Local Anesthetic Syringe Ergonomics and Student Preferences


Abstract: With a diverse population of dentists, dental hygienists, and dental assistants, there is a wide range of sizes and shapes of individuals. Ergonomic considerations have resulted in the design of many adjustable delivery systems, chairs, and pieces of equipment. Companies have marketed instrumentation specifically for people with small hands, yet little research has been done regarding the advertising claims. The objective of this study was to compare the perceptions of dental and dental hygiene students after they used a conventional syringe and a petite syringe that has been marketed as advantageous for individuals with smaller hands. The two syringes were compared for aspiration, injection, and sense of control. A total of 181 students were invited to serve as subjects in the study, and ninety participated. The study involved two phases. During phase I, students used conventional and petite syringes to give a simulated inferior alveolar nerve block injection. In phase II, students gave a simulated palatal injection using both sizes of syringes. After performing the simulations, the students responded to a questionnaire. The students reported that the petite syringe gave them control, and 62.2 percent of them preferred it to the conventional syringe. There were differences in preferences between female and male students and also differences in preferences based on students’ glove sizes. The female students preferred the petite syringe when aspiration was required. Overall, the students who wore small and extra small gloves had a preference for the petite syringe and felt it provided a sense of control, a key component when learning to provide injections.

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Using ergonomics and developing proper posture in performing dentistry and dental hygiene are important skills that are taught to dental and dental hygiene students to develop good health, safety, and efficiency. The evolution of sit-down dentistry addressed some of the concerns with posture, such as strain on muscles in the legs, back, and neck. Four-handed dentistry further improved ergonomics. The visual field improved, and work could be more efficient and generally more productive. Ergonomic chairs with adjustable heights, seat pans that do not compromise circulation, and quality back supports helped work-related health and safety issues. In 1992, dentists and dental manufacturers believed that the U.S. Occupational Safety and Health Administration (OSHA) was preparing to have all employers evaluate the risk of ergonomic problems for employees.1 Although OSHA made the requirements for other industries, dentistry was not specifically included. Nevertheless, many design changes in dental products occurred in anticipation that the ruling would universally apply.

It has been hypothesized that dentists and dental hygienists have heightened risks for wrist deviations and overextension due to repetitive movements. However, Bramson et al. reported electromylogram task data that indicated, in all but two instances, that the forces generated in dental tasks were below risk levels of the determined maximum voluntary contraction that could cause injury; and the wrist posture deviations were within normal limits for the daily, routine tasks of dental hygienists.1 Despite this, cumulative trauma disorders related to ergonomics in the dental setting remain a concern. Studying cumulative trauma disorders is very difficult. Attempts to assess the prevalence have resulted in reports that range
from as low as 1 percent to as high as 54 percent. In 1997, the American Dental Association (ADA) conducted a survey in which 9.2 percent of dentists responded that they were diagnosed with a repetitive motion disorder. However, Hamann et al. showed abnormal sensory nerve conduction and/or symptoms of carpal tunnel syndrome through electrodiagnostic and self-report to be 2.9 percent to 4.8 percent depending upon the electrodiagnostic criteria. Carpal tunnel syndrome, white finger syndrome, trigger finger, and other body pain may be related to many factors, including inappropriate instrumentation size. Paroxysmal circulatory disturbances resulting in numbness and tingling have been reported with vibrations at frequencies below 30 Hz in which actual changes occur in the neural, osteoarticular, and vascular systems. The neural, osteoarticular, and vascular changes are subtle and cumulative.

The curriculum in dental schools and dental hygiene programs stresses posture, patient positioning, and proper hand positioning as well as the use of properly sized gloves. Proper body mechanics are essential to overall health. Rising et al. found that 46 to 71 percent of students suffer musculoskeletal pain while in dental school. Inappropriately sized instrumentation may impact hand health as well. As the population of dentists becomes more diverse in physical size and dental hygienists’ duties expand, instruments may need to be redesigned to accommodate various needs. The number of female dentists has steadily increased from 2.6 percent of active private practitioners in 1982 to 12.8 percent in 1997. The ADA Survey Center reported a 2004–05 female dental student enrollment of 43.8 percent. Many manufacturers advertise ergonomic equipment and instrumentation with anecdotal marketing reports that the equipment is better than the conventional items. A literature search revealed no peer-reviewed comparisons of petite dental syringes and conventional syringes.

The underlying hypothesis for this study is that accommodations to meet specific physical needs of a diverse student population and an increasingly diverse community of practitioners may improve learning and delivery of health care. The objective was to compare the preferences of dental and dental hygiene students after they used a conventional syringe and a petite syringe that has been marketed as advantageous for dental practitioners with small hands. The research is particularly important because students in dentistry and dental hygiene need to learn to administer local anesthetics as one of their fundamental skills. Proper position of the needle and adequate aspiration, to avoid injecting into a blood vessel, are critical components.

Subjects and Methods

The second-, third-, and fourth-year dental students (n=131) and the junior and senior dental hygiene students (n=50) attending West Virginia University were mailed letters inviting them to participate in the Institutional Review Board-approved activities. The questionnaire (see Figure 1) was included in this mailing. No incentive or reward was involved.

The study consisted of two phases. During phase I, volunteer student subjects performed a simulated inferior alveolar nerve block injection using a conventional syringe and a petite syringe. Students were then asked to provide their assessment of the ease of aspiration and injection while using each syringe. Students’ responses were recorded on a survey we developed using a five-point Likert-type scale in which 1=undecided, 2=completely disagree, 3=disagree, 4=agree, and 5=completely agree. Additional questions were posed concerning gender, age, glove size, student status, and syringe preference.

Many schools use an orange to simulate injecting into soft tissues when students are learning to perform injections. Accordingly, an orange was used as the simulation medium for the inferior alveolar nerve block injection. During phase II of the study, students used both syringes to perform a simulated palatal injection without aspiration and then provided their assessment of each instrument on the questionnaire. Because of its density and rigidity, an apple was selected as the simulation medium for the palatal injection.

There were four experiment stations. At each station, there were a conventional syringe (Cook-Waite) preloaded with a carpule of lidocaine with 1:100,000 epinephrine and a 27 gauge long needle; a petite syringe (Septodont Petite) preloaded with a carpule of lidocaine with 1:100,000 epinephrine and a 27 gauge long needle; an apple secured in a plastic cup; an orange secured in a plastic cup; and boxes of different sizes of gloves.

At two of the stations, the researchers labeled the conventional syringes “A” and the petite syringes “B.” At the other two stations, the researchers labeled the conventional syringes “B” and the petite syringes “A.” Four subjects entered the area and chose one of the four stations, and the experiment proceeded,
untimed. The students gloved with their usual size of glove.

During phase I, the students were instructed to simulate the inferior alveolar nerve block injection. They followed written instructions and began with the syringe labeled “A,” inserted the needle to the depth of the hub into the orange, aspirated, and injected one-third of the local anesthetic from the carpule into the orange. They removed and appropriately recapped the needle, then responded to questions about the injection. They then used the syringe labeled “B” and followed the same procedure.

During phase II, the students were instructed to simulate a palatal injection. They followed written instructions and replaced the spent local anesthetic carpules in both syringes with new carpules of lidocaine with 1:100,000 epinephrine, then began the injection with the syringe labeled “A,” inserted the needle into the apple at a depth of 2–3 mm, and injected one-fourth of the anesthetic from the carpule into the apple.
They removed and appropriately recapped the needle, then responded to questions about the injection. They then used the syringe labeled “B” and followed the same procedure. When the students had completed both phases, they finished the questionnaire.

Results

Of the 181 students (131 dental students and fifty dental hygiene students) invited to participate, 49.7 percent (90 students) responded. There were 51 percent (forty-six) females and 49 percent (forty-four) males. Dental students comprised 88.9 percent (eighty) of the participants, and dental hygiene students comprised 11.1 percent (ten). The reason for low dental hygiene student participation was not determined. Due to the low dental hygiene student participation level, the data were collapsed into gender and glove size categories. Dental hygiene student preferences were not specifically evaluated. Data were analyzed using the statistical computer package JMP (SAS Institute, Cary, NC). Overall responses, male/female responses, and responses based on glove size were analyzed. Results are displayed in Tables 1 and 2.

We used the Mann-Whitney rank test for nonparametric data and a neutral response (2.5) as the null hypothesis mean in the statistical analysis. Overall, the students agreed/completely agreed when asked specifically if they felt comfortable and in control using the conventional syringe. (The mean was a significantly positive 4.37—significantly larger than 2.5 with p<.0001.) The students also agreed/completely agreed that they felt comfortable and in control using the petite syringe with the same hypothesis being tested. (The mean was a significantly positive 4.32—significantly larger than 2.5 with p<.0001.) Both syringes performed well in providing a sense of control. Overall, though, there were 62.2 percent (p<0.05) who preferred the petite syringe to the conventional syringe.

The Mann-Whitney rank test with a null hypothesis mean of 2.5 was also used to evaluate phase I, in which the simulated inferior alveolar nerve block injection was performed. The overall data showed that students agreed/completely agreed (mean 3.91; p<0.001) that the conventional syringe could be used to easily perform the simulated palatal injection. Students also agreed/completely agreed (mean 3.93; p<0.001) that the petite syringe could be used to easily perform the simulated palatal injection.

Table 1. Mean ratings of syringe use acceptability

<table>
<thead>
<tr>
<th></th>
<th>Petite Syringe</th>
<th>Standard Syringe</th>
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<tbody>
<tr>
<td>Sense of control</td>
<td>4.32</td>
<td>4.37</td>
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<tr>
<td>Ease of simulated inferior alveolar block injection</td>
<td>4.51</td>
<td>4.48</td>
</tr>
<tr>
<td>Ease of simulated palatal injection</td>
<td>3.93</td>
<td>3.91</td>
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<tr>
<td>Ease of aspiration (all subjects)</td>
<td>4.29</td>
<td>3.97</td>
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<tr>
<td>Ease of aspiration (females)</td>
<td>4.30</td>
<td>3.76</td>
</tr>
<tr>
<td>Ease of aspiration (males)</td>
<td>4.27</td>
<td>4.18</td>
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</tbody>
</table>

Note: Item responses (strongly disagree=1; strongly agree=5) were on a five-point Likert scale. Items were summed and averaged for scale means (range 1 to 5). For all ratings, significant agreement over the neutral response with p<0.0001.

Table 2. Syringe preferences (in percentages)

<table>
<thead>
<tr>
<th></th>
<th>Petite Syringe</th>
<th>Standard Syringe</th>
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<tbody>
<tr>
<td>Overall preference</td>
<td>62.20</td>
<td>37.80</td>
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<tr>
<td>Female preference</td>
<td>89.10</td>
<td>10.90</td>
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<tr>
<td>Male preference</td>
<td>45.40†</td>
<td>54.60†</td>
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<tr>
<td>Those who wore small/extra small gloves</td>
<td>78.26</td>
<td>22.70</td>
</tr>
<tr>
<td>Those who wore medium gloves</td>
<td>50.00†</td>
<td>50.00†</td>
</tr>
<tr>
<td>Those who wore large gloves</td>
<td>25.00</td>
<td>75.00</td>
</tr>
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†Values did not suggest a specific preference for these groups and were not significant.
small gloves, 50 percent of those who wore medium gloves, and 25 percent of those who wore large gloves (Pearson chi-square=12.037; p=0.0024). Gender differences were highlighted in the simulated aspiration of an inferior alveolar nerve block injection. Females responded that they agreed/completely agreed (mean 4.3 of 5) that aspiration could be easily performed with the petite syringe and agreed/completely agreed with a mean of 3.76 of 5 that aspiration could be easily performed with the conventional syringe. The differences were significant with a one-sided p-value of 0.017.

Discussion

In this study, two types of simulated injections were performed to determine dental and dental hygiene students’ perceptions of the ease of use and their subjective rating of control during injection. A conventional syringe and a petite syringe that is being marketed to accommodate diversity in the dental workforce (i.e., more females with smaller physical features) were compared. There was a preference for the petite syringe by 62.2 percent of the subjects. It is only when the data are separated into size or gender differences that the significance of the different preferences become evident. The female subjects preferred aspiration with the petite syringe. It has been suggested that people with smaller hands, identified by their use of small-sized gloves, are better able to manipulate a petite syringe because the smaller distance to the thumb ring on the petite syringe requires less of a hand span to aspirate, which facilitates the aspiration and increases the sense of control. In an educational environment, improving the sense of control and confidence is very important for all of the students.

After the experiment, some of the students commented that other design features such as weight, the design for the rest placement of the index finger, and the size of the thumb ring were areas in which improvements could be made by the manufacturer to make administering injections more comfortable for the provider. The findings are noteworthy because many states have changed their dental laws to permit dental hygienists to perform injections. Many dental hygienists are female and wear small gloves; thus, a petite syringe may be an asset to that group. Although weight was not evaluated in this study, the petite syringe’s lighter weight may also benefit practitioners with smaller hands.

More research in ergonomic issues relating to dental instrument design to provide greater comfort for dental providers in the course of a workday is needed. Musculoskeletal symptoms have led some practitioners to leave dentistry. Research related to improving the delivery of dental care for the patient, dentist, or dental hygienist may alleviate these losses from the work force, absenteeism from work, or work-related disability.

Conclusion

The petite syringe may provide a significant improvement in the administration of local anesthetics for providers with smaller hands. Previously, to accommodate a smaller hand span, students were instructed to reduce the volume of the anesthetic cartridge by expressing (wasting) some of the anesthetic. The technique helped with the process of aspiration, but insufficient analgesia often resulted and a second injection may have been needed. The petite syringe provides an alternative by accommodating a smaller hand span.

REFERENCES