A Comparison of the Pain Perceived During Intravenous Catheter Insertion After Injection With Various Local Anesthetics

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This study compared 4 local anesthetics, 1% lidocaine, 1% lidocaine with sodium bicarbonate, 2% chloroprocaine, and 0.5% bupivacaine, in a double-blinded manner for pain on intradermal injection and pain during subsequent intravenous (IV) cannulation with an 18-gauge catheter. The subjects rated their pain, using 100-mm visual analog scales, related to the local injection itself and again after the IV catheter was inserted.

No statistical differences were noted in pain scores after the injection of the local anesthetic (P = .134) or on insertion of the IV catheter itself (P = .394). However, there was a low correlation between the pain perceived during the injection of local anesthetic and insertion of the IV catheter (r = 0.483; P = .001).

We found that there were no differences in pain produced by 1% lidocaine, 1% lidocaine with sodium bicarbonate, 2% chloroprocaine, and 0.5% bupivacaine during intradermal injection. There were also no differences in pain produced by an 18-gauge IV catheter being inserted after administration of any of these local anesthetics. Thus, any of these 4 local anesthetics may be used, and the choice may be based on other factors such as price and convenience.

Keywords: Intravenous cannulation, local anesthetics, pain.

Insertion of an intravenous (IV) catheter is required for most surgical procedures and can provoke anxiety and pain. To minimize pain, intradermal or subcutaneous injection of a local anesthetic before IV cannulation is common. However, the injection of a local anesthetic may itself produce pain.

Several studies have evaluated the pain on local anesthetic injection or IV catheter insertion. Nuttall et al[1] studied 280 preoperative patients, randomized to receive 1 of 4 treatments: normal saline, benzyl alcohol in normal saline, alkalinized 1% lidocaine, or nothing and found that benzyl alcohol in normal saline and alkalinized 1% lidocaine produced the least pain on injection and that alkalinized 1% lidocaine was best at reducing the pain of IV catheter insertion. Babcock et al[2] found no significant difference in the pain of drug injection or in the pain of IV catheter insertion between 1% lidocaine and bacteriostatic normal saline containing benzyl alcohol. However, catheter insertion was more painful without either solution than with either solution.

Ales et al,[3] using a Latin square crossover design in which each volunteer received both drugs in random order and alternating the left and right hands, compared 2% chloroprocaine and 1% lidocaine and found no significant differences in the amount of pain associated with drug injection or IV insertion. Both of the local anesthetics tested were equally effective in minimizing pain. However, Marica et al[4] found that volunteers given 2% chloroprocaine had significantly lower mean pain scores compared with volunteers given 1% lidocaine intradermally into the volar forearm.

Bupivacaine is a local anesthetic frequently used for infiltration anesthesia and for surgical procedures. Although not typically used for IV cannulation, it may provide adequate pain relief. In a small study of 24 healthy volunteers evaluating combined intradermal and subcutaneous injection into the volar forearm, Morris et al[5] found that 0.5% bupivacaine was less painful than 1% etidocaine but more painful than 2% chloroprocaine and 1% lidocaine. In contradistinction to the findings of Marica et al,[4] Morris et al[5] also found that lidocaine was less painful than chloroprocaine. Intravenous cannulation was not performed. In another study, the same investigators found that adding sodium bicarbonate solution to lidocaine reduced the pain on injection.[6] Another study, also using intradermal injections into the volar forearm, found similar pain scores between 1% lidocaine and 0.25% bupivacaine, but that the effects of bupivacaine lasted longer.[7] Although very rare adverse reactions have been reported with all of these local anesthetics, when used in appropriate doses, they are considered equally safe.[8-10]

	Bupivacaine 0.5% (n = 30)	Buffered lidocaine 1% (n = 30)	Lidocaine 1% (n = 30)	Chloroprocaine 2% (n = 30)	*P*
Mean ± SD age, y	55 ± 16	54 ± 13	52 ± 16	54 ±18	.862
No. (%) men	17 (57)	17 (57)	17 (57)	9 (30)	.094

Table 1. Participant Ages and Sex

	Group				
	Bupivacaine	Buffered lidocaine	Lidocaine	Chloroprocaine	*P*
Local injection	8.5 (1-54)	6 (0-65)	11 (2-52)	4.5 (0-30)	.134
Intravenous catheter insertion	2.5 (0-12)	1 (0-59)	3.5 (0-26)	1 (0-26)	.394

Table 2. Pain Ratings[a]

[a] Data are given as the median (range) in millimeters on a 100-mm visual analog scale.

Several of these studies are limited in that they tested the pain on injection only in nonsurgical volunteers.[3-7] Only 2 studies evaluated local anesthetic use in preoperative patients.[1,2] Patients admitted for surgery may be more anxious than healthcare personnel volunteering for a local anesthetic study, and their anxiety may influence their perceptions of pain.[11] Another limitation is that only a few studies evaluated the amount of pain on IV catheter insertion.[1-3]

Considering the conflicting data reported in the literature and the limitations produced by not studying their effects in preoperative surgical patients or for IV catheter insertion, the present study was conducted to determine whether there were significant differences in the amount of pain experienced with injection of 4 local anesthetics (1% lidocaine, 1% lidocaine buffered with sodium bicarbonate, 2% chloroprocaine, or 0.5% bupivacaine) tested and to determine which of the 4 local anesthetics was superior at minimizing pain when an 18-gauge IV catheter was inserted in the dorsum of the hand. A secondary objective was to determine the association, if any, between pain on drug injection and IV catheter insertion.

Methods

This randomized, double-blinded, controlled study was approved by the institutional review board of St Vincent Mercy Medical Center, Toledo, Ohio. Consecutive patients were approached on each of 6 mornings. Written informed consent was obtained from each participant. Patients were included if they were 18 years old or older, scheduled for an elective surgical procedure, competent to make decisions, and able to read and speak English and required an IV for their procedure. Any patient with a previous allergic reaction to any local anesthetic was excluded from the study.

Subjects ranked their pain on 2 occasions. Pain produced by the injection of the local anesthetic was rated before the IV catheter was inserted. The pain of the IV catheter insertion was rated immediately after the catheter was secured. The pain rankings were accomplished by having participants place a mark on separate (100-mm) visual analog scales (VASs) that ranged from "no pain" to "worst possible pain" for both objectives. Age and sex were recorded for each participant.

The study medications were 1% lidocaine, 0.5% bupivacaine, 2% chloroprocaine, and 1% lidocaine buffered with 8.4% sodium bicarbonate (9:1 ratio). The medications were drawn up into 1-mL tuberculin syringes and placed in sealed white envelopes by 2 investigators (M.E. and R.T.) who were not present for the local infiltration and subsequent IV catheter insertions. A computer-generated random code was used to assign each envelope to each patient.

The IV cannulas were inserted by the other investigators (R.M.B., F.J.Z., and M.K.B.), who were blinded to the drugs in the envelopes. A tourniquet was placed on the forearm and the dorsal surface of the hand examined for a suitable vein in which to place the 18-gauge cannula (ProtectIV Safety I.V. Catheter, JELCO, Smiths Medical ASD, Inc, Southington, Connecticut). The area was then cleaned with alcohol. Next, using a tuberculin 1-mL syringe with a 25-gauge needle, 0.2 mL of local anesthetic was injected intradermally during a 3-second period. If the vein formed a "Y" shape, the local anesthetic was injected between the arms of the Y, distal to the trunk of the vein. If the vein was linear or quasi-linear, the local anesthetic was placed on the side that minimized the angle of IV catheter insertion.

Participants were then asked to rate the pain using the VAS. The investigator waited 30 seconds (measured by a watch) after the injection of local anesthetic before proceeding with insertion of an 18-gauge IV catheter. After insertion of the IV catheter, the participant used the second VAS to rate the pain of catheter insertion.

To determine the number of patients needed to find results with an α of .05, a β of .8, and a population standard deviation of 17 mm (from the results of Ales et al[3]), a power analysis was performed and showed that

30 subjects were required for each of the 4 groups to find a 10-mm difference in pain scores between the best and worst groups.[12] Pain scores were compared with the Kruskal-Wallis test, age with analysis of variance, and sex with the χ^2 test. The Pearson correlation coefficient was used to determine the association in pain intensity between local anesthetic injection and cannula insertion. A *P* value less than .05 denoted statistical significance. We used SPSS, version 16.0 (SPSS Inc, Chicago, Illinois), to determine the *P* values.

Results

We analyzed the data for 120 patients who gave informed consent and participated in the study. No patient was excluded. Subjects in all groups were of similar age (Table 1). Although the majority of the subjects who received chloroprocaine were women and the other groups were predominantly men, this difference did not reach statistical significance (*P* = .094) (Table 1).

All catheters were inserted successfully on the first attempt. Pain for most patients on local anesthetic injection was low (Table 2) and did not differ between groups (*P* = .134). Also, pain on IV catheter insertion was very low in all groups (Table 2) and without intergroup differences (*P* = .394). There was, however, a low correlation (*r* = 0.483) between the pain perceived on injection of the local anesthetic and insertion of the IV catheter (*P* ≤ .001; Figure).

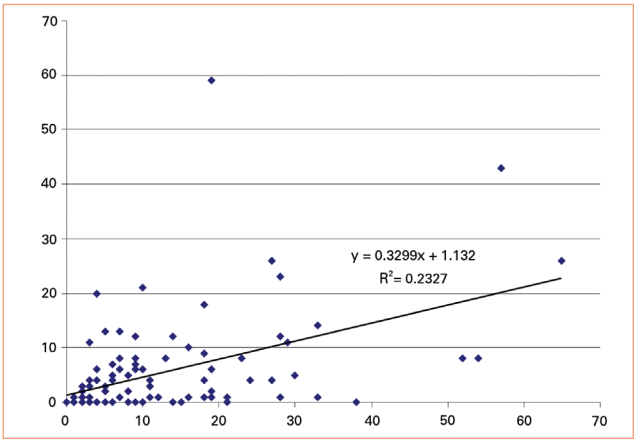

Figure. Association Between Pain on Local Anesthetic Injection and Intravenous (IV) Catheter Insertion

Discussion

Insertion of an IV catheter often causes pain and discomfort and may cause patients to have increased fear about pain for the upcoming surgical procedure. Using a local anesthetic to reduce this pain is common, but little research exists to examine which drug is most effective. We found that of the 4 drugs tested (1% lidocaine, 1% lidocaine buffered with sodium bicarbonate, 0.5% bupivacaine, and 2% chloroprocaine), all produced similar pain on intradermal injection (Table 2), and the pain produced by IV cannulation was also similar in all 4 groups (Table 2). Our results differ from the findings of previous studies that found differences in pain scores between different drugs when pain was assessed on the local anesthetic injection and IV cannulation.[1,3,4] One reason for our findings of no significant differences between groups, in contrast with the differences found in other studies, is that our patients were older. The subjects in the study by Marica et al[4] were 18 to 55 years old (mean, 30 years), whereas our patients were 54 ± 16 years. Although Nuttall et al[1] did not provide ages, their patients were from a military facility and presumably younger than ours. Older patients have a higher rate of neuropathies,[13] and even subclinical neuropathies may have decreased the pain perceived by patients during our study. This loss of pain perception would tend to bias our study toward the null result, that is, finding no differences in our 4 groups.

In contradistinction to other studies[1,4] that found that sodium bicarbonate added to lidocaine as a buffer decreased the pain of injection, we found no benefit to this strategy, perhaps because our pain scores for lidocaine without buffer were already quite low (Table 2). Thus, we cannot recommend this extra step of work and extra expense.

We also found a correlation (*r* = .483; *P* < .001) between pain on local anesthetic injection and IV insertion. This finding probably indicates that patients who perceive one event as painful tend to perceive other events as painful. Further study is indicated to determine whether patients who perceive local anesthetic injection or IV cannulation as painful perceive surgery as more painful and require higher analgesic doses to achieve an equal measure of postoperative comfort.

One limitation of this study is that we did not control for other conditions. A variety of factors, such as, depression,[14] age,[13] comorbidities,[13,14] chronic pain,[13] smoking,[15] sex,[16] and psychological perceptions[17] may affect pain perception, and investigators in future studies may want to study their effects on local anesthetic injection and IV insertion. However, we included consecutive patients rather than limiting our patients to people who were young, healthy, or ASA physical status 1 or 2, as done in other studies.[1,3,4] Our patients were not assessed for or excluded for altered peripheral sensorium. We included everyone to improve generalizability of our findings by including older or sicker patients.

Another limitation of our study is the 30-second wait time between injection of the local anesthetic and IV catheter insertion. We chose this time as a reasonable period in which all subjects could mark the VAS for pain of local anesthetic injection. However, our results of no differences in IV insertion may not hold if a shorter wait period had been used. Nuttall et al[1] used a 15-second wait period

and found no difference in pain on IV catheter insertion after administration of alkalinized lidocaine, plain lidocaine, or chloroprocaine. They did not test bupivacaine. Other studies did not describe the wait time.[2,3,14]

Recently, Pud et al[18] described a difference in pain perception in male subjects between their dominant and nondominant hands. Future studies should control for hand dominance. A final limitation relates to the skill of the inserter and the size of the IV catheter. All 3 inserters in this study were senior CRNA students with several years of experience as registered nurses inserting IV catheters. Inserters with less experience or less skill or using larger IV catheters, such as 14- or 16-gauge catheters, may produce more pain on IV insertions, and further study is needed to evaluate this factor. Nor did we study insertion of arterial or central venous lines. The deeper tissue planes of these structures might react differently to the local anesthetics and produce different levels of pain. Further study is needed for these catheters.

Conclusion

We found no differences in pain produced by 1% lidocaine, 1% lidocaine with sodium bicarbonate, 2% chloroprocaine, and 0.5% bupivacaine during intradermal injection. There were also no differences in pain produced by an 18-gauge IV catheter being inserted after the administration of any of these local anesthetics. Thus, any of these 4 anesthetics may be used, and the choice may be based on other factors such as price and convenience.

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