)	0	0	16 (3.8)	8 (3.2)	0.204	644 (96.4)
Time 2	316 (47.3)	48 (11.5)	20 (7.9)	176 (42.3)	72 (28.6)	18.93**	352 (52.7)

Note. N=668; Percentages do not equal 100% due to those that selected "would rather not answer" or "NA"; BC=Board Certified; NBC= not Board Certified; *p <0.05; **p<0.001

Table 8

Overall Level of Satisfaction and Reported Efficacy

Variable	Very Negative	Negative	Neutral	Positive	Very Positive	N/A
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Overall Satisfaction						
Price	164 (24.8)	312 (47.3)	136 (20.6)	28 (4.2)	4 (0.6)	16 (2.4)
Plaque/Hygiene	28 (4.3)	68 (10.4)	344 (52.4)	164 (25.0)	20 (3.0)	32 (4.9)
Bulk of Brackets	68 (10.4)	212 (32.3)	252 (38.4)	96 (14.6)	16 (2.4)	12 (1.8)
Difficulty Finishing	148 (22.6)	176 (26.8)	180 (27.4)	72 (11.0)	52 (7.9)	28 (4.3)

	Increased	Decreased	No effect
	N (%)	N (%)	N (%)
Efficacy			
Treatment Time	48 (7.6)	192 (30.6)	388 (61.8)
Chair-side Time	40 (6.4)	404 (64.3)	184 (29.3)
Total # Patient Visits	68 (10.9)	228 (36.5)	328 (52.6)
Difficulty Finishing	392 (62.4)	52 (8.3)	184 (29.3)

Table 9

Reported Efficacy between Practitioners Who are Board Certified and Those Who are Not

	Increased		Decreased		No effect		
	BC	NBC	BC	NBC	BC	NBC	
Efficacy	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	Chi-Square
Treatment Time	36 (9.3)	12 (5.0)	120 (30.9)	72 (30.0)	232 (59.8)	156 (65.0)	4.24
Chair-side Time	20 (5.2)	20 (8.3)	252 (64.9)	152 (63.3)	116 (29.9)	68 (28.3)	2.54
Total # Patient Visits	44 (11.5)	24 (10.0)	144 (37.5)	84 (35.0)	196 (51.0)	132 (55.0)	0.98
Difficulty Finishing	244 (62.9)	148 (61.7)	40 (10.3)	12 (5.0)	104 (26.8)	80 (33.3)	7.24*

Note. NA. BC=Board Certified; NBC= not Board Certified; *p<0.05

Biomedical IRB – Exempt Review
Deemed Exempt

DATE: **May 23**, 2011

TO: **Dr. Marcia Ditmyer,** Dental Medicine

FROM: Office of Research Integrity – Human Subjects

RE: Notification of review by /Cindy Lee-Tataseo/
Ms. Cindy Lee-Tataseo, BS, CIP, CIM
Protocol Title: Survey Comparing Perceptions between Orthodontists and Orthodontic Residents in use of Self-Ligating Brackets
Protocol # 1105-3818

This memorandum is notification that the project referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46 and deemed exempt under 45 CFR 46.101(b)2.

PLEASE NOTE:
Upon Approval, the research team is responsible for conducting the research as stated in the exempt application reviewed by the ORI – HS and/or the IRB which shall include using the most recently submitted Informed Consent/Assent Forms (Information Sheet) and recruitment materials. The official versions of these forms are indicated by footer which contains the date exempted.

Any changes to the application may cause this project to require a different level of IRB review. Should any changes need to be made, please submit a **Modification Form**. When the above-referenced project has been completed, please submit a **Continuing Review/Progress Completion report** to notify ORI – HS of its closure.

If you have questions or require any assistance, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 895-2794.

APPENDIX B: Email letter to Orthodontics

Dear Orthodontic Practitioner,

This email is being sent to request your participation in a web-based survey as part of a Master's thesis project at the University of Nevada Las Vegas, School of Dental Medicine, Graduate Dental Education Orthodontics' Program.

The purpose of this research study is to compare perceptions of efficacy and efficiency of Self-Ligating Brackets vs. Conventional Brackets between practicing Orthodontist Practitioners and Orthodontic Residents. Your opinion is very important to us. This questionnaire will require approximately 20-25 minutes of your time. Your responses to this survey will be **confidential** and has been approved by the UNLV Office of Research Integrity – Human Subjects (Protocol # 1105-3818).

If you have any questions, please contact Dr. John-David Beuhler at john-david.beuhler@sdmail.sdm.unlv.edu and/or Dr. Marcia Ditmyer at marcia.ditmyer@unlv.edu.

To take the survey online, please go to the following web address:

http://www.zoomerang.com/Survey/WEB22CBAEVRZUC

Your participation is greatly appreciated and crucial to the success of this study. Thank you for your professional courtesy.

Respectfully,

John-David Buehler, DDS
Orthodontic Resident

Marcia Ditmyer, PhD
Assistant Professor
Department of Biomedical Sciences

Survey Comparing Perceptions between Orthodontists and Orthodontic Residents in use of Self-Ligating Brackets

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Survey Comparing Perceptions between Orthodontists and Orthodontic Residents in use of Self-Ligating Brackets

Page 1 - Heading

You are invited to participate in a short survey that is being conducted as part of a orthodontic residents master's thesis project at UNLV School of Dental Medicine, Graduate Education Program.

Purpose: The purpose of this study is to compare perceptions of efficacy and efficiency of Self-Ligating Brackets vs. conventional brackets between practicing Orthodontists and Orthodontic Residents.
Procedures: If you volunteer to participate in this study, you will be asked to complete this short 20-25 minute survey about your use and attitudes of self-ligating brackets.

Benefits of Participation: There may be no direct benefits to you as a participant in this study. However, we hope to learn information about the use of self-ligating brackets to help provide information for practitioners regarding treatment planning.

Page 1 - Heading

Risks of Participation: This study will include only minimal risks. You may become uncomfortable when answering some of these questions. If you feel uncomfortable, you can simply not answer that item in the survey or discontinue the survey at any time.

Cost/Compensation: There will not be a financial cost to you to participate in this study. The study will take approximately 20-25 minutes of your time. You will not be compensated for your time.

Page 1 - Heading

Contact information: If you have any questions or concerns about the study, you may contact by email Dr. John-David Beuhler at john-david.beuhler@sdmail.sdm.unlv.edu or Dr. Marcia Ditmyer at marcia.ditmyer@unlv.edu or by phone at (702) 774-2646. For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted, you may contact the UNLV Office of Research Integrity - Human Subjects at 702-895-2794, or toll free at 877-895-2794, or via email at IRB@unlv.edu.

Voluntary Participation: Your participation in this study is voluntary. You may refuse to participate in this entire study or in any part of the study. You may withdraw at any time without effect to your relations with the university. You are encouraged to ask questions about this study at the beginning or at any time during the research study.

Page 1 - Heading

Confidentiality: All information gathered in this study will be kept confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for 3 years after completion of the study. After the storage time the information gathered will be destroyed.

Page 1 - Question 1 - Choice - One Answer (Bullets)

Click 'I agree' if you have read the information above and agree to participate in this study.

- ❍ I agree

Page 2 - Heading

General Directions: This is a survey of your perceptions regarding the use of Self-Ligating Brackets vs. Conventional Brackets. The information presented will ask about your perceived efficiency and efficacy of one Self-Ligating over Conventional Brackets. Your responses will remain confidential and only aggregate information will be reported. In this first section, please select the response that best describes your ue of Self-Ligating Brackets.

Page 2 - Question 2 - Choice - One Answer (Bullets)

Do you use Self-Ligating Brackets in your practice?

- ❍ Yes
- ❍ Yes-exclusively
- ❍ No

Page 2 - Question 3 - Choice - One Answer (Bullets)

What is the slot size that you USE?

- ❍ 0.018"
- ❍ 0.022"
- ❍ Both

Page 2 - Question 4 - Choice - One Answer (Bullets)

What is the slot size you PREFER?

- ❍ 0.018"
- ❍ 0.022"
- ❍ Both

Page 3 - Question 5 - Rating Scale - Matrix

Please select how much a factor influenced your decision to use Self-Ligating Brackets (scale of 1 to 5 with 1 being not at all influencial and 5 being extremely influencial).

	Not at all influencial	Slightly influential	Somewhat influencial	Very influential	Extremely influential	N / A
Speed of treating cases	❍	❍	❍	❍	❍	❍
Time savings chairside	❍	❍	❍	❍	❍	❍
C o s t	❍	❍	❍	❍	❍	❍

Rate of alignment and space	❍	❍	❍	❍	❍	❍
Closure	❍	❍	❍	❍	❍	❍
Plaque indices	❍	❍	❍	❍	❍	❍
Periodontal health	❍	❍	❍	❍	❍	❍
Patient comfort	❍	❍	❍	❍	❍	❍
Lower level of friction	❍	❍	❍	❍	❍	❍
Sales representative/Company reputation	❍	❍	❍	❍	❍	❍
Advertising	❍	❍	❍	❍	❍	❍
Quality of product (consistency)	❍	❍	❍	❍	❍	❍
Past experience with system	❍	❍	❍	❍	❍	❍
Colleague's experience with system	❍	❍	❍	❍	❍	❍
Employer's preference for Self-Ligation	❍	❍	❍	❍	❍	❍

Page 4 - Heading

Which of the following brackets have you used in your practice?

If yes, indicate whether you have had a positive experience or negative experience with the bracket system.

Page 4 - Question 6 - Rating Scale - Matrix

Which of the following brackets have you used in your practice?

If yes, indicate whether you have had a positive experience or negative experience with the bracket system.

	YES	NO	Positive Experience	Negative Experience	Would rather not comment	N/A
Damon	❍	❍	❍	❍	❍	❍
RMO Synergy	❍	❍	❍	❍	❍	❍
GAC Innovation R	❍	❍	❍	❍	❍	❍
Speed	❍	❍	❍	❍	❍	❍
Time 2	❍	❍	❍	❍	❍	❍
Smartclip	❍	❍	❍	❍	❍	❍

Page 4 - Question 7 - Rating Scale - Matrix

Please select the factors associated with your opinions regarding Self-Ligating Brackets.

(Scale of 1 to 5 with 1 being very negative and 5 being very positive)

	Very negative	Negative	Neutral	Positive	Very positive	N/A
Price	❍	❍	❍	❍	❍	❍
Plaque/Hygiene concerns	❍	❍	❍	❍	❍	❍
Bulk of the brackets	❍	❍	❍	❍	❍	❍
Difficulty finishing	❍	❍	❍	❍	❍	❍

Page 4 - Question 8 - Rating Scale - Matrix

What affect do you find that Self-Ligating brackets have on (select the best response):

	Shorten	Lengthen	No effect
Treatment time	❍	❍	❍
Chairside Time	❍	❍	❍
Total Number of Patient Visits	❍	❍	❍
Difficulty finishing	❍	❍	❍

Page 5 - Question 9 - Yes or No

During your residency did/do you have experience bonding cases with Self-Ligating Brackets?

- ❍ Yes
- ❍ No

Page 5 - Question 10 - Yes or No

If yes to previous question, will this factor or does this factor into your decision to use Self-Ligating brackets in your practice?

- ❍ Yes
- ❍ No

Page 5 - Heading

Please answer the following demographic information.

Page 5 - Question 11 - Choice - One Answer (Bullets)

Gender

- ❍ Male
- ❍ Female

Page 5 - Question 12 - Choice - One Answer (Bullets)

I am currently:

- ❍ Orthodontic Practitioner
- ❍ Orthodontic Resident

Page 5 - Question 13 - Yes or No

If an orthodontic practitioner, I am board certified.

- ❍ Yes
- ❍ No

Page 5 - Question 14 - Choice - One Answer (Bullets)

Age Group

- 25-35
- 36-45
- 46-55
- 56-65
- 65+

Page 5 - Question 15 - Choice - One Answer (Bullets)

Region where you did your residency

- Northeast
- Southeast
- Midwest
- Southwest
- West

Page 5 - Question 16 - Choice - One Answer (Bullets)

Region in which you practice or plan to practice

- Northeast
- Southeast
- Midwest
- Southwest
- West

APPENDIX D: Email Letter to Orthodontic Residents

Dear Orthodontic Resident,

This email is being sent to request your participation in a web-based survey as part of a Master's thesis project at the University of Nevada Las Vegas, School of Dental Medicine, Graduate Dental Education Orthodontics' Program.

The purpose of this research study is to compare perceptions of efficacy and efficiency of Self-Ligating Brackets vs. Conventional Brackets between practicing Orthodontist Practitioners and Orthodontic Residents. Your opinion is very important to us. This questionnaire will require approximately 20-25 minutes of your time. Your responses to this survey will be **confidential** and has been approved by the UNLV Office of Research Integrity – Human Subjects (Protocol # 1105-3818).

If you have any questions, please contact Dr. John-David Beuhler at john-david.beuhler@sdmail.sdm.unlv.edu

To take the survey online, please go to the following web address:

http://www.zoomerang.com/Survey/WEB22CBAEVRZUC

Your participation is greatly appreciated and crucial to the success of this study. Thank you for your professional courtesy.

Respectfully,

John-David Beuhler, DDS
Orthodontic Resident

Marcia Ditmyer, PhD
Assistant Professor
Department of Biomedical Sciences

References

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LICENSE

Nevada Limited Dental License since August 2008
New York State Dental License since July 2005.

CLINICAL EXPERIENCE

Postgraduate Orthodontic Resident – University of Las Vegas Nevada Advanced Education in Orthodontics and Dentofacial Orthopedics
Duties: Providing all aspects of clinical care of orthodontic patients. Obtaining a Masters degree in Oral Biology, and leading case presentations.

Clinical Fellow – University of Las Vegas Nevada Advanced Education in Orthodontics and Dentofacial Orthopedics
Duties: Providing and assisting in clinical care of orthodontic patients. Engaging in literature review, attending case presentations, and assisting residents in research projects.
July 2008 – June 2009

Clinical Instructor/Assistant Professor in the Department of Oral Diagnostic Sciences at the State University of New York at Buffalo
Duties: Instructing dental students on appropriate radiographic techniques, interpretation of normal and pathological findings, and evaluating/grading students on acceptable infection control, treatment planning, and radiographic techniques.
July 2006 – June 2008

Attending Dentist – Kaleida Health Residency Buffalo General
Duties: Supervising residents and hygienists in hospital-based residency. Providing hands-on education, and coordinating comprehensive treatment.
October 2007 – June 2008

Dentist – Tuscarora Native Reservation / Niagara Falls Memorial Medical Center
Duties: Providing comprehensive dental care on Native Americans.
November 2007 – June 2008

Kaleida Health General Practice Residency
Duties: Performing dental procedures in clinic setting, dental evaluations of patients on the skilled nursing floor, attending scheduled educational conferences, dental and trauma call. Rotations in Anesthesia, Family Medicine, Emergency Medicine, TMD Clinic, Pediatrics (with interceptive ortho), and Oral surgery.
June 2005 – June 2006

EDUCATION

University of Las Vegas Nevada Advanced Education in Orthodontics and Dentofacial Orthopedics
School of Dental Medicine
Las Vegas, NV
Masters of Oral Biology, Dec 2011

State University of New York at Buffalo
School of Dental Medicine
Buffalo, NY
Doctor of Dental Surgery, May 2005
Academic Honors: Barrett Scholarship

State University of New York at Geneseo
Geneseo, NY
Bachelor of Science degree, May 2000
Major: Chemistry
Minor: Piano Pedagogy
Academic Honors: Dean's List

PROFESSIONAL ORGANIZATIONS

American Dental Association. 2005 - Present
New York State Dental Association 2000 - Present
Eighth District Dental Society 2006 – Present
American Association of Orthodontists 2009 – Present

RESEARCH

"The Effect on the Upper Soft Tissue Airway in Response to Class II Correction with the Herbst Appliance" December 2003

"Parental Attitudes Towards the Use of 3-D X-Ray Examination in Orthodontic Care"
July 2008 – June 2009
"Practicing Orthodontists' Use and Perceived Efficacy of Self-Ligating Brackets" July 2009 – November 2011