SURVEY OF TEMPORARY ANCHORAGE DEVICE UTILIZATION IN GRADUATE ORTHODONTIC PROGRAMS AND ORTHODONTIC PRACTICES IN THE UNITED STATES

A Thesis
Presented in Partial Fulfillment of the Requirements for
The Degree Master of Science in the
Graduate School of The Ohio State University

By
Jeffrey Michael Shirck, B.S., D.D.S.

*****

The Ohio State University
2009

Master’s Examination Committee:
Dr. Sarandeep Huja, Advisor
Dr. F. Michael Beck
Dr. Allen Firestone
Dr. Katherine Vig

Approved by

___________________
Advisor
Graduate Program in Dentistry
ABSTRACT

Introduction: There is limited data about current utilization of Temporary Anchorage Devices (TADs) in orthodontic practices and residency programs. This survey aimed to obtain information on clinical protocol as well as trends in TAD placement. The survey was mailed to academic institutions and private practitioners to determine if differences existed between the two groups. Methods: A survey was prepared and administered to all 61 accredited orthodontic residencies in the United States, excluding The Ohio State University, and an equal number of private orthodontic practitioners. Results: The response rate was 63.9% for private practitioners and 70.4% for orthodontic residency programs. The survey showed that 69.2% of private practitioners and 82.9% of residency programs report placing the majority of TADs in their practice. TADs were placed in 6.0% of the private practitioner patients and in 5.3% of patients treated in residency programs. Topical combined with local anesthesia was the anesthetic of choice for 59% of private practitioners and 65% of orthodontic residency programs. Loading TADs immediately was preferred by 79% of private practitioners and 61.9% of orthodontic residency programs. TADs were most frequently used for anterior en-masse retraction. Conclusions: There was little difference in clinical usage of TADs between private practitioners and orthodontic residency programs.
Dedicated to my family
ACKNOWLEDGEMENTS

I would first like to thank my master’s thesis committee: Dr. F. Michael Beck, Dr. Allen Firestone, Dr. Sarandeep Huja, and Dr. Katherine Vig. The many hours they spent helping me create this survey, as well as improve this manuscript, were essential to completing the final product. I would like to give special recognition to my thesis advisor, Dr. Sarandeep Huja, for consistently keeping me on the track to completion and making sure to give me additional encouragement.

I would also like to thank all of my co-residents during my three years here. I particularly would like to recognize my fellow classmates: Dana Casaus, Darin Lunt, Brittany Potts, Belinda Weltman, and Jared Zwick. I have enjoyed sharing the past three years with everyone and have appreciated the help given to me.

A special thank you is due to Delta Dental Master’s Thesis Award Program. Their financial assistance was extremely helpful in distributing my survey to the subjects. I would also like to give thanks to James Van Hoose, Anatole Olenjik, and Mike Knutson for their assistance in compiling a list of private practitioners to distribute the survey.

I would finally like to thank my parents (Tom and Judy), wife (Zhenia), and sister (Jennie) for all of their help through my years of schooling. Their consistent love and support has been crucial to my success.
VITA

March 21, 1981............................................Born – Columbus, OH

1999-2002.............................................B.S. Biology
   Summa Cum Laude
   The Ohio State University
   Columbus, OH

2002-2006.............................................D.D.S.
   Summa Cum Laude
   The Ohio State University
   Columbus, OH

2006-Present........................................Graduate Resident in Orthodontics
   The Ohio State University
   Columbus, OH

FIELDS OF STUDY

Major Field: Dentistry

Specialty: Orthodontics
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Dedication</td>
<td>iii</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>iv</td>
</tr>
<tr>
<td>Vita</td>
<td>v</td>
</tr>
<tr>
<td>Chapters:</td>
<td></td>
</tr>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2. Materials and Methods</td>
<td>8</td>
</tr>
<tr>
<td>3. Manuscript</td>
<td>13</td>
</tr>
<tr>
<td>4. General Conclusions</td>
<td>32</td>
</tr>
<tr>
<td>5. General Reference List</td>
<td>40</td>
</tr>
<tr>
<td>Appendix A (Cover Page)</td>
<td>43</td>
</tr>
<tr>
<td>Appendix B (Informed Consent)</td>
<td>45</td>
</tr>
<tr>
<td>Appendix C (Survey – Clinical questions)</td>
<td>50</td>
</tr>
<tr>
<td>Appendix D (Survey – Didactic questions)</td>
<td>55</td>
</tr>
<tr>
<td>Appendix E (Results Table from Didactic questions)</td>
<td>58</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

Orthodontic treatment strategies routinely involve reciprocal forces. While this aids orthodontic mechanics in many cases, often it poses many problems from undesirable reciprocal tooth movements. The solution to the undesirable reactionary force in orthodontics is “anchorage”, which is a resistance to unwanted tooth movement.\textsuperscript{1} Anchorage in orthodontics is provided by combining a group of teeth together, and their root surface area, to oppose the force applied to a tooth, or group of teeth, with a smaller root surface area. Anchorage can be categorized as: minimum, moderate, or maximum.

The search for a possible source for anchorage, other than the other teeth in the mouth, has been a goal throughout the history of orthodontics.

Extraoral force, such as headgear, has provided a source for indirect anchorage. The major drawback of extraoral force is poor patient compliance. The search for an intraoral solution by means of skeletal anchorage dates back to 1945, when vitallium screws were inserted into bone and used to retract the canine teeth of dogs.\textsuperscript{1} More recently, technological advances in skeletal anchorage have resulted in the reemergence of skeletal anchorage in orthodontic technical practice.

The current forms of temporary skeletal anchorage can be categorized as mini-screws and mini-plates, and are collectively referred to as TADs.\textsuperscript{1} Mini-screws are
further subdivided into self-drilling and non-self-drilling.\textsuperscript{2,3} Mini-plates, which require a surgical flap for placement and removal, are attached to alveolar bone by surgical screws. Self-drilling screws have a sharp tip, threaded body, and do not require a pilot hole to be placed prior to insertion. Non-self-drilling screws require a pilot hole to be drilled prior to placement because their tip is not sharp enough to penetrate cortical bone and cut an access path in bone.\textsuperscript{6} The popularity of TADs has increased due to their ability to provide reliable anchorage without requiring patient compliance.\textsuperscript{4} It has been reported that anchorage from TADs simplifies previously complex treatments.\textsuperscript{5} In contrast to traditional dental implants, TADs use mechanical retention as the main source of anchorage without the need for osseointegration.\textsuperscript{2}

The literature is replete with the clinical application of TADs. These include, but are not limited to: correction of deep overbites by intrusion of anterior teeth, closure of open bites by intruding posterior teeth, closure of extraction/edentulous spaces via retraction or protraction, repositioning malposed teeth in a mouth with partial edentulism, intrusion of super-erupted molars in order to surgically place an implant restoration in the opposing occlusion, and molar uprighting.\textsuperscript{1,3,7-10} A recent use of TADs, which actually does not involve orthodontic anchorage, has been as temporary replacement of missing maxillary lateral incisors in a growing patient.\textsuperscript{11}

There is no universally accepted protocol for the placement of TADs, but most case reports and research studies describe the procedure used in their study. While most studies report TADs are surgically placed under local anesthesia, it is also recognized that profound anesthesia of the teeth is not desired due to potential complications.\textsuperscript{1,3,4,7,9,10,12,13} Topical anesthesia to the teeth without local anesthesia injections has been advocated in
recent literature.\textsuperscript{14-16} An alternative to local anesthesia and topical anesthesia is a MadaJet XL (MADA Medical Product, Inc). The MadaJet XL uses pneumatic pressure to discharge a local anesthetic through the mucosa.\textsuperscript{16}

Major determinants of TAD success are the condition of the soft and hard-tissues surrounding the device and the patient’s oral hygiene. Research has advocated the placement of TADs into keratinized tissue when possible.\textsuperscript{1} Knowledge of local anatomy is important to avoid any iatrogenic complications when surgically placing the TAD or drilling a pilot hole. To prevent accidentally damaging an adjacent tooth, an intraoral radiograph with a surgical guide has been promoted.\textsuperscript{1,2} Due to variation in root morphology, taking a postoperative radiograph to confirm that no root or nerve damage had occurred is advisable.\textsuperscript{12}

The timing of load application is different for traditional dental implants and TADs. Traditional dental implants cannot be loaded immediately because this decreases the likelihood of osseointegration. Because complete osseointegration is not desired with TADs, immediate loading is acceptable. Some studies support healing periods ranging from 2 weeks to 12 weeks.\textsuperscript{13,17-19} Another study suggested this healing period is unnecessary because the mechanical retention obtained upon insertion is sufficient for orthodontic loading of 150 grams.\textsuperscript{20}

Potential complications of TAD placement and utilization have been a significant concern for practitioners. Complications that have been reported in the literature include: inflammation and infection of soft tissues adjacent to the TAD\textsuperscript{1}, peri-implantitis\textsuperscript{21}, TAD fracture upon insertion or removal\textsuperscript{12,21}, damage to adjacent teeth and their periodontal ligament\textsuperscript{12,21}, TAD slippage defined as when the TAD does not insert into the bone but
rather slips past the bone and enters the posterior submandibular space\textsuperscript{21}, nasal and maxillary sinus perforation\textsuperscript{21}, apthous ulcers\textsuperscript{21}, soft tissue coverage of the TAD head and auxiliary\textsuperscript{21}, and osseointegration\textsuperscript{21}. When using topical anesthetics containing phenylephrine, ex. TAC 20 (Steven’s Pharmacy) or Profound PET (Steven’s Pharmacy), there is another reported concern. Phenylephrine is a direct-acting sympathomimetic agent. This agent can cause cardiac complications involving hypertension and vasoconstriction; but this has not occurred when used for orthodontic applications\textsuperscript{14}.

Recent dental literature has addressed the dental/medical complications for patients taking oral and intravenous bisphosphonates. Bisphosphonates are a class of medications that are prescribed for the treatment of osteoporosis, Paget’s disease, hypercalcemia from malignancy, or metastatic bone lesions\textsuperscript{22}. These drugs are under scrutiny in the dental community because patients taking bisphosphonates have a higher rate of developing osteonecrosis of the jaws than the normal population\textsuperscript{22}. The guidelines should be different for patients taking oral versus intravenous bisphosphonates as bisphosphonate-associated osteonecrosis of the jaws has not been linked with dental implant placement and patients taking oral bisphosphonates\textsuperscript{23}. There is currently insufficient evidence to associate TAD placement or utilization and bisphosphonate associated osteonecrosis of the jaws.

Acceptable criteria for TAD success are resistance to orthodontic force and no persistent inflammation, infection, or excessive TAD mobility\textsuperscript{5,7,12,17}. While complication rate influences overall clinical TAD success rate, there are other factors as well. Oral hygiene is widely recognized as a factor that contributes to success rate\textsuperscript{5,12}. Surgical placement site is another and some studies showed that TADs placed in the
maxilla shows a significantly higher success rate than in the mandible, whereas others report no difference. Additionally, placing TADs into movable alveolar mucosa can increase complications such as tissue irritation and overgrowth leading to a decreased success rate. Screw diameter is another factor to consider. It is suggested that a screw diameter of 1mm or less contributes to failure due to TAD fracture. Age does not appear to be a factor unless the patient is still growing, where there is increased mobility in the growing patient. Surgically placing a TAD too close to the adjacent tooth root increases the chances for failure. Even with all these potential problems, success rates published in journals have ranged from 84.7% to 92.5%. 
STATEMENT OF THE PROBLEM

The objective of this research is to highlight and compare the current state of knowledge, training, and utilization of temporary anchorage devices in the United States graduate orthodontic residencies and private practices.

TADs are quickly gaining popularity in orthodontics. This technology remains new and a significant amount of knowledge remains to be gained. Evidence-based clinical protocols and standard didactic curriculums have not been established in the United States to define a surgical placement protocol and specific clinical utilization of TADs.

While the current success rates reported in the literature are high, such studies have been published by orthodontists who have significant clinical experience in placing and utilizing TADs. Studies have not been published that report success rates for clinicians and orthodontic residency programs during the learning curve. Clinical questions in this survey are constructed to obtain a realistic success rate for temporary anchorage devices in general. The survey will provide new information to determine how many advanced orthodontic graduate programs have incorporated TADs into their clinic, didactic curriculum, and research projects. By surveying both academic institutions and private orthodontic practitioners, a comparison of how the two groups may differ in their experiences will be available. A survey of orthodontists conducted in
2007 by Journal of Clinical Orthodontics reported that while seventy-five percent of the respondents were not using TADs, a large majority indicated they will use them in the future. With more orthodontic clinicians deciding to incorporate TADs into their clinical practice, this survey should provide useful information of utilization trends in 2007-2008.
CHAPTER 2
MATERIALS AND METHODS

SPECIFIC AIMS AND HYPOTHESES

The objective of the current study was to survey orthodontists in order to further understand the clinical applications and protocols for TAD utilization. A second objective was to evaluate how orthodontic residency programs have integrated teaching and incorporating TAD protocols into the curriculum. The specific aims were to evaluate the (private orthodontic practitioners and graduate orthodontic program directors):

a) type of TADs used

b) dental specialist responsible for placing TADs

c) difference in dental specialist who surgically places the TADs in specific regions (palate, maxilla buccal, mandible lingual, mandible buccal, infrazygomatic crest, and retromolar pad)

d) minimum patient age for placement of a TAD

e) method of anesthesia used for the placement of TADs

f) specialty of practitioners surgically placing TADs in non-keratinized tissue

g) percentage of patients receiving TADs
h) average duration (in months) the TADs are loaded before removal
i) recommended healing or waiting period before loading the TADs
j) clinical application of TADs [maxillary and mandibular posterior distalization, anterior retraction, posterior mesialization, anterior intrusion, posterior intrusion; traction for impacted teeth; molar uprighting; and abutment for composite build-up for temporization of missing maxillary laterals]
k) the complications pediatric patients (<18 years old) experience from TADs placed
l) percentage of respondents who are placing TADs in patients who are taking oral bisphosphonates
m) the overall percentage success rate for TADs (non-self-drilling mini-screws, self-drilling mini-screws, and mini-plates)

and the (residency program directors only):

p) number of didactic courses taught that are TAD specific
q) number of course hours that are TAD specific
r) number of full-time faculty who are treatment planning TADs
s) percentage of full-time faculty who are treatment planning TADs
t) number of part-time faculty treatment planning TADs
u) percentage of part-time faculty treatment planning TADs
v) number of full-time faculty surgically placing TADs
w) percentage of full-time faculty surgically placing TADs
x) number of part-time faculty surgically placing TADs
y) percentage of part-time faculty surgically placing TADs
z) minimum graduation requirement of the number of TADs surgically placed by each resident
aa) number of TAD surgical placement procedures that must be observed before a resident is allowed to surgically place a TAD independently
bb) percentage of current research projects investigating TADs
c) presence of a log of TAD placement maintained by the department
d) outcomes used to document TAD success/failure
e) year the first TAD was utilized for anchorage in the clinic
f) year the first TAD was surgically placed in the orthodontic clinic
g) opinion as to whether TADs are considered a standard of care in contemporary orthodontic practice

The null hypothesis:

There is no difference in factors related to TAD utilization between private orthodontic practitioners and graduate orthodontic programs.
STUDY DESIGN

The need existed to survey orthodontic practitioners and residency programs and evaluate complication factors, uses, and success rates of TADs. A questionnaire was developed that allowed the respondent to address each of our specific aims. The survey was first administered as a pilot study to five faculty members to assess the understandability, appropriateness, and comprehensibility of each question to eliminate any ambiguity in the questions. Once the modifications were made, the questionnaire, and a cover letter with informed consent, were submitted to the Institutional Review Board at Ohio State University for approval (protocol number 2007H0211).

The survey was distributed to the two groups. Group I was comprised of the sixty-one orthodontic residencies listed on the American Dental Association’s website, excluding Ohio State University. The surveys were addressed to the orthodontic program directors. Group II was comprised of sixty-one private orthodontic practitioners identified by orthodontic supply representatives and academicians as currently utilizing TADs in their practice. The survey also included a cover letter with the survey description and an informed consent form (Appendix A-D). It was estimated that the informed consent would take two minutes to complete and the questionnaire would require fifteen minutes to complete. The survey consisted of fifteen clinical questions and was administered to both groups. Group I had an additional eighteen didactic
questions related to the residency programs. Participation was voluntary and there were no financial incentives for participating. A research assistant coded the surveys, which were sent to the subjects with a return address to the research assistant. The numeric coding of the surveys eliminated bias and maintained the confidentiality of the respondents. The survey was mailed three times, if required, with eight weeks between each mailing. Telephone reminder calls to the private practitioners were made each time the survey was sent to maximize response rate. An excel spreadsheet was developed to compile and code all responses. For questions involving a “yes” or “no” answer, the “yes” answers were recorded as “1” into the spreadsheet and the “no” answers were recorded as “0”. For questions involving responses in a multiple choice format, the questions were assigned a number increasing in value. For example, A: = 1, B: = 2, C: = 3. Questions requiring write-in responses were recorded with the exact numerical answer given, except in the cases where respondents wrote a range in which the answer was recorded as the average of the range. For example, for a respondent writing 8-10%, the answer was recorded as 9%. When the surveys were completed and returned, the data were transferred into a spreadsheet and statistically analyzed.
CHAPTER 3

MANUSCRIPT:

TEMPORARY ANCHORAGE DEVICE UTILIZATION: A COMPARISON OF ORTHODONTIC GRADUATE PROGRAMS AND PRIVATE PRACTITIONERS

Introduction: There is limited data about current utilization of Temporary Anchorage Devices (TADs) in orthodontic practices and residency programs. This survey aimed to obtain information on clinical protocol as well as trends in TAD placement. The survey was mailed to academic institutions and private practitioners to determine if differences existed between the two groups. Methods: A survey was prepared and administered to all 61 accredited orthodontic residencies in the United States, excluding The Ohio State University, and an equal number of private orthodontic practitioners. Results: The response rate was 63.9% for private practitioners and 70.4% for orthodontic residency programs. The survey showed that 69.2% of private practitioners and 82.9% of residency programs report placing the majority of TADs in their practice. TADs were placed in 6.0% of the private practitioner patients and in 5.3% of patients treated in residency programs. Topical combined with local anesthesia was the anesthetic of choice for 59% of private practitioners and 65% of orthodontic residency programs. Loading TADs immediately was preferred by 79% of private practitioners and 61.9% of orthodontic residency programs. TADs were most frequently used for anterior en-masse retraction. Conclusions: There was little difference in clinical usage of TADs between private
practitioners and orthodontic residency programs.

**INTRODUCTION**

Orthodontic treatment mechanics routinely involve utilizing reciprocal forces. While this aids orthodontic tooth movement in few cases, more often it can eventually result in undesirable consequences. Anchorage is a resistance to unwanted tooth movement and counteracts the undesirable reactionary force in orthodontics.¹ The two most common forms of temporary skeletal anchorage are mini-screws and mini-plates; and are frequently referred to as TADs. Mini-plates differ from mini-screws in that the former require a surgical flap for placement and removal, and are attached to alveolar bone by surgical screws. The popularity of TADs has increased due to their ability to provide reliable anchorage without requiring patient compliance.² It has been reported that anchorage from TADs simplifies previously complex treatments.³ In orthodontics, TAD use includes, but is not limited to: correction of deep overbites by intrusion of anterior teeth, closure of open bites by intruding posterior teeth, closure of extraction/edentulous spaces via retraction or protraction, repositioning malposed teeth in a mouth with partial edentulism, intrusion of super-erupted molars in order to provide enough space to restore the opposing occlusion, molar uprighting, and temporary replacement of missing maxillary lateral incisors in a growing patient.¹,⁴-⁹

There is no universally accepted protocol for the placement of TADs. While most studies report that TADs are placed under local anesthesia, it is also recognized that profound anesthesia of the teeth is not desirable.¹,²,⁴,⁶-⁸,¹⁰,¹¹ Achieving anesthesia by a MadaJet XL (MADA Medical Product, Inc) or topical compounds without local
anesthesia injections has been advocated in recent literature.\textsuperscript{12-14}

Major determinants of TAD success are the condition of the soft and hard-tissues at site of insertion, as well as the patient’s oral hygiene.\textsuperscript{1} The placement of TADs into keratinized tissue when possible has been advocated.\textsuperscript{1} Making use of an intra-oral radiograph with a surgical guide can help prevent iatrogenic damage to the adjacent teeth.\textsuperscript{1,15} Due to variation in root morphology, it has been suggested to take a post-operative radiograph to confirm that no root or nerve was damaged.\textsuperscript{10} A healing period may be unnecessary because the mechanical retention immediately obtained upon insertion is sufficient for orthodontic loading of 150 grams.\textsuperscript{16,17} Potential complications of TAD placement and utilization have been a significant concern for practitioners. Complications that have been reported in the literature include: inflammation and infection of soft tissues adjacent to the TAD\textsuperscript{1}, peri-implantitis\textsuperscript{18}, TAD fracture upon insertion or removal\textsuperscript{10,18}, damage to adjacent teeth and their periodontal ligament\textsuperscript{10,18}, TAD slippage such as when the TAD does not insert into the bone but rather slips past the bone, nasal and maxillary sinus perforation, apthous ulcers, soft tissue overgrowth of the TAD head and auxiliary, and osseointegration.\textsuperscript{18}

Bisphosphonates are prescribed for the treatment of osteoporosis, Paget’s disease, hypercalcemia from malignancy, and metastatic bone cancers.\textsuperscript{19} These drugs are under scrutiny in the dental, medical, and bone biology communities because patients taking bisphosphonates have a higher rate of developing osteonecrosis of the jaws than the normal population.\textsuperscript{19} There is currently insufficient evidence to associate TAD placement/utilization and bisphosphonate associated osteonecrosis of the jaws.

Criteria for TAD success are the ability to resist orthodontic forces as well as no
persistent inflammation, infection, or excessive mobility.\textsuperscript{3,4,10,20} Factors associated with the success of TADs include poor oral hygiene, surgical placement site, and screw diameter.\textsuperscript{2-4,10,20} Placing TADs into movable alveolar mucosa may increase complications such as tissue irritation and soft tissue overgrowth.\textsuperscript{2,17,20,21} Increased mobility has been observed in younger age groups.\textsuperscript{3,4} TADs too close to the adjacent tooth root increases the chances for failure.\textsuperscript{19} Even with all these potential problems, skeletal anchorage success rates have ranged from 84.7\% to 92.5\%.\textsuperscript{3,4,10,11,21,22}

While the current success rates reported in the literature are high, such studies have been published by experienced orthodontists. By examining both academic institutions and private practitioners, it may be possible to determine how the two groups differ in their experiences. This survey provides an objective method to evaluate orthodontists in two practice settings of TAD utilization.

**MATERIALS AND METHODS**

A survey was developed to obtain information on: 1) types of TADs used; 2) dental specialist responsible for placing TADs overall; 3) ability to surgically place TADs in non-keratinized tissue; 4) percentage of patients receiving TADs; 5) method of anesthesia used; 6) average duration the TADs are loaded; 7) dental specialist responsible for placing TADs in specific sites; 8) minimum age of the patient; 9) average healing period before loading the TADs; 10) specific clinical applications of TADs; 11) the complications experienced by patients <18 years old; 12) TAD utilization frequency in patients who are taking oral bisphosphonates; 13) reported success rate for TADs; 14) radiographs used for the treatment planning TAD placement; 15) time point that radiographs were utilized. The questionnaire, along with a cover letter and informed
consent, was approved by the Institutional Review Board at Ohio State University.

The survey was distributed to two groups. The first group consisted of all 61 orthodontic residencies listed on the American Dental Association’s website. The surveys were mailed to the residency program directors. The second group was comprised of 61 private practitioners who were identified by orthodontic supply representatives and academicians as orthodontists currently utilizing TADs in their clinical practice. The survey consisted of fifteen clinical questions. The participation was voluntary and no financial incentives were provided. A designated research assistant coded the surveys. The surveys were mailed with a return address of the research assistant. The numeric coding of the surveys eliminated bias and maintained the confidentiality of the respondents. The survey was mailed three times, as required, with approximately eight weeks between each mailing. Telephone call reminders to the private practitioners were made each time the survey was sent to maximize response rate. Questions requiring write-in responses were recorded with the exact numerical response. When respondents wrote a range, it was recorded as the median of the range. The data was entered into a spreadsheet and T-tests, Chi-squared and Fisher’s Exact tests were applied to the data when applicable.

RESULTS

The final response rate was 63.9% for private practitioners, and 70.4% for the orthodontic residency programs. The first question examined the type of TADs utilized (Fig 3.1). The responses showed that 87.2% of the private practitioners and 86% of the residency programs utilize self-drilling TADs. In addition, 53.8% of the private practitioners and 69.2% of the residency programs were placing non-self-drilling TADs
as well. Mini-plates were being utilized in 17.9% of private practices and 27.9% of residency programs.

Question 2 examined the dental specialist responsible for placing the TADs (Fig. 3.2). The majority of TADs are placed by orthodontists: 69.2% of private practitioners and 82.9% of residency programs. In private practices, an equal number, 12.8%, of TADs are referred out to oral surgeons and periodontists. In residency programs, however, oral surgeons accounted for 9.8%, while periodontists represented only 4.9% of the responses. A Fisher’s Exact test was used to compare the difference in the referral patterns existed between orthodontic residencies and private practitioners (p = 0.0163).

The survey showed that 70% of private practitioners and 58% of orthodontic residency programs placed TADs in non-keratinized tissue as well as keratinized tissue. TADs were placed in 6.0% of the private practitioner patients and in 5.3% of patients treated in residency programs (Table 3.1).

Regarding the method of anesthesia used prior to placement of TADs, 59% of private practitioners and 65% of orthodontic residency programs use topical and local anesthesia only. The data showed that 30.8% of private practitioners use topical only compared to 28% of orthodontic residencies and 7.7% of private practitioners use local anesthesia only versus 7% of orthodontic residencies. A small number, 2.6%, of private practitioners use I.V. sedation. All methods of anesthesia delivery showed no statistical difference between groups when evaluated with a Fisher Exact test (p = 0.906).

Orthodontists placed majority of the TADs in all areas in the mouth except on the lingual of the mandible (29% of the private practitioners and 41.7% of orthodontic residency programs) and infrazygomatic crest (41.7% of private practitioners and 21.2%
of orthodontic residency programs) in both groups of respondents. With regard to the retromolar pad area, oral surgeons placed the TADs for 30.3% of private practitioners and 41.7% of orthodontic residency programs. On average, private practitioners apply orthodontic force to TADs for 8.2 months before removal, while orthodontic graduate residents load TADs for 9.3 months (Table 3.2).

The mean minimum age for placement of a TAD in private practices was 12.1 years old and 13.4 years for the graduate orthodontic clinic. Nearly half of the respondents (48.7% of private practitioners and 52.8% of orthodontic residencies) indicated that there was no minimum age (Table 3.3).

TADs were immediately loaded and loading TADs within 1-7 days was the response by 79% and 10.3% of private practitioners, respectively. In the orthodontic residency programs, 61.9% of the TADs were loaded immediately. An additional 19% of residencies reported there was no recommended waiting period before loading the TADs.

A variety of clinical uses of TADs were investigated (Table 3.4). Maxillary anterior en-masse retraction and maxillary posterior intrusion were the most reported clinical usage by 95% of private practitioners, while the most commonly reported usage by orthodontic residencies was mandibular posterior mesialization. When the respondents were asked which clinical usage was used most often, both the private practitioners and orthodontic residency programs reported maxillary anterior en-masse retraction.

No adverse sequellae of TAD placement were reported in patients <18 years old by 69.2% private practitioners and 71.4% orthodontic residencies. Potential problems in children were prolonged pain, infection, non-compliance, and self-destruction. Less than
15% of respondents from either group reported these problems, although infection had statistically higher reporting in residency programs compared to private practitioners (Chi-Square p = 0.0324).

A small minority of respondents were placing TADs in patients taking bisphosphonates. Only 9.3% of orthodontic residency programs and 10.2% of private practitioners were placing TADs in patients taking oral bisphosphonates.

The overall success rates in the residency programs and private practices were divided into three categories. The reported success rates for non-self-drilling TADs were 81.2% and 72.6% for private practitioners and orthodontic residency programs, respectively. Private practitioners had success rates of 83.9% for self-drilling TADs while orthodontic residencies reported an 80.1% success rate. A larger difference was found for mini-plates with 84.8% success rates for private practitioners and only 66.1% for orthodontic residencies. The difference was not significant due to the low number of respondents in both groups who reported using mini-plates.

The types of radiographs used for treatment planning of TAD placement differed between private practitioners and orthodontic residencies. The types of radiographs preferred for TAD treatment planning were peri-apical x-rays: 15.4% vs. 83.7%, cone beam CT: 18% vs. 48.8%, panoramic: 92.3% vs. 60.7%, vertical bite-wings: 2.6% vs. 14%, for practitioners and residencies respectively. The results were statistically significantly different between groups in peri-apical use (Chi-square p <.0001), cone beam CT use (Chi-square p = 0.0032), and panoramic use (Chi-square p = 0.0008).

While both groups report using radiographs prior to TAD placement, 87.2% of private practitioners, 83.7% of orthodontic residency programs, there were differences at
other time points. A radiograph immediately post-surgery was reported by 58.1% of orthodontic residencies compared with 35.9% of private practitioners. Another difference between the groups was that 30.2% of orthodontic residency programs reported using a radiopaque pre-surgical guide, while none of the private practitioners reported doing so.

**DISCUSSION**

This survey compared clinical protocols associated with the placement and use of TADs by practitioners and residency programs. The survey was mailed to 61 private practitioners and 61 orthodontic residency programs in the United States. A very good response rate was obtained for private practitioners and orthodontic residency programs.

The private orthodontic practitioners were chosen based on the recommendation from sales representatives and academic orthodontists. We attempted to identify orthodontists with significant expertise using TADs in their practice. The results obtained in this survey represent practitioners who used TADs, not all orthodontists. According to the 2008 Survey of AAO members, 80% of orthodontists have cases involving TADs, but it is important to note that survey only had a 6% response rate and may not represent an accurate depiction of the prevalence of TAD usage. It was interesting to note that the majority of private practitioners and orthodontic residency programs were not only utilizing TADs, but also placing them in various sites. It is anticipated that this trend will continue with all recent graduates of current residency programs placing TADs.

The majority of the respondents (59% of private practitioners and 65% of orthodontic residency programs) used a combination of topical and local anesthesia for
TAD placement. These percentages are similar to the 2008 survey of AAO members on mini-screw usage which reported 64.1% of the respondents using this combination of anesthetics.23 We did offer a write-in section to this question which asked the respondent to list the topical anesthetic used in their practice. While less than 10% filled in this section, their answers consisted of TAC 20 (Steven’s Pharmacy, Inc), Dep Blu (Steven’s Pharmacy, Inc), Profound PET (Steven’s Pharmacy, Inc), and Madajet (MADA, Inc) infiltration.

When asked to choose which TAD utilization technique was used most often, 44% of private practitioners and 69% of orthodontic residencies selected multiple usages. All responses were evaluated and anterior en-masse retraction was the usage most often listed. In case a clinical use was not listed, there was a line for the respondents to write any additional usages. The two write-in answers were “reverse pull traction” and “unilateral palatal expansion.”

There is an interest in the earliest age that patients can receive a TAD. The average minimum age for the placement of a TAD in the private practitioner group was 12.1 years old and 13.4 years old for the orthodontic residency. The question was written in such a way that the respondent could write-in an age or check a box stating “there is no age minimum.” Based on whether a write-in or check was marked, the responses were divided into two categories. Close to half of the respondents checked that there was no minimum age, but comments made by the respondents further explained their responses. The responses suggest that there is no age minimum, as defined by chronologic age. The consensus implied that the minimum age requirement is when the patient has a full permanent dentition except for 2nd permanent molars.
Bisphosphonate-associated osteonecrosis of the jaws, ONJ, has been an area of intense interest in recent dental literature. While there has been no documented link between TAD placement/utilization and bisphosphonates-associated ONJ, most practitioners are currently favoring the side of caution. A potential reason for why so few respondents are placing TADs in patients taking oral bisphosphonates could be due to the construction of the question, “Are you placing TADs in patients taking oral bisphosphonates?” If the question asked if the practitioner was willing to place TADs in these patients, such comments as “not yet but would consider,” leaves us to believe that more respondents would have answered differently.

The success rate of TADs is of great interest to orthodontists. It is difficult to estimate an accurate success rate because it is dependent on its definition. Success can be defined as achieving the desired clinical outcome with TAD supported anchorage, or it can merely be the absence of mobility, infection, or other complications. With this limitation in mind, it remains important to examine the success rate. The reported clinical success rates in literature ranges from 84.7% to 92.5%.\(^3,4,10,11,21,22\) The clinical success rates published have generally been reported by experts in the field. The private practitioners reported average success rates lower than the above range, but higher than the orthodontic residency programs, although not statistically significant (p>0.22 for all types).

The types of radiographs, as well as the time points in which radiographs were obtained, used to treatment plan TAD placement are important. The accessibility to the various type of radiology equipment appears to be the main reason for the difference between the two groups. The fact that 83.7% of orthodontic residencies use peri-apical x-
rays while only 15.4% of private practitioners could be interpreted that the private practitioners would use peri-apicals if they had the machine in their office rather than rely on panoramic x-rays for TAD placement. We did not, however, ask the respondents what type of radiology equipment they have ready access. More orthodontic residency respondents took post-insertion x-rays to confirm placement than private practitioners is possibly due to the experience and technique comfort level on the private practitioners’ side or that the orthodontic residency respondents are in a learning environment. One respondent did note that we did not include “lateral ceph” as an answer and suggested that we should have because lateral cephs are used pre and post-insertion for TADs placed into the palate.

The ability of the TADs to help with complicated or previously impossible treatment is a reason for their popularity. Based on the use of TADs in residency programs, we anticipate that more orthodontists will place and utilize TADs and that TADs will become a standard part of the practitioner’s armamentarium. A survey conducted in 2007 by Journal of Clinical Orthodontics reported that while seventy-five percent of the respondents were not using TADs, a large majority indicated they will use them in the future. With more orthodontic clinicians deciding to incorporate TADs into their clinical practice, this survey provides use information of utilization trends in 2007-2008.

CONCLUSIONS

- Self-drilling TADs are more commonly used than non-self-drilling and mini-plates
- In most cases, orthodontic faculty/residents and orthodontic private practitioners
who utilize TADs in their practice generally place their own TADs

- A majority of private practitioners and residency programs are willing to place TADs in non-keratinized gingiva as well as keratinized gingiva
- Topical anesthesia combined with local infiltration is the most common method of achieving anesthesia for TAD insertion
- 8-9 months is the average amount of time a TAD is utilized in the mouth before removal
- TADs are loaded immediately in most applications
- The most common use for TADs is anterior en-masse retraction
- Approximately 10% of respondents from both groups were willing place TADs in a patient taking oral bisphosphonates
- Most private practitioners use panoramic x-rays to treatment plan TADs, while residency programs utilize panoramic, peri-apical, and cone-beam CTs on a regular basis

REFERENCES


2. Park HS, Jeong SH, Kwon OW. Factors affecting the clinical success of screw implants used as orthodontic anchorage. 2006;130:18-25.

3. Cornelis MA et al. Patients’ and orthodontists’ perceptions of mini-plates used


FIGURES

PP = Private Practitioners

OR = Orthodontic Residencies

Fig. 3.1 Preferred Type of TAD
PP = Private Practitioners

OR = Orthodontic Residency Programs

Fig. 3.2 Specialist Responsible for Placing Majority of TADs
## TABLES

### TABLE 3.1 Average Age of Patients Receiving TADs

<table>
<thead>
<tr>
<th>Groups</th>
<th>Respondents</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practitioners</td>
<td>38</td>
<td>6</td>
<td>6.27</td>
<td>0.5</td>
<td>25</td>
</tr>
<tr>
<td>Residencies</td>
<td>43</td>
<td>5.3</td>
<td>3.81</td>
<td>0.05</td>
<td>15</td>
</tr>
</tbody>
</table>

### TABLE 3.2 Total Months TADs are Loaded

<table>
<thead>
<tr>
<th>Groups</th>
<th>Respondents</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practitioners</td>
<td>38</td>
<td>8.2</td>
<td>2.7</td>
<td>3.5</td>
<td>15</td>
</tr>
<tr>
<td>Residencies</td>
<td>41</td>
<td>9.3</td>
<td>4</td>
<td>4</td>
<td>18</td>
</tr>
</tbody>
</table>

### TABLE 3.3 Average Min Age for TAD Placement

<table>
<thead>
<tr>
<th>Groups</th>
<th>Respondents</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practitioners</td>
<td>17</td>
<td>12.1</td>
<td>1.9</td>
<td>8.5</td>
<td>16</td>
</tr>
<tr>
<td>Residencies</td>
<td>22</td>
<td>13.4</td>
<td>2.3</td>
<td>10</td>
<td>18</td>
</tr>
</tbody>
</table>

### Table 3.4 Percent of respondents using TADs in clinical scenarios

<table>
<thead>
<tr>
<th>Clinical Usage</th>
<th>Practitioners</th>
<th>Residencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary posterior distalization</td>
<td>77%</td>
<td>72%</td>
</tr>
<tr>
<td>Maxillary anterior retraction</td>
<td>87%</td>
<td>95%</td>
</tr>
<tr>
<td>Maxillary posterior mesialization</td>
<td>87%</td>
<td>93%</td>
</tr>
<tr>
<td>Maxillary anterior intrusion</td>
<td>69%</td>
<td>81%</td>
</tr>
<tr>
<td>Maxillary posterior intrusion</td>
<td>92%</td>
<td>95%</td>
</tr>
<tr>
<td>Mandibular posterior distalization</td>
<td>62%</td>
<td>53%</td>
</tr>
<tr>
<td>Mandibular anterior retraction</td>
<td>67%</td>
<td>72%</td>
</tr>
<tr>
<td>Mandibular posterior mesialization</td>
<td>95%</td>
<td>93%</td>
</tr>
<tr>
<td>Mandibular anterior intrusion</td>
<td>59%</td>
<td>67%</td>
</tr>
<tr>
<td>Mandibular posterior intrusion</td>
<td>69%</td>
<td>74%</td>
</tr>
<tr>
<td>Traction for impacted teeth</td>
<td>44%</td>
<td>47%</td>
</tr>
<tr>
<td>Molar uprighting</td>
<td>62%</td>
<td>74%</td>
</tr>
<tr>
<td>Maxillary lateral incisor abutment</td>
<td>23%</td>
<td>12%</td>
</tr>
</tbody>
</table>
CHAPTER 4

RESULTS and COMPREHENSIVE DISCUSSION

RESULTS DIDACTIC QUESTIONS

The results from the didactic questions can be found in Appendix E.

DISCUSSION CLINICAL QUESTIONS

The intent of this survey was to gain information from clinically relevant questions that pertain to clinical practice as well as evaluate how the responses from private practitioners compare with orthodontic residency programs. The survey was mailed to 61 private practitioners and 61 orthodontic residency programs in the United States with a response rate of 63.9% for private practitioners and 70.4% for the orthodontic residency programs. The results were examined and a comparison was made between the groups for similarities and differences.

The private practitioners given the survey were chosen based on the recommendation from sales representatives and academic orthodontists. It was our intent to choose orthodontists with significant expertise using TADs in their practice and the majority of private practitioners and orthodontic residency programs surveyed place their own TADs. It is likely that this trend will continue with all graduates of residency programs placing TADs and most practitioners incorporating TADs into their practice.
The majority of the respondents (59% of private practitioners and 65% of orthodontic residency programs) used a combination of topical and local anesthesia for TAD placement. This compares similarly to the 2008 Survey of AAO members on Mini-screw Usage had 64.1% of the respondents using this combination. We did offer a write-in section to this question which asked the respondent to list the topical used in their practice. While less than 10% filled in this section, the answers consisted of TAC 20, Dep Blu, Profound PET, and Madajet infiltration.

The clinical uses of TADs appear to be increasing. It was our goal to include any use that has been published in a journal or textbook. The question was phrased such that equal weight was given to every response so it was possible that a practitioner could check a box for seldom usage or regular usage, with no way to discriminate the responses. To counter this possibility, a follow-up write-in question asked which single procedure was used most often. Many respondents, 44% of private practitioners and 69% of orthodontic residencies, wrote in two or three uses. The answers were tabulated and anterior en-masse retraction was considered the most frequent usage. The two write-in answers were “reverse pull traction” and “unilateral palatal expansion.”

There is an interest in the earliest age for a patient to receive a TAD. The average minimum age for the placement of a TAD in the private practitioner group was 12.1 years old and 13.4 years old for the orthodontic residency. The question was written in such a way that the respondent could write-in an age or check a box stating “there is no age minimum.” Based on whether a write-in or check was marked, the answers were divided into two categories. Close to half of the respondents checked that there was no minimum age, but rather there is a minimum age not defined by chronologic age. Many
respondents noted that the minimum age is when the patient has a full permanent
dentition except for 2nd permanent molars, although there is no data to validate a
minimum age or time point.

Bisphosphonates have been of great interest in dental literature. While there has
been no link between TAD placement/utilization and bisphosphonate associated
osteonecrosis of the jaws, our study indicated that most practitioners are currently
unwilling to take the risk. A potential reason for why the response was so low could be
due to the phrasing of the question, “Are you placing TADs in patients taking oral
bisphosphonates?” If the question asked if the practitioner was willing to place TADs in
these patients more respondents might have answered differently.

A major interest for orthodontists is the overall success rate of TADs. It is
difficult to estimate an accurate success rate because it is dependent on the definition of
“success.” Success can be defined as achieving the desired clinical outcome with TAD
anchorage, or can merely be the absence of mobility, infection, or other complications.
With this limitation in mind, it remains important to examine the success rate. The
reported clinical success rates in literature ranges from 84.7% to 92.5%. The clinical
success rates published have generally been reported by experts in the field with a
significant amount of clinical TAD experience. The private practitioners reported
average success rates slightly lower than the above range. The private practitioners’
success rate averages were slightly higher than the orthodontic residency programs, but
not statistically significant. Assuming the private practitioners have placed more TADs
than residents, it then can be interpreted that the learning curve for TAD placement is not
extremely steep but the success level plateaus early.
The types of radiographs, as well as the time points in which radiographs were obtained, used to treatment plan TAD placement are important. The accessibility to the various types of radiology equipment appears to be the main reason for the difference between the two groups. The fact that 83.7% of orthodontic residencies use peri-apical x-rays while only 15.4% of private practitioners could be interpreted that the private practitioners would use peri-apical x-rays if they had the machine in their office, rather than rely on panoramic x-rays for TAD placement. More orthodontic residency respondents took post-insertion x-rays to confirm placement than private practitioners is possibly due to technique comfort level on the private practitioners’ side or that the orthodontic residency respondents are in a learning environment. One respondent did note that we did not include “lateral ceph” as an answer and suggested that we should have because lateral ceps are used pre and post-insertion for TADs placed into the palate.

DISCUSSION DIDACTIC QUESTIONS

The second part of the survey, given only to residency program directors, had questions that focused on curriculum and TAD incorporation into a residency program. Programs are very diverse; some only have a handful of faculty compared to others, just as the number of residents per residency program is different. When applicable, the questions did quantify total numbers as well as percentages to offset this limitation. The results of the didactic portion of the survey can be found in Appendix 1.5.

Reporting an average of one TAD course does not quantify the extent of didactic training in programs. Asking how many courses are devoted to TAD learning was not
specific enough. A respondent could define a course as one lecture while another defines it as a series of lectures. For this reason it was important to quantify the number of didactic course hours. The range of 0-66 hours is very wide and makes the accuracy of the 8.9 hour average inaccurate. The median value for this group is probably more reflective and showed a value of 5 hours.

The faculty knowledge of TAD procedures is important when integrating TADs into clinical curriculum. On average, 3 full-time faculty treatment plan TADs, which represented 80% of the full time faculty in a program. An average of 5 part-time faculty treatment plan TADs, but interestingly, that only represented 52.5% of the total. The amount of full-time and part-time faculty surgically placing TADs was lower than the amount that are treatment planning TADs, which was expected. The trend did continue with a higher proportion of full-time faculty placing TADs compared to part-time faculty.

There was a very low response rate to having a minimum graduation requirement of TADs placed compared to our survey response rate. The four respondents who did answer this question reported an average of 5.5, but the low response rate most likely indicates the vast majority of programs do not have a requirement. When inquiring about a minimum observation before a resident was allowed to place a TAD, one respondent felt we should have included an answer of “our residents do not place them” in addition to the “there is no minimum” response. This would decrease potential errors in response.

The most common outcome used to document a TAD success/failure was TAD mobility. Respondents were permitted to answer “other”; these fill-in answers were prolonged pain, effectiveness, and loss of TAD. A checklist of “mobility, infection, prolonged pain, effectiveness, and loss of TAD” is comprehensive and represents a
reasonable way to document a success/failure.

TAD utilization and surgical placement occurred in a majority of the orthodontic programs by 2005. This can be interpreted to mean that the majority of orthodontic graduates since then have had experience with TADs. It was interesting that a majority (85%) of the respondents felt that TADs are a standard of care in contemporary orthodontics. The current prevalence of TADs in programs, increased resident experience with TADs, and program directors’ enthusiasm for TADs should ensure more widespread use within private practice and more innovation to continue. It is possible that TAD placement and utilization will become included in the accreditation standards for orthodontic advanced specialty programs, similar to needing a case involving orthognathic surgery.

The ability of the TADs to help with complicated or previously difficult biomechanics is a reason for their popularity. Based on the use of TADs in residency programs, we anticipate that more orthodontists will place and utilize TADs and that TADs will become a standard part of the practitioner’s armamentarium. A survey conducted in 2007 by Journal of Clinical Orthodontics reported that while seventy-five percent of the respondents were not using TADs, a large majority indicated they will use them in the future. With more orthodontic clinicians deciding to incorporate TADs into their clinical practice, this survey provides use information of utilization trends in 2007-2008.
CONCLUSIONS

• Self-drilling TADs are more commonly used than non-self-drilling and mini-plates
• In most cases, orthodontic faculty/residents and orthodontic private practitioners who utilize TADs in their practice generally place their own TADs
• A majority of private practitioners and residency programs are willing to place TADs in non-keratinized gingiva as well as keratinized gingiva
• Topical anesthesia combined with local infiltration is the most common method of achieving anesthesia for TAD insertion
• 8-9 months is the average amount of time a TAD is utilized in the mouth before removal
• TADs are loaded immediately in most applications
• The most common use for TADs is anterior en masse retraction
• Approximately 10% of respondents from both groups were placing TADs in a patient taking oral bisphosphonates
• The majority of private practitioners use panoramic x-rays to treatment plan TADs, while residency programs utilize panoramic, peri-apical, and cone-beam CTs on a regular basis
• On average, 80% of full-time faculty treatment plan TADs while only 42.3% surgically place TADs
• A higher proportion of full-time faculty treatment plan and surgically place TADs compared to part-time faculty
• Only half of orthodontic residency programs maintain a TAD log to document experience and provide valid data
• TAD mobility and infection are the most common outcomes used to determine TAD success/failure
• 85% of residency program directors either “agree” or “strongly agree” that TADs are considered to be a standard of care in contemporary orthodontics
• The median year for TAD clinical utilization and surgical placement in the orthodontic clinic was 2005


4. Park HS, Jeong SH, Kwon OW. Factors affecting the clinical success of screw implants used as orthodontic anchorage. 2006;130:18-25.


Dear Doctor:

I am inviting and respectfully requesting you to participate in a research project to examine the utilization of Temporary Anchorage Devices (TADs) in graduate orthodontic residencies and in private practice. I am a graduate orthodontic resident working on my Master’s Thesis at the Ohio State University College of Dentistry. This project has approval of our Institutional Review Board. Your program/practice is only identified by a random number and confidentiality will be maintained.

This letter contains:
1. Informed consent form which requires your signature and takes approximately 2 minutes to complete. The signature page is flagged for your convenience.
2. Questionnaire, which would take approximately 15 minutes of your time (33 questions).
3. Stamped envelope for the signed informed consent and questionnaire.

Purpose of this study: To identify how TADs are currently used in an academic setting and in private practice. This knowledge will then be used to identify if there are trends and differences between the two groups. I hope to share my results by publishing them in the American Journal of Orthodontics and Dentofacial Orthopedics or another suitable referred journal.

Your participation is voluntary. Should you feel that another faculty member in your Department would be better able to complete this survey I would appreciate their input. I would be extremely grateful if you could kindly return the survey in no later than 3-4 weeks.

If you have any questions or concerns about completing the questionnaire or about being in this study, you may contact me at shirck.2@osu.edu.

Sincerely,

Dr. Jeff Shirck

**Thesis Advisory Committee:**
Dr. Sarandeep Huja (Advisor)
Dr. Katherine Vig
Dr. Allen Firestone
Dr. F. Michael Beck
APPENDIX B

CONSENT FORM
The Ohio State University Consent to Participate in Research

Survey of Temporary Anchorage Device Utilization in Graduate Orthodontic Residency Programs and Orthodontic Practices in the United States

Researcher: Dr. Jeff Shirck

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate.

Your participation is voluntary.

Please consider the information carefully. Feel free to ask questions before making your decision whether or not to participate. If you decide to participate, you will be asked to sign this form and will receive a copy of the form.

Purpose:
The purpose of this study is to identify how Temporary Anchorage Devices (TADs) are currently used in an academic setting and private practice. This knowledge will then be used to identify if there is a statistically significant difference between the two groups.

Procedures/Tasks:
Complete a written survey.

Duration:
15 Minutes

You may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you, and you will not lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.

Risks and Benefits:
A possible risk is disclosure of responses. A benefit is that it serves to help orthodontists and orthodontic residency programs compare their TAD usage and techniques.

Confidentiality:
Efforts will be made to keep your study-related information confidential. However, there may be circumstances where this information must be released. For example, personal
information regarding your participation in this study may be disclosed if required by state law. Also, your records may be reviewed by the following groups (as applicable to the research):

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices;
- The sponsor, if any, or agency (including the Food and Drug Administration for FDA-regulated research) supporting the study.

The participants’ responses will remain confidential because their responses will be recorded with a numerical ID that is unknown to the principal investigator. The participants will be given a three-digit ID that is randomly generated by a research assistant. The responses will be published in a format that will not indicate where individual responses came from. The data will be stored in the Ohio State Orthodontic Archival and Research facility (Postle Hall room 3054). This facility is locked and only limited access is available to authorized personnel. The surveys will be further placed in a locked cabinet within this facility. Only the PI and GTA will have access to the specific cabinet during the time course of the study, but only the research assistant will have access to the codes so that the PI and GTA are blinded.

**Incentives:**
There will be no financial incentives.

**Participant Rights:**
You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you are a employee at Ohio State, your decision will not affect your grades or employment status.

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

**Contacts and Questions:**
For questions, concerns, or complaints about the study you may contact Jeff Shirck at shirck.2@osu.edu.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-
800-678-6251.

If you are injured as a result of participating in this study or for questions about a study-related injury, you may contact Jeff Shirck at shirck.2@osu.edu.
Signing the consent form

I have read (or someone has read to me) this form and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study.

I am not giving up any legal rights by signing this form. I will be given a copy of this form.

<table>
<thead>
<tr>
<th>Printed name of subject</th>
<th>Signature of subject</th>
<th>AM/PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Date and time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Printed name of person authorized to consent for subject (when applicable)</th>
<th>Signature of person authorized to consent for subject (when applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AM/PM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relationship to the subject</th>
<th>Date and time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Investigator/Research Staff

I have explained the research to the participant or his/her representative before requesting the signature(s) above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

<table>
<thead>
<tr>
<th>Printed name of person obtaining consent</th>
<th>Signature of person obtaining consent</th>
<th>AM/PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Date and time</td>
</tr>
</tbody>
</table>
APPENDIX C

CLINICAL SURVEY QUESTIONS
Survey of Temporary Anchorage Device Utilization in Graduate Orthodontic Programs and Orthodontic Practices in the United States

**CLINICAL** (15 Questions)

1) What types of temporary anchorage devices (TADs) are used in your orthodontic program? (check all that apply)
   - □ Self-drilling
   - □ Self-tapping
   - □ Mini-plates
   - □ Other:_____________________
   - □ None of the above
   - □ Don’t know

2) Who surgically places the **MAJORITY** of TADs? (Check one box only)
   - □ Oral and Maxillofacial Surgeons
   - □ Periodontists
   - □ Orthodontists
   - □ Orthodontic residents
   - □ Other
   - □ Not sure

3) Do your orthodontic faculty/residents place TADs in non-keratinized tissue as well as keratinized tissue?
   - □ Yes
   - □ No

4) Please estimate the percentage of total orthodontic patients who receive TADs?
   _____________________________%

5) What method of anesthesia is used for the placement of the **MAJORITY** of the TADs? (Check one box only)
   - □ Topical anesthesia only (please indicate which formula:____________________)
   - □ Topical anesthesia and local infiltration
   - □ Local anesthesia
   - □ IV sedation
   - □ Other

6) How many months in duration (on average) are the **MAJORITY** of the temporary anchorage devices loaded before removal?
   ________________________________months
7) Sometimes the decision of who (orthodontist/periodontist/OMFS) will surgically place the TADs is site specific, who surgically places the **MAJORITY** of the TADs in these specific regions? (Check one box only for each area)
   I) Palate:
   - □ Oral Maxillo-Facial Surgeons
   - □ Periodontists
   - □ Orthodontists
   - □ Orthodontic residents
   II) Maxilla Buccal:
   - □ Oral Maxillo-Facial Surgeons
   - □ Periodontists
   - □ Orthodontists
   - □ Orthodontic residents
   III) Mandible Lingual:
   - □ Oral Maxillo-Facial Surgeons
   - □ Periodontists
   - □ Orthodontists
   - □ Orthodontic residents
   IV) Mandible Buccal:
   - □ Oral Maxillo-Facial Surgeons
   - □ Periodontists
   - □ Orthodontists
   - □ Orthodontic residents
   V) Infrazygomatic crest:
   - □ Oral Maxillo-Facial Surgeons
   - □ Periodontists
   - □ Orthodontists
   - □ Orthodontic residents
   VI) Retromolar pad:
   - □ Oral Maxillo-Facial Surgeons
   - □ Periodontists
   - □ Orthodontists
   - □ Orthodontic residents

8) What is the minimum patient age for placement of a TAD?
   Indicate minimum age:____________________________
   - □ There is no age minimum limit
9) Is there a recommended healing/waiting period before loading the TADs? If so, how early are the **MAJORITY** of the TADs loaded after surgical placement? (Check one box only)

- □ There is no recommended waiting period before loading the TADs due to instructor preferences and/or other factors
- □ TADs are loaded immediately
- □ TADs are loaded within 1-7 days post-insertion
- □ TADs are loaded 8-14 days post-insertion
- □ TADs are loaded 14-28 days post-insertion
- □ TADs are loaded more than 28 days post-insertion

10) Please check the box for **ALL** case types that your orthodontic clinic uses TADs:

Maxilla
- □ Posterior Distalization
- □ Anterior Retraction (en masse retraction)
- □ Posterior Mesialization
- □ Anterior Intrusion
- □ Posterior Intrusion

Mandible
- □ Posterior Distalization
- □ Anterior Retraction (en masse retraction)
- □ Posterior Mesialization
- □ Anterior Intrusion
- □ Posterior Intrusion
- □ Traction for impacted teeth
- □ Molar uprighting
- □ Abutment for composite build-up for temporization of missing Maxillary lateral incisors
- □ Other (please be specific: ____________________________)

□ **Considering the above applications, which is most frequent?**________________________

11) What sequellae have pediatric patients (<18 years old) experienced from TADs placed? (check all that apply)

- □ Prolonged pain (longer duration than 48 hours)
- □ Infection
- □ Non-compliance
- □ Self-destruction
- □ Other (_________________________)

53
12) Are you placing TADs in patients who are taking oral bisphosphonates (ex. Fosamax)?
   □ Yes
   □ No

13) Please indicate the overall percentage success rate for TADs:
   □ Not known
   Mini-screws (self-tapping): ___________________________
   Mini-screws (self-drilling): ___________________________
   Mini-plates: ___________________________

14) What type of radiographs are utilized when specifically treatment planning for TAD placement (not during the surgical placement of the TAD)? (check all that apply)
   □ Peri-Apical
   □ Cone Beam CT
   □ Panoramic
   □ Vertical Bitewing
   □ Combination (please indicate:_______________________)
   □ None

15) Please indicate at which time point radiographs are obtained during surgical placement of TADs (check all that apply):
   □ Pre-surgical placement
   □ Pre-surgical placement with radiopaque surgical guide
   □ During Surgical placement (implant partially inserted)
   □ Immediately post-surgical placement
   □ X-rays are not used during TAD surgical placement
APPENDIX D

DIDACTIC SURVEY QUESTIONS
DIDACTIC (18 Questions)

1) How many didactic courses are taught in your section (non-CE) that are TAD specific?
   Please indicate the number:_______________________________
   □ Not Known

2) How many didactic course hours are TAD specific?
   Please indicate the number:_______________________________
   □ Not Known

3) How many full-time faculty members are treatment planning TADs?
   Please indicate the number:_______________________________
   □ Not Known

4) What percentage of full-time faculty members are treatment planning TADs?
   Please indicate the percentage:_______________________________
   □ Not Known

5) How many part-time faculty members are treatment planning TADs?
   Please indicate the number:_______________________________
   □ Not Known

6) What percentage of part-time faculty members are treatment planning TADs?
   Please indicate the percentage:_______________________________
   □ Not Known

7) How many full-time faculty members are surgically placing TADs?
   Please indicate the number:_______________________________
   □ Not Known

8) What percentage of full-time faculty members are surgically placing TADs?
   Please indicate the percentage:_______________________________
   □ Not Known

9) How many part-time faculty members are surgically placing TADs?
   Please indicate the number:_______________________________
   □ Not Known

10) What percentage of part-time faculty members are surgically placing TADs?
    Please indicate the percentage:_______________________________
    □ Not Known
11) What is the minimum graduation requirement of the number of TAD surgical placement for each resident?
   Please indicate the number: ____________________________
   □ There is no requirement

12) How many TAD surgical placement procedures must be observed before a resident is allowed to surgically place a TAD independently?
   Please indicate the number: ____________________________
   □ There is no minimum

13) What percentage of your current research projects investigate TADs?
   Please indicate the percentage: ________________________
   □ Not Known

14) Does your orthodontic department maintain a separate log of all TAD placements?
   □ No
   □ Yes

15) What outcomes are used to document TAD success/failure? (Check all that apply)
   □ None
   □ TAD mobility
   □ Infection
   □ Other (____________________)

16) What year was a TAD first utilized for anchorage in your clinic (regardless of who surgically placed the TAD)?
   □ We have not used a TAD for anchorage
   Please indicate the year: ____________________________

17) What year was a TAD first surgically placed in your orthodontic clinic (by a faculty and/or orthodontic resident)?
   □ Our clinic does not surgically place TADs
   Please indicate the year: ____________________________

18) Do you consider TADs to be a standard of care in contemporary orthodontic practice?
   □ Strongly Agree
   □ Agree
   □ Neutral
   □ Disagree
   □ Strongly Disagree
APPENDIX E

DIDACTIC RESULTS
<table>
<thead>
<tr>
<th>Variable</th>
<th>Respondents</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of didactic TAD courses</td>
<td>39</td>
<td>1.1</td>
<td>1.2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Number of didactic TAD course hours</td>
<td>38</td>
<td>8.9</td>
<td>12.9</td>
<td>0</td>
<td>66</td>
</tr>
<tr>
<td>Number of Full-time faculty treatment planning TADs</td>
<td>43</td>
<td>3.1</td>
<td>1.6</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Percentage of Full-time faculty treatment planning TADs</td>
<td>41</td>
<td>80.7</td>
<td>25.5</td>
<td>18.5</td>
<td>100</td>
</tr>
<tr>
<td>Number of Part-time faculty treatment planning TADs</td>
<td>38</td>
<td>5.8</td>
<td>5.2</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Percentage of Part-time faculty treatment planning TADs</td>
<td>39</td>
<td>52.5</td>
<td>33.2</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Number of Full-time faculty surgically placing TADs</td>
<td>43</td>
<td>1.8</td>
<td>1.7</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Percentage of Full-time faculty surgically placing TADs</td>
<td>43</td>
<td>42.5</td>
<td>36.1</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Number of Part-time faculty surgically placing TADs</td>
<td>34</td>
<td>2.9</td>
<td>3.9</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Percentage of Part-time faculty surgically placing TADs</td>
<td>34</td>
<td>26.6</td>
<td>30.9</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Minimum TAD Placement Graduation Requirement</td>
<td>4</td>
<td>5.5</td>
<td>3.7</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Min TAD procedure observation before resident placement</td>
<td>11</td>
<td>2.2</td>
<td>1.8</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Percentage of current research projects involve TADs</td>
<td>37</td>
<td>10.7</td>
<td>12.3</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Orthodontic Dept have a log of TAD placement</td>
<td>Yes: 21</td>
<td>No: 21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which outcomes used to document TAD success/failure</td>
<td>None: 4 out of 43</td>
<td>TAD mobility: 36 out of 43</td>
<td>Infection: 25 out of 43</td>
<td>Other: 11 out of 43</td>
<td></td>
</tr>
<tr>
<td>TADs are standard of care in contemporary orthodontics</td>
<td>Strongly Agree: 41.86%</td>
<td>Agree: 44.19%</td>
<td>Neutral: 9.30%</td>
<td>Disagree: 4.65%</td>
<td>Strongly Disagree: 0.00%</td>
</tr>
</tbody>
</table>