Injection pain and postinjection pain of the anterior middle superior alveolar injection administered with the Wand® or conventional syringe

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Objective. The purpose of this prospective, randomized, blinded study was to compare the pain of injection and postinjection pain of the AMSA injection using the computer-assisted Wand Plus® injection system versus a conventional syringe.

Study design. Using a crossover design, 40 subjects randomly received 2 blinded AMSA injections using the Wand Plus® system and a conventional syringe, at 2 separate appointments. The AMSA injection site was centered halfway between the midpalatine raphe and gingival margin of the first and second premolars. The pain of needle insertion, anesthetic solution deposition pain, and postinjection pain were recorded on a Heft-Parker VAS for the 2 AMSA injections.

Results. For needle insertion, 38% of the subjects had moderate/severe pain with the Wand Plus® and 34% moderate/severe pain with the conventional syringe, with no significant difference between techniques. There was a significant difference for solution deposition pain, with the conventional syringe causing more moderate/severe pain (42% conventional vs. 25% for the Wand Plus®). Regarding postinjection pain, after numbness wore off there was no significant difference between the Wand Plus® injection technique (0% moderate pain) and the conventional syringe technique (8% moderate pain). Postinjection, approximately 8% to 10% of the subjects experienced slight palatal swelling and 2% experienced temporary numbness. These problems resolved quickly and were considered minor.

Conclusions. The AMSA injection, using the Wand Plus®, resulted in similar pain ratings for needle insertion as the conventional syringe but statistically lower pain ratings upon anesthetic solution deposition. However, the AMSA, using either the Wand Plus® or a conventional syringe, has the potential to be a painful injection. We found the incidence of postinjection pain and sequelae was low with both techniques.


Traditionally, maxillary teeth have been anesthetized by administering an infiltration injection on the buccal or labial aspect of the target tooth. Recently, a new technique has been introduced for anesthetizing maxillary teeth: the anterior middle superior alveolar (AMSA) injection.1-3 Friedman and Hochman1-3 state that pulpal anesthesia of the maxillary central and lateral incisors, canines, and first and second premolars, for an expected duration of 45 to 60 minutes, will be achieved with the AMSA injection of 0.6 to 1.4 mL of anesthetic solution. Those authors also state that palatal soft tissue anesthesia is achieved without numbness to the lips and face, or interference with the muscles of facial expression. A bilateral AMSA injection supposedly anesthetizes 10 maxillary teeth extending from the second premolar on one side to the second premolar on the opposite side.2 The AMSA injection site is located palatally at a point that bisects the premolars and is approximately halfway between the midpalatine raphe and the crest of the free gingival margin1-3 (Fig 1). The AMSA injection derives its name from the injection’s ability to supposedly anesthetize both the anterior and middle superior alveolar nerves.1-3

The middle superior alveolar (MSA) and anterior superior alveolar (ASA) nerves branch from the infraorbital nerve before they exit from the infraorbital foramen4 (Fig 2). The middle superior alveolar nerve is thought to innervate the maxillary premolars and plays some role in pulpal innervation of the mesiobuccal root of the first molar.4 The anterior superior alveolar nerve provides pulpal innervation to the central and lateral incisors and canines.4 The plexus where the 2 nerves join is the target site for the AMSA injection.1-3

Traditionally, palatal injections administered with a conventional syringe have the potential to be painful. The Wand Plus® local anesthesia system has been...
developed to supposedly enable a virtually painless injection.1-3,5 The majority of the literature on the computer-assisted injection system has dealt with the pain of injection, with the computer-assisted injection system compared to injections using a conventional syringe.6-17 In general, the results have been favorable6,7,11-17 with the computer-assisted injection system, with only 2 studies showing no difference8,9 and 1 study showing higher pain ratings10 with the computer-assisted injection system.

Friedman and Hochman1 state that the AMSA technique is comfortable for the patient when administered with the computer-assisted injection system. There are 8 studies that have evaluated the pain of the AMSA or palatal injections using the computer-assisted injection system.8-11,15,17,18 Except for the studies by Asarch et al,8 Saloum et al,9 and Goodell et al,10 the computer-assisted injection system resulted in less pain than the conventional syringe injection for AMSA and palatal injections.6,11,15,17,18

The purpose of this prospective, randomized, blinded study was to compare the pain of injection and postinjection pain of the AMSA injection using the computer-assisted Wand Plus® injection system versus a conventional syringe.

MATERIALS AND METHODS

Forty adult subjects participated in this study. All subjects were in good health and were not taking any medication that would alter pain perception as determined by a written health history and oral questioning. Inclusion criteria were: between the ages of 18 and 65 years; in good health (ASA classification I or II); informed consent granted. Exclusion criteria were: allergy to lidocaine or sulfites; history of significant medical problem (ASA classification III or greater); have taken CNS depressants (including alcohol or any analgesic medications) within the last 48 hours; pregnancy; or inability to give informed consent. The Ohio State University Human Subjects Review Committee approved the study, and written informed consent was obtained from each subject. After completion of the medical history and consent form, the subjects completed Corah’s Dental Anxiety Scale questionnaire.19-21

The 40 blinded subjects randomly received 2 anterior middle superior alveolar (AMSA) injections at 2 separate appointments spaced at least 1 week apart in a crossover design. If postinjection sequelae occurred, the second appointment was delayed until complete healing was observed. The subjects received AMSA injections of 1.4 mL of 2% lidocaine (28 mg) with 1:100,000 epinephrine (14 μg) (Xylocaine; Dentsply, York, Pa) using the Wand Plus® local anesthesia system (Milestone Scientific, Deerfield, Ill) at one appointment and the same amount of lidocaine with epinephrine, using a conventional syringe (Dentsply), at the other appointment. A single provider gave all injections. The provider practiced the AMSA injection on emergency and routine endodontic patients, using both the computer-assisted injection system and conventional syringe, for 3 months before starting the current study. The Wand Plus® local anesthesia system5 is described in previous articles.1-3,23

Before the experiment, the 2 anesthetic techniques were randomly assigned 6-digit numbers from a random number table. The random numbers were assigned to a subject to designate which technique was to be administered at each appointment. The blinding of the AMSA injection was accomplished by (1) blindfolding the subject at both appointments during the administration of the injections, and (2) activating the computer-assisted injection system at both appointments so the subject would hear the chiming of the unit during the
conventional syringe injection. The handpiece of the computer-assisted injection system was placed into a suction tip to collect the anesthetic solution while the conventional syringe injection was given. Additionally, during the computer-assisted injection, a conventional loaded syringe was placed on the instrument tray so the subject would see both the computer-assisted injection system and conventional syringe as he or she entered the operatory. Only the random numbers were recorded on the data collection sheets to further blind the experiment.

For the conventional syringe injection, 0.4 mL of anesthetic solution was withdrawn from a standard cartridge of 2% lidocaine with 1:100,000 epinephrine using a 1-mL tuberculin syringe (Becton Dickinson, Franklin Lakes, NJ) and a sterile technique. This cartridge was placed in a conventional aspirating syringe equipped with a 27-gauge 1-inch needle (Sherwood Medical, St. Louis, Mo). Therefore, this procedure ensured that the same volume of anesthetic solution was delivered with each of the 2 techniques.

For the computer-assisted injection system, a cartridge of 2% lidocaine with 1:100,000 epinephrine was placed into the plastic barrel of the unit’s handpiece assembly, and placed into the cartridge holder socket with a quarter turn in a counterclockwise direction. The cap was removed from the needle and the foot pedal depressed once to activate the purge cycle to remove air from the plastic tubing and fill the line with anesthetic solution.

Before the injection, each subject was informed of the pain ratings for needle insertion and deposition of solution and shown the visual analog scale (VAS). A Heft-Parker VAS was used in this study (Fig 3). Immediately after the AMSA injection, each subject rated the pain for each injection phase on the VAS. The VAS was a 170-mm line with various descriptive terms. The subjects placed a mark on the scale where it best described their pain level. To interpret the data, the VAS was divided into the following 4 categories: No pain corresponded to 0 mm on the scale; mild pain was defined as greater than 0 mm and less than or equal to 54 mm and included the descriptors of faint, weak, and mild pain; moderate pain was defined as greater than 54 mm and less than 114 mm; severe pain was defined as equal to or greater than 114 mm and included the descriptors of strong, intense, and maximum possible.

The soft tissue of the palate and surrounding tissue was visually inspected to ensure that this area was healthy before the start of the study. The AMSA injection was administered with the computer-assisted injection system according to the recommendations of Friedman and Hochman. The subject was informed that the injection would take almost 5 minutes and that they would hear chimes during the injection. The subject was placed in a supine position with the head tilted up and back. The AMSA injection site was centered halfway between the midpalatine raphe and the gingival margin of the first and second premolars (Fig 1). A cotton tip applicator was used to apply 0.2 mL of topical anesthetic (benzocaine; Patterson Brand, St Paul, Minn) at the injection site for 1 minute. The injection was performed with a 27-gauge, 1-inch Luer-Lok needle (Becton Dickinson). For the needle insertion phase of the injection, the needle bevel was placed against the palatal tissue, without puncturing the tissue, and a plain cotton tip applicator was firmly pressed on the needle tip for the prepuncture phase of needle insertion. The computer-assisted injection system was activated at a slow rate (by partially depressing the foot pedal) for 8 seconds to supposedly force the anesthetic solution into the tissue. By removing the foot from the foot pedal, the unit was activated to cruise control (continuous flow of anesthetic solution at the slow rate). One chime from the computer-assisted injection system’s machine corresponded to 1 second, allowing audible monitoring of the elapsed time. On the slow setting, approximately 1 drop of anesthetic solution was delivered every other second. The handpiece, with attached needle, was reoriented to a 45° angle and rotated in an axial manner (45° clockwise
and 45° counterclockwise) for needle insertion. The needle was slowly advanced 1-2 mm, followed by a brief pause of 4 chimes. The needle was advanced another 2-4 mm until bone was gently contacted, followed by a pause of 4 chimes. The needle was then withdrawn slightly. The cotton tip applicator was then removed to observe the palate for blanching. Approximately 0.08 mL of anesthetic solution was delivered during the needle insertion phase.

For the solution deposition phase of the injection, the unit’s handpiece was held in position at the depth described above and the computer-assisted injection system continued on cruise control, at the slow setting, to deposit the anesthetic solution. Visually monitoring the green lights on the unit and audibly monitoring the corresponding chimes determined when the deposition of solution was complete. Approximately 1.32 mL of anesthetic solution was delivered during the solution deposition phase. The operator had direct vision of the injection site and if leakage of the anesthetic solution was noticed the needle was repositioned until no leakage occurred. The operator waited 10 seconds before slowly removing the needle from the injection site. This supposedly allowed the anesthetic solution to dissipate within the tissue and reduced the amount of solution dripping from the site before needle withdrawal. After needle withdrawal, the conventional syringe was emptied into the sink and placed back on the instrument tray so both the computer-assisted injection system and the syringe appeared used. The blindfold was then removed.

For the conventional syringe injection, the subject was informed that the injection would take almost 5 minutes and that they would hear chimes during the injection. The subject was placed in a supine position with the head tilted up and back. The same AMSA injection site was chosen as for the computer-assisted injection technique (Fig 1). A cotton tip applicator was used to apply 0.2 mL of topical anesthetic (benzocaine, Patterson Brand) at the injection site for 1 minute. The injection was performed with a 27-gauge 1-inch needle (Sherwood Medical). For the needle insertion, the same puncture regimen was used as for the Wand Plus® except it was done with a conventional syringe. During this time, the computer-assisted injection system was activated by means of the computer-assisted injection system’s handpiece was withdrawn from the suction apparatus and placed into its plastic housing to mimic its use. The blindfold was then removed.

The subjects were asked to indicate, after the second appointment, which injection technique they preferred. No operative or restorative dental procedures were performed. Additionally, no probing or needle sticks of the soft tissues were performed. The first and second premolars, canine, and lateral and central incisors were pulp tested in 4-minute cycles for 60 minutes. The results have been reported elsewhere. Pulp testing the teeth would not result in postinjection pain or sequelae. All subjects completed postinjection surveys after each AMSA injection administered. The subjects rated pain in the injection area, using the previous VAS, upon discontinuation of anesthesia on the day of the appointment and upon waking in the morning for 3 days following the appointment. Patients were also instructed to describe and record any problems, other than pain, that they experienced.

Data were analyzed nonparametrically. Between technique differences in pain ratings for needle insertion, solution deposition, and post-injection survey were analyzed using the multiple Wilcoxon matched-pairs, signed-ranks test. With 40 subjects and a nondirectional alpha risk of 0.05, the power of the Wilcoxon test to
detect a difference of \( \pm 10 \) mm on the visual analogue scale was greater than 99%. Preference between technique differences was assessed using the chi-square test of equal proportions. All statistical comparisons were considered significant at \( P < 0.05 \).

RESULTS

Twenty men and 20 women ranging in age from 19 to 36 years (average age 27 years) participated in this study. The mean dental anxiety score was 5.9 \( \pm 1.6 \) SD from a possible score of 4 to 20. A score of 4 corresponded to the least anxious and 20 indicated the most anxious.

Anesthetic injection pain ratings are summarized in Table I. For needle insertion with the computer-assisted injection system, 38\% of the subjects reported moderate pain and none reported severe pain. For needle insertion with the conventional syringe, 32\% of the subjects reported moderate pain and 2\% reported severe pain. There were no significant differences (\( P > 0.05 \)) in needle insertion between the 2 techniques.

For solution deposition with the computer-assisted injection system, 25\% of the subjects reported moderate pain and none reported severe pain. For solution deposition with the conventional syringe, 40\% of the subjects reported moderate pain and 2\% reported severe pain. There was a significant difference (\( P < 0.05 \)) between the 2 techniques.

For preference of technique, 45\% (18/40) preferred the computer-assisted injection system, 35\% (14/40) preferred the conventional syringe, and 20\% (8/40) had no preference. The differences were not significant (\( P > 0.05 \)).

Postinjection pain is summarized in Table II. When anesthesia wore off on the day of the appointment, 8\% of the subjects reported moderate pain and none reported severe pain after receiving the AMSA injection with the computer-assisted injection system, and no subject reported moderate or severe pain after receiving the AMSA with the conventional syringe. Pain ratings decreased over the next 3 days for both techniques. There were no significant differences (\( P > 0.05 \)) between the 2 techniques.

Table III lists the percentage of subjects who experienced postinjection sequelae. Three subjects (8\%) who received the AMSA with the computer-assisted injection system and 4 subjects (10\%) who received the AMSA with conventional syringe reported slight palatal swelling at the site of injection. One subject (2\%)...
reported temporary numbness at the site of injection after the conventional syringe injection, and none reported numbness after using the computer-assisted injection.

**DISCUSSION**

Clinically, the low mean anxiety score, using Corah’s Dental Anxiety Scale questionnaire, of 5.9 indicates minimal anxiety. If more anxious patients had participated in this study, pain ratings could have been higher. Many factors such as anxiety, fear, trust, perceived control over painful stimulus, interpretation of the painful stimulation, and personality influence pain.24 Additionally, because we studied a young adult population, the results of this study may not apply to children or the elderly.

Table I reports the pain of needle insertion and anesthetic solution deposition for both techniques. Recently, Fukayama et al18 divided the pain of the AMSA injection into needle insertion and deposition. They reported that when using a prepuncture technique and a 32-gauge needle, 15% (3 of 20) of the patients reported moderate pain and none reported severe pain. The difference between Fukayama et al’s18 study and ours may be related to the higher number of subjects in our study, use of different needle sizes, or differences in subject populations.

Friedman and Hochman1-3 speculated that the prepuncture technique, the careful axial needle rotation, and the controlled slow anesthetic deposition rate would reduce the sensation of needle insertion. Unfortunately, even with these techniques and a slow deposition rate, needle insertion was not painless. There was no significant difference (P > .05) between needle insertion for the AMSA injections administered with the computer-assisted injection system or conventional syringe (Table II). In the current study, every effort was made to duplicate the computer-assisted injection system’s prepuncture technique when giving the conventional syringe injection. This may explain why the 2 techniques resulted in similar needle insertion ratings (Table I). Another explanation could be that the prepuncture technique, which is based on the anesthetic solution being forced into the palatal epithelium before needle penetration occurs, is not effective. It has been speculated that the computer-assisted injection system creates a continuous positive solution pressure that delivers anesthetic solution that precedes the needle path.4 The information in the Wand Plus® manual states “This anesthetic pathway is believed to assist in virtually eliminating discomfort as the needle penetrates through the tissue.” Unfortunately, due to the moderate pain ratings recorded in this study, these speculations do not seem to apply to needle insertion with the AMSA injection using the computer-assisted injection system.

The results of the current study would caution practitioners not to advise patients that needle insertion with the AMSA injection will be painless, because 32% to 38% of the subjects rated needle insertion as moderately painful.

Although previous studies6,8-11,15,17 did not divide the AMSA injection into needle placement or solution deposition, they did report overall findings on the AMSA injection. Hochman et al6 administered 0.45 mL of anesthetic solution to dentists at the AMSA site and found 4% had moderate pain with the computer-assisted injection system and 56% had moderate/severe pain with a conventional syringe. Saloum et al8 administered 0.3 mL of anesthetic solution at the AMSA site and found that the computer-assisted injection system was slightly less painful than the conventional syringe, but the difference was not statistically significant. Gibson et al,11 studying the traditional palatal injection in children aged 5-13 years, found that with the computer-assisted injection system significantly fewer children exhibited disruptive behavior during the initial 15 seconds of the injection when compared to a conventional syringe injection. Additionally, the children receiving the conventional palatal injection rated the experience as extremely more painful more often than those children who received the palatal injections with the computer-assisted injection system. Allen et al17 administered palatal—anteri or superior alveolar (P-ASA), anterior middle superior alveolar (AMSA), buccal, and palatal injections in children aged 2-5 years and found that the computer-assisted injection system significantly reduced disruptive behaviors when compared to a conventional syringe injection. Asarch et al,8 also studying palatal injections in children ages 2-5, found the computer-assisted injection system was not statistically different than the conventional syringe injection. Goodell et al10 studied adult patients undergoing routine endodontic treatment and administered infiltrations, inferior alveolar nerve blocks, and palatal injections. They found the conventional atraumatic syringe injection resulted in significantly less pain of injection than the computer-assisted injection system. Primusch and Brooks15 compared the slow and fast rate of the computer-assisted injection system when administering palatal injections in adults. They found that the slow rate was statistically less
painful than the fast rate. When the pain of the AMSA injection was divided into needle insertion and solution deposition, Fukayama et al\(^\text{18}\) reported that when 1.8 mL of 2\% lidocaine with 1:80,000 epinephrine was deposited with a computer-assisted injection system, 15\% (3 of 20) of the subjects had moderate pain and none reported severe pain. Again, the difference between the Fukayama et al\(^\text{18}\) study and ours may be related to the higher number of subjects in our study or differences in subject populations.

While it is difficult to compare the previous studies to the current study because of the different volumes used, the combining of various injection techniques for statistical analysis, and the differences in population groups, we can conclude that, generally, the computer-assisted injection does result in less pain than the conventional syringe injection for AMSA and palatal injections. However, as found in this study, the AMSA injection administered with the computer-assisted injection system does not result in a painless injection.

Because the deposition rate is controlled with the computer-assisted injection, it is not possible to decrease the rate of solution deposition. The AMSA injection with the computer-assisted injection, on the slow setting, took approximately 4 minutes and 45 seconds. Slowing the rate of deposition further, by the manufacturer’s settings, would result in an injection time of perhaps 6 to 8 minutes. We feel the increase in solution deposition time may not be clinically practical. Additionally, studies would have to determine if a slower rate of deposition would result in less pain with the AMSA injection.

There was a significant difference (\(P < .05\)) between the AMSA techniques using the computer-assisted injection and a conventional syringe for solution deposition pain (Table I). Therefore, for solution deposition, the computer-assisted injection reduced the pain of injection by delivering a slow controlled rate of anesthetic infusion. In the current study, every effort was made to duplicate the computer-assisted injection of anesthetic solution when giving the conventional syringe injection. However, it was not possible to control the precise pressure compared to the computer-assisted injection. We can speculate that with the conventional syringe injection, the operator intermittently increases thumb pressure on the plunger of the syringe. Subsequently, as the solution is injected into the tightly bound tissue of the palate, the pressure is elevated and pain results. Because the computer-assisted injection controls the rate of anesthetic solution deposition, it resulted in less pain. However, while solution deposition with the computer-assisted injection resulted in less moderate to severe pain than did the conventional syringe, the results of the current study would caution practitioners not to advise patients that solution deposition will be painless, because 25\% of the subjects rated solution deposition as moderately painful.

Postinjection pain ratings of the AMSA, at the time anesthesia wore off on the day of the appointment, were similar for the computer-assisted injection and conventional syringe injections, with no significant differences between techniques (Table II). The incidence of moderate pain decreased over the next day, and by day 2 only 1 subject reported moderate pain. By day 3, no subjects reported moderate pain (Table II). Clinically, the conventional syringe technique did not statistically cause more postoperative pain than the computer-assisted injection. There are no published reports to compare the post-injection pain of the AMSA injection with the current study. In general, we can state that the AMSA injection, using either the computer-assisted injection or conventional syringe, does not result in a great amount of post-injection pain.

Table III lists the post-injection sequelae for each technique. Palatal swelling was seen most often when postinjection sequelae occurred (8\%-10\%). All swellings resolved by the third day. Two percent (1 subject in the conventional syringe technique) reported temporary numbness at the site of the injection—which resolved by the third day. Therefore, all sequelae were minor problems and resolved within a relatively short period of time.

The pain and postinjection pain and sequelae may be related to the volume of solution injected. However, the volume of anesthetic solution used in this study is not considered excessive in the description of the technique by Hochman and Freidman\(^\text{1,4}\); they advocated using 0.9 to 1.4 mL for efficacy of the AMSA injection. Future studies could compare reduced volumes of solution to determine if there would be less injection pain and postinjection sequelae.

For preference of technique, 45\% (18/40) preferred the computer-assisted injection, 35\% (14/40) preferred the conventional syringe, and 20\% (8/40) had no preference. There were no significant differences in preference between the 2 techniques. Previous studies\(^\text{8,11-14}\) have evaluated preference for the computer-assisted injection versus a conventional syringe. Gibson et al,\(^\text{11}\) studying P-ASA, AMSA, buccal, and palatal injections in children aged 5-13 years, found no significant difference in overall satisfaction rating for the computer-assisted injection versus the conventional syringe injection. Similarly, Asarch et al,\(^\text{8}\) also studying palatal and buccal injections and inferior alveolar nerve blocks in children ages 2-5, found that average posttreatment acceptability and satisfaction scores were not significantly different between the computer-assisted injection and conventional syringe. Nicholson et al\(^\text{12}\) studied maxillary injections and inferior alveolar nerve
blocks in adult patients and found that 50% of the patients preferred the computer-assisted injection, 20% preferred the conventional syringe, and 30% had no preference. Tan et al.13 performed injections for minor anal surgery and found that postoperatively 80% preferred the computer-assisted injection, 10% preferred the conventional syringe, and 10% had no preference. Rosenberg14 performed injections for periodontal procedures and found that computer-assisted injection was highly preferred when compared to conventional syringe injections. Therefore, the studies by Asarch et al.8 Gibson et al.,11 and the current study showed no significant preference for the computer-assisted injection; while 3 other studies.12-14 have shown a preference for the computer-assisted injection.

In conclusion, the AMSA injection using the Wand Plus® resulted in similar pain ratings for needle insertion as the conventional syringe but statistically lower pain ratings upon anesthetic solution deposition. However, the AMSA, using either the Wand Plus® or a conventional syringe, has the potential to be a painful injection. We found the incidence of postinjection pain and sequelae was low with both techniques.

REFERENCES


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