The effect of piezoelectric and magnetostrictive scaling devices on treatment outcomes

Thesis

Presented in Partial Fulfillment of the Requirements for the Degree Master in Dental Hygiene in the Graduate School of The Ohio State University

By

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Abstract

There are two types of ultrasonic devices used by dental hygienists; magnetostrictive (M) and piezoelectric (P). Research supports using these devices during prophylaxes/periodontal debridement but there is little evidence determining which is superior. The purpose of this study was to determine if any differences between the magnetostrictive and piezoelectric scaling devices existed in calculus removal, patient preference and practitioner preference. Subjects included senior dental hygiene students and patients of The Ohio State University College of Dentistry.

This double-blinded study employed a quantitative experimental randomized split mouth design on contra-lateral quadrants for the evaluation of calculus removed by each device. Five calibrated examiners recorded the presence of calculus on the quadrants assigned prior to and post treatment. Upon completion of each device, patients completed a visual analog scale (VAS) to gauge patient preference and each student completed a five point Likert survey to measure practitioner preference. Twenty-three subjects completed the study. Data reveals the M device removed more calculus than the P device (70.5% vs 66.1% respectively).

Results from the student survey reveal the M device was significantly more user friendly than the P device. Device M scored an average total likert score of 21.0
vs. 18.7 for device P. Results from the patient VAS reveal M is preferred for discomfort, vibration and noise factors. This data provides strong evidence that device M is preferred for this group of hygiene students. However, all other differences in the data were not significant. This significant difference in student practitioner preference is likely due to a major limitation of the previous experience imbalance between the two devices. This reveals a need for required experiences with both ultrasonic devices throughout the dental hygiene students’ clinical education.
Acknowledgements

I would like to extend the utmost gratitude to Michele Carr for serving as my advisor, believing in me, providing me with countless opportunities, and encouraging me over the last 5 years. I must acknowledge a mentor of mine, Rachel Henry, for imparting priceless wisdom, being a constant role model, and for serving as an investigator and advising committee member for this project. Master’s program director Wendy Moore, and my internship supervisor Denise Kissell deserve acknowledgement for helping to shape this research and making this project possible by contributing as investigators in this study. Lastly, I acknowledge my family for holding me up from day 1, supporting my dreams through graduate school, and providing a roof over my head for the same duration.
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PUBLICATIONS


FIELDS OF STUDY

Major Field: Dental Hygiene
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Chapter 1: Introduction

Currently, there are two types of ultrasonic modalities available to the dental hygienist, including the magnetostrictive (M) and piezoelectric (P) devices. Studies have not yet confirmed the most effective or preferred mechanism.

Significance of problem

Ultrasonic scaling devices have become a staple in today’s treatment of periodontal disease behind solid evidence. Research supports the use of these devices in periodontal debridement but there is little evidence to support the selection of one unit type over the other. Focusing on calculus removal and patient preference are significant indicators of which device is of higher quality. The purpose of this study was to determine if any differences between the magnetostrictive and piezoelectric scaling devices existed in calculus removal, patient preference and practitioner preference.

Research questions

1. Is there a difference in the amount of calculus removed by the piezoelectric and magnetostrictive scaling devices?
2. Is there a practitioner or patient preference between the piezoelectric and magnetostrictive scaling devices?

Operational Definitions

Magnetostrictive - An instrument that uses a pulsing magnetic field applied to a metal stack that flexes to move tip in an elliptical pattern.¹

Piezoelectric - An instrument that uses pulsing voltage applied to ceramic crystals that fly and move the tip in a reciprocating pattern.¹

Ultrasonic - Pertaining to sound frequencies so high (greater than 20 kilohertz) they cannot be perceived by the human ear.¹

Debridement - The removal of foreign material and/or devitalized tissue from the vicinity of a wound.¹

Visual Analog Scale - A simple assessment tool consisting of a 10 cm line with 0 on one end, representing no pain, and 10 on the other, representing the worst pain ever experienced, which a patient marks to indicate the severity of his or her pain.¹
Chapter 2: Review of the Literature

Periodontal disease is rampant among adults in the United States. Over 80% of adults suffering from this disease there is a heavy focus on stopping and preventing periodontitis.\textsuperscript{2,3} Periodontitis can lead to halitosis, root sensitivity, attachment loss, bone loss, loss of teeth, and systemic complications.\textsuperscript{2} Calculus irritates the periodontal tissues and harbors biofilm thus leading to further destruction of the periodontium.\textsuperscript{2,4} A crucial step to stopping the progression and preventing the disease is removing calculus.\textsuperscript{2-9}

Periodontal Debridement

The removal of biofilm and calculus is absolutely essential in the treatment of periodontal disease.\textsuperscript{2,4-6,10-13} The level of success and healing correlates to the amount of deposit and biofilm effectively detached.\textsuperscript{2} Periodontitis is caused by bacterial infection, so the removal of this key factor is a significant step in treatment.\textsuperscript{2,4} Endotoxins have been found to be harmful and contribute to periodontal disease and should be removed as well.\textsuperscript{2,8,13,15} All of these substances must be targeted in periodontal debridement with the goal of taking away minimal tooth structure. Cementum and dentin on root surfaces must be optimally conserved to promote maximum reattachment and healing.
Periodontal Debridement Modalities

There are several different ways to remove calculus and biofilm. Hand scalers, sonic scaling devices, and ultrasonic scaling devices are among the most common instruments used to remove calculus. Initially in dentistry hand scaling was exclusively used until an increasing amount of evidence revealed that ultrasonics were effective at removing calculus.\textsuperscript{2, 4} Consistent trends across studies show that ultrasonic scalers are just as effective at removing deposits as hand instruments.\textsuperscript{2, 4, 6-8} In addition, studies show ultrasonics take significantly less time to detach calculus from root surfaces and leave the treated root surfaces smoother to promote optimal healing and reattachment.\textsuperscript{2, 4-6, 10-13} The magnetostrictive and piezoelectric ultrasonic scaling devices are the two main types of ultrasonic units being utilized in machine-driven debridement today.

Mechanisms of Ultrasonic Technology

Ultrasonic units’ mechanism of removing calculus is by way of high frequency vibrations that breakdown the deposit.\textsuperscript{2-10} The high level of vibrating energy is created in an oscillation generator.\textsuperscript{4, 10} This energy is conducted from the generator to the tip which results in vibrations with frequencies of 25,000-50,000 Hz.\textsuperscript{5, 10, 12} A stream of water flows from the handle onto the tip to cool the metal of the ultrasonic scalers, especially the magnetostrictive device. This lavage presents a benefit called cavitation in which the loose biofilm and bacteria are destroyed by
tiny bubbles bursting and tearing bacterial cell walls before washing it away. Another benefit produced by the water is called acoustic micro streaming where waves of water flow from the tip and disrupt the plaque biofilms. The vibration of the tip causes this flow and movement of the water. Acoustic turbulence also disrupts plaque biofilm as a result of a swirling motion created by the quick movements of the tip. The high frequency vibrations were originally used to take away and shape enamel. It was not until the 1950s that this technology was used for debridement.

Magnetostrictive Mechanisms

The two types of ultrasonic scalers are piezoelectric and magnetostrictive. Both of the devices use vibrations to remove calculus, but differ in their method of generating the vibrations. The magnetostrictive type vibrates by sending magnetic pulses through a metal stack, which moves the tip to attack debris. The metal stack is attached to the tip and inserts into the hand piece. The metal stack contains an iron-based magnetic rod and the hand piece contains a copper wire that becomes magnetic when electrically charged. When the foot pedal is pressed the electrical current is sent through the hand piece and a phenomenon of magnetizing and demagnetizing causes the stack to contract and expand back to its original shape. This process results in a 360-degree motion, which makes all surfaces of the tip active and capable of effectively scaling calculus. Heat is produced on the tip
and within the hand piece of this instrument and a lavage of water is present to cool the active metal. 4

Piezoelectric Mechanisms

The piezoelectric unit tip vibrates by pulses of electricity colliding with ceramic crystals. 3, 19-21 The crystals are inside a transducer within the hand piece of the unit. 3 When the foot pedal is pressed an electrical current is sent up through the transducer and converted to mechanical energy. 3 This mechanical energy creates a linear, back and forth motion of the tip. 3, 4, 10 This motion makes the two lateral sides active therefore the most effective scaling is done with these two surfaces of the tip. 3, 4

Ultrasonics vs. Hand Scalers

Hand scalers were the gold standard when it came to removing biofilm and calculus. More than fifty years ago ultrasonics started to be used for periodontal debridement. 3, 4, 10, 12 Studies have shown that ultrasonic scalers are equally effective at removing calculus as hand scalers with a few distinct advantages. 4 According to Wamsley et al ultrasonics require less technical skill than hand instruments. 10 Oda et al found they inflict less fatigue than the traditional hand instruments and Schmidlin et al determined they have been found to take away less tooth structure than hand instruments. 11, 12 Singh et al concluded hand scalers also take longer to remove deposits than an ultrasonic scaler. 15 In a review of sonic and ultrasonic
technologies. Arabaci et al determined the effects of the water being sprayed to cool the tip of the ultrasonic scaler produces an added benefit as cavitation kills and flushes away bacteria. Several studies investigated patients’ perception of pain and concluded that ultrasonic scalers cause less pain to patients. An additional benefit of ultrasonic tips is that they do not require sharpening like the hand instruments. Ultrasonics have become a reliable tool in biofilm and calculus removal. The advantages are clear and treatment with ultrasonic technologies has become the standard of care in nonsurgical periodontal therapy.

**Piezoelectric vs. Magnetostrictive**

Previous research has a lack of consistency when comparing magnetostrictive and piezoelectric technology, however some trends are starting to emerge. There has been no significant difference found in the calculus removal or root surface roughness between the two instrument types. Busslinger et al found that the piezoelectric was more efficient in removing calculus than the magnetostrictive, but this study was performed on extracted teeth. The same study found that magnetostrictive scalers left a smoother root surface than piezoelectric scalers. On the contrary, Yousefimanesh et al found the piezoelectric unit left a smoother root surface than the magnetostrictive when applying identical lateral forces.
A patient preference for the piezoelectric ultrasonic was found in a study by Muhney et al.\textsuperscript{20} This study evaluated preference by gauging perception of vibration, noise, and sensitivity for each of the device types.\textsuperscript{20}

**Rationale**

The purpose of this study was to determine if any differences between the magnetostrictive and piezoelectric scaling devices existed in calculus removal, patient preference and practitioner preference. There is room for more investigation of devices M and P to add to the body of evidence available when making a selection between them.
Chapter 3: Materials and Methods

Introduction

This experimental study aimed to investigate the presence of any difference in the calculus removal outcomes, patient preference and operator preference between the piezoelectric and magnetostrictive ultrasonic devices. The experiment was performed with human subjects. The Institutional Review Board at The Ohio State University approved the protocol. The subjects were patients and dental hygiene students at The Ohio State University College of Dentistry. Student practitioners scaled one quadrant with each type of device. Calculus removal was evaluated to gauge effectiveness and a survey was administered to the students and patients to determine preference.

Sample

The sample for this study included 17 senior dental hygiene students. This provided a total of 23 patient subjects. Senior dental hygiene students were used to minimize the difference in skill level in calculus removal. The convenience sample of patient subjects included new or existing patients of The Ohio State University College of Dentistry presenting for treatment exhibiting a moderate level of calculus, in contralateral quadrants and chose to voluntarily participate in the study. The quadrant being debrided must have had at least five teeth present and at least
three spots of readily detectable calculus. Any patient with a contraindication to ultrasonic use, patients with a pacemaker, patients that were pregnant, and patients that required local anesthetic or any type of pain control were excluded from this study. A consent form and oral explanation was presented to each patient prior to experimentation. The convenience sample of 17 senior dental hygiene students also completed a consent form, participated on a volunteer basis, and their grade was not affected by participation or lack of participation in the study. A main purpose of hygiene treatment is the removal of calculus and student participation kept progress towards that goal with minimal interference, while they gained experience with both types of ultrasonic devices.

**Research Design**

This study employed a quantitative experimental randomized split mouth design with a pre/post evaluation on contra-lateral quadrants for the evaluation of calculus removed by each of the ultrasonic devices. Brand new piezoelectric devices were used in this study. Students were trained in the use of device P and had to pass a skill evaluation. The skill evaluation form was identical to the one students have previously passed for device M in their clinical education. Investigators were calibrated for calculus detection twice. First before data collection began and again half way through the study. Students spent 15 minutes in each quadrant with M in one and 15 minutes with P in the other. The
magnetostrictive scaling device used in this study was the Cavitron® SPSTM Scaler G98A by Dentsply International® and the piezoelectric scaler was the Biosonic Suvi® by Coltene Whaledent®. The order of the device usage and the quadrant assigned was randomized. The tips used for each device were universal tips with similar length and width, set to medium power. Device M used the 30K Focused Spray Powerline Insert (USA-10)(Dentsply International, York, PA) and device P used the PE 38 tip (Coltene Whaledent Cuyahoga Falls, OH). Investigators were blinded to the device used in each quadrant of the selected and scaled arch. Immediately after each device was used, patients completed a visual analog scale to gauge their preference. Following the use of each unit type, a survey questionnaire to measure practitioner preference was administered to students. This survey utilized the Likert scale and open comments to gather qualitative data concerning the preference of each device.

Data Collection

Data was collected in the spring semester and autumn semester of 2014 in the The Ohio State University College of Dentistry student clinics. There were three main groups of data collected. Areas of readily detectable calculus before and after the scaling, patient completion of three visual analog scales, and student answers on the Likert scale to survey questions. Likert scale questions were given a value of one to five from not user friendly to very user friendly. Visual analog results were
recorded in millimeters ranging from 0-100. A 100mn visual analog scale to gauge pain and discomfort has been validated in previous studies.\textsuperscript{21} Millimeters and patient preference shared an inverse relationship. A lower millimeter mark indicates a more preferable device type, a higher millimeter mark indicates lower preference for the device type. Calculus removal was entered as a percentage removed. The first set of calculus data was retrieved after the patient signed consent and the second set of calculus data was collected at the conclusion of instrumentation with both ultrasonic devices. Investigators used the ODU 11/12 explorer for the detection of calculus. Patient and practitioner survey data was obtained immediately following the use of each individual instrument. Data was entered and coded anonymously. Non-parametric two tailed Wilcoxon signed rank tests were run on all three sets of data to determine if there were any significant differences between devices M and P. This non-parametric test was used due to the uneven distribution of data.
Chapter 4: Results

The purpose of this study was to determine if any differences between the magnetostrictive and piezoelectric scaling devices existed in calculus removal, patient preference and practitioner preference. Data was collected from 17 student subjects and 23 total patient subjects. This indicates that some student subjects saw multiple patient subjects.

Calculus Removal

In the removal of calculus, device M removed an average of 70.5% and device P removed an average of 66.1%. While device M removed slightly more calculus on average with this group of subjects, there was no statistically significant difference between the two devices (p=0.525). (table D.1)

Patient Preference

In testing for patient preference, subjects indicated more discomfort in all three categories for device P. For discomfort subjects marked an average of 20.3mm for device M and 24.7mm for device P. For noise subjects the average marking was 18.8mm for device M and 28.7mm for device P. Subjects marked mm on average of 13.2mm for device M and 19.0mm for device P for vibration. This
indicates that patients may prefer device M. However, p-values indicate that these differences are not significant. (table D.2)

Practitioner Preference

The data for practitioner preference yielded the most significant results. Device M received a higher average Likert scale score on all five survey questions. Device M received an total average score of 21.043 while device P received 18.739. This supports that device M is perceived as more user friendly than device P. The p-value of 0.0053 indicates a significant difference between the devices regarding practitioner preference. (table D.3)
Chapter 5: Discussion

The results of this study show no significant difference between the devices in calculus removal and patient preference. A significant difference was found in practitioner preference, as the student practitioners preferred the magnetostrictive to the piezoelectric ultrasonic scaler.

This study yielded a similar result to Silva et al’s study on calculus removal. Both studies determined there was no significant difference between the two devices in the removal of calculus. Silva et al allowed practitioners 20 minutes in each quadrant compared to 15 minutes in this study and patients were required to have six surfaces of calculus in each quadrant compared to three surfaces in this study. Additionally, Silva et al rated each surface of calculus 0-3 according to severity while this study used only 0 for absent or 1 for present. Buslinger et al yielded a different result as they determined that the piezoelectric was more effective at scaling calculus. However, this study was done on extracted teeth using mechanized scaling.

Mulney et al also evaluated patients’ perception with devices M and P. On 75 patient subjects Mulney et al determined that pain and vibration were significantly higher with device M, while this study found no significant differences among the 23 patient subjects regarding patient preference. This study used two quadrants, while Mulney et al used all four quadrants.
Limitations

The students’ previous level of experience with the two device types likely biases the results for practitioner preference in this study. Prior to the study, this sample of student practitioners only had experience with device M. The training session and competency exercise on the typodont mouth was their only experience with device P. When comparing the two or more semesters with numerous uses with device M to the single experience with device P, this limitation must be strongly considered when evaluating the data.

This same limitation could have had an effect on the remaining two sets of data. Although no statistically significant differences were found in calculus removal and patient preference, the lack of experience with device P could lead to less calculus removed and negative patient perception. In addition, it is likely there are varying levels of calculus removal skills between students practitioners in their senior year.

Having five investigators collecting data presents a limitation. Even with two exercises in calculus detection calibration, perfect continuity and consistency is never guaranteed. Additionally, each investigator did not see an equal number of subjects for data collection due the nature of the convenience sample. For example, one investigator saw 14 subjects compared to one subject seen by another investigator during this study.
The sample size seen in this study poses another limitation. Having only 23 subjects made for difficulty in obtaining sufficient data for statistically significant results. Among these 23 patients it was assumed that anxiety was not a factor when they completed the visual analog scale and that they had no previous knowledge of the device type being used on them. Since a convenience sample was used there could have been a lack of diversity among the patient subjects. Demographic data should be collected to evaluate diversity in future studies. Furthermore, there were 17 student subjects treating 23 patient subjects. This indicates that some students saw more patient subjects than others, thus skewing results to their preference and skills. There was one student that saw three patient subjects.

Recommendations

The major limitation of students having previous experience with device M likely had a significant effect on the results. This reveals a need for required experiences with both ultrasonic devices throughout the dental hygiene students’ clinical education. Dental hygienists will be better prepared to use either device and form unbiased opinions of each as they could use either as a working practitioner. Multiple previous experiences with both devices will yield more unbiased results for all three aspects of this study. Future research should be done to determine if schools require experiences with both device types in the clinical education of students.
The large number of investigators was necessary to cover the many clinic sessions during the week in this dental hygiene program to attempt to enlist a maximum number of subjects. Using fewer investigators and establishing an interrater reliability quotient in future studies will serve to provide more calibrated results in calculus removal data set.

With no statistical differences in calculus removal effectiveness and patient preferences there is no distinct difference between device M and P. When choosing between the two device types the buyer should continue considering factors such as financial value, reputation, additional features, and personal preference of the practitioner that will be using the device most frequently. There is an opportunity for research to determine which device types are currently being used by practitioners and motivating factors for device selection.

Future studies should aim to see more subjects. Holding the main data collection period in the fall semester when students are not yet seeking a patient for the clinical regional board examination and focused on finishing remaining graduation requirements can allow for more opportunities to successfully recruit subjects.

Future studies should consider separating the three purposes of this study. One study should evaluate patient preference only and another should evaluate practitioner preference and calculus removal. The study investigating calculus removal and practitioner preference can remove the exclusion criteria of the patient
subject using any form of pain control and will yield many more subjects while meeting the calculus inclusion requirement. Testing patient preference in a separate study can draw more subjects by removing the calculus inclusion criteria and focusing solely on the visual analog scale. By separating the purposes of this study into two separate studies many patient subjects can be enrolled in one study or the other when they present for hygiene treatment or periodontal therapy.

Conclusion

The results of this study show that there is no significant difference in calculus removal and patient preference between the magnetostrictive and piezoelectric devices. While a significant difference in practitioner preference exists in favor of the magnetostrictive device, the lack of previous experience with the piezoelectric must be taken into account. Dental hygiene programs should consider equal clinical experiences with both devices in the education of their students. It is important for students to be competent and knowledgeable in the use of both technologies. Future studies should continue to investigate differences in the outcomes of the two ultrasonic device types.
References


19. Yousefimanesh, H.; Robati, M.; Kadkhodazadeh, M.; Molla, R. A comparison of magnetostrictive and piezoelectric ultrasonic scaling devices:


Appendix A – Operator Questionnaire

Operator Questionnaire

Circle your answers:

1. This ultrasonic device was easy to use.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

2. It was effective in removing calculus.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

3. This unit decreases the time needed to treat my patient.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

4. This unit was not user friendly.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

5. Calculus was difficult to remove with this ultrasonic device.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

6. Please leave comments about the ultrasonic device below:

   [Blank space for comments]

Circle your answers:

Type of device: M or P
1. This ultrasonic device was easy to use.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

2. It was effective in removing calculus.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

3. This unit decreases the time needed to treat my patient.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

4. This unit was not user friendly.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

5. Calculus was difficult to remove with this ultrasonic device.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

6. Please leave comments about the ultrasonic device below:

   Type of device: M or P
## Appendix B – Patient Visual Analog Scale

### Patient Survey

**Patient ID__________________**
**Date:___________________**

<table>
<thead>
<tr>
<th>No Discomfort</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discomfort</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimal Vibration</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimal Noise</th>
<th>Excessive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise</td>
<td></td>
</tr>
</tbody>
</table>

**Type of device: M or P**
No Discomfort | Severe Discomfort

Minimal Vibration | Severe Vibration

Minimal Noise | Excessive Noise

Type of device: M or P
Appendix C – Examiner pre/post test calculus detection form

Examiner Calculus Detection Form

Pt. ID # ___________________________ Date ____________________

Quad P ☐ Quad M ☐

Before Ultrasonic Scaling

After Ultrasonic Scaling

Examiner initials:
Appendix D – Tables

<table>
<thead>
<tr>
<th>Device</th>
<th>Avg. % removed</th>
<th>Standard Dev.</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piezoelectric</td>
<td>66.087</td>
<td>±23.631</td>
<td>0.525</td>
</tr>
<tr>
<td>Magnetostrictive</td>
<td>70.522</td>
<td>±17.375</td>
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</tr>
</tbody>
</table>

Table D.1: Mean Calculus Removal
<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discomfort</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezoelectric</td>
<td>24.696</td>
<td>±19.291</td>
<td>0.675</td>
</tr>
<tr>
<td>Magnetostrictive</td>
<td>20.348</td>
<td>±18.386</td>
<td></td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezoelectric</td>
<td>28.706</td>
<td>±19.526</td>
<td>0.4110</td>
</tr>
<tr>
<td>Magnetostrictive</td>
<td>18.765</td>
<td>±16.730</td>
<td></td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piezoelectric</td>
<td>19.043</td>
<td>±19.512</td>
<td>0.3332</td>
</tr>
<tr>
<td>Magnetostrictive</td>
<td>13.217</td>
<td>±14.882</td>
<td></td>
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</tbody>
</table>

Table D.2: Mean Patient VAS
<table>
<thead>
<tr>
<th>Question</th>
<th>Piezoelectric</th>
<th>Magnetostrictive</th>
</tr>
</thead>
<tbody>
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<td>Question 1</td>
<td>3.652</td>
<td>4.478</td>
</tr>
<tr>
<td>Question 2</td>
<td>4.043</td>
<td>4.304</td>
</tr>
<tr>
<td>Question 3</td>
<td>3.783</td>
<td>3.826</td>
</tr>
<tr>
<td>Question 4</td>
<td>3.435</td>
<td>4.522</td>
</tr>
<tr>
<td>Question 5</td>
<td>3.826</td>
<td>3.913</td>
</tr>
<tr>
<td>Total</td>
<td>18.739</td>
<td>21.043</td>
</tr>
<tr>
<td>P-Value</td>
<td></td>
<td>0.0053*</td>
</tr>
</tbody>
</table>

Table D.3: Mean Student Practitioner Survey Response