Local Anesthetics: What’s New in Minimal Pain Injection and Best Evidence in Pain Control

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Summary: Local anesthesia in plastic surgery is undergoing a revolution. In the last 10 years, significant improvements in technique have permitted surgeons to do more and more under pure local anesthesia to increase patient safety and convenience while maintaining total patient comfort during the injection of the local anesthesia and while the procedure is accomplished. Many procedures which used to require sedation are now being performed without it. This article explores some of the new advances in local anesthesia such as painless blunt-tipped cannula local anesthetic infiltration, decreased pain with sharp needle tip injection, and long-lasting local anesthetics with delayed release from liposomal encapsulation. This article also examines the best evidence of the last 10 years of advances in pain control with local anesthesia. (Plast. Reconstr. Surg. 134: 40S, 2014.)

The last decade has witnessed major improvements in local anesthetic injection and application techniques, which have permitted surgeons to do more and more under pure local anesthesia with minimal pain during the injection of the local agents. This has led to increase in patient safety and convenience while maintaining total patient perioperative comfort. Many procedures in hand surgery,1 cosmetic surgery,2 facial skin cancer reconstruction,3 and other procedures such as adult cleft lip repair4 can now be performed with the wide awake approach without sedation. For the patient, many of these procedures have been reduced to the simplicity of an office dental procedure. In addition, postoperative pain control with new developments in local anesthesia have also improved the patient experience.

This article will review 2 exciting new areas of minimal pain local anesthetic injection techniques, new medications, and the best evidence to support the changing landscape of local anesthesia in plastic surgery.

Injecting Local Anesthesia in a Minimally Painful Fashion

Local Anesthetic Injection with Percutaneous Blunt Cannulae

This is likely the single most important development in local anesthesia injection technique that the lead author has seen in his lifetime. (See video, Supplemental Digital Content 1, which demonstrates a blunt-tipped cannula being easily passed through subcutaneous fat for minimal pain and decreased bruising subcutaneous injection of large areas with local anesthesia during a blepharoplasty, available in the “Related Videos” section of the full-text article on PRSJournal.com or, for Ovid users, available at http://links.lww.com/PRS/B99.)

Blunt-tipped cannulae have been shown to be able to infiltrate hyaluronic acid fillers in sensitive areas such as the lip with minimal pain (level IV evidence).5 Fine 30-gauge cannulae introduced through skin perforation created by 27-gauge needles were originally developed to increase safety with filler injection so that the blunt needle tip would not penetrate blood vessels and embolize filler material in the periorbital area. Now the entire lower eyelid can be filled through one needle poke in the superior cheek skin with

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the greatly added benefits of minimal pain and bruising.

These same blunt-tipped cannulae can be painlessly passed beneath the skin for injection of large areas with local anesthesia during a blepharoplasty. This video is available in the “Related Videos” section of the full-text article on PRSJournal.com or, for Ovid users, available at http://links.lww.com/PRS/B99.

Decreasing the Pain of Injection with Sharp Needles

The second major new technique is to inject local anesthesia with minimal pain with traditional sharp needles. It is possible to consistently and reliably teach medical students and resident learners how to administer local anesthetics in an almost painless manner, even with sharp needles (level IV evidence).4,6 When injecting with sharp needles, the pain of injection can be decreased by (1) buffering lidocaine and epinephrine with 8.4% bicarbonate; (2) warming the local anesthetic; (3) distracting the patient (music, look away) or the area of injection (pinch or pressure near the injection point); (4) using smaller 27- or 30-gauge needles; (5) stabilizing the syringe with both hands to avoid needle wobble; (6) injecting 0.5 cc perpendicularly subdermally and pausing until the patient says the needle pain is gone; (7) injecting an additional 2 cc before moving the needle and then moving and injecting antegradely very slowly with 1 cm of local always palpable or visible ahead of the needle; (8) reinserting needles within 1 cm of blanched areas; and (9) learning from each patient you inject by asking them to score you by telling you each time they feel pain during the injection process3 (Fig. 6).

LIPOSOmatic DELIVERY OF LOCAL ANESTHETICS

Concept and Pharmacology

Liposomal bupivacaine is a little like a honeycomb with vesicles that open as they become exposed over time to release the local anesthetic contained within. With liposomal bupivacaine in Exparel (Pacira Pharmaceuticals, Inc, San Diego, Calif.), 3% of the bupivacaine is free at the time of injection and the rest is contained in the liposomal vesicles. The concept behind this new technology is that the local anesthesia can last longer for effective pain relief as it is gradually delivered from the vehicle over time so the breakdown is slower.

Pharmacologically speaking, liposomal bupivacaine offers time to onset of numbness characteristics similar to traditional bupivacaine (level II evidence).7 This is because 3% of the bupivacaine is free and not in liposomes. However, pharmacodynamic studies reveal that it takes longer for liposomal bupivacaine to reach maximum plasma concentrations and to be eliminated than nonliposomal bupivacaine (level I evidence).8

A 2013 liposomal bupivacaine femoral nerve blockade dose-response study in 14 volunteers demonstrated a high variability of block magnitude among subjects and, surprisingly, an inverse relationship of dose and response magnitude9 (level IV evidence).

Evidence Demonstrating Value in Injected Liposomal Anesthetics

At the time of this writing, many surgeons provide anecdotal very positive early experience with Exparel (liposomal bupivacaine) for operations from abdominoplasty to carpal tunnel, the literature supporting its use in plastic surgery is still scarce. However, most of the literature is still at the basic science level or from other specialties.

A 2013 study of Exparel in abdominoplasty 10 (level IV evidence) concluded that patients experienced reduced postoperative pain, required less postoperative narcotic medication, and resumed both earlier ambulation and normal activity. However, there was no control group for comparison.
In a pooled analysis from 9 studies representing 5 different surgical procedures (inguinal hernia repair, total knee arthroplasty, hemorrhoidectomy, breast augmentation, and bunionectomy), liposome bupivacaine was associated with statistically significant and clinically meaningful lower pain scores at 72 hours, delayed and less consumption of opioids, and fewer opiate adverse events than bupivacaine alone.\(^{11}\) They did not provide sufficient separate data or comments for the breast augmentation group in this article. In the hemorrhoid study, the median time to first opioid use was 19 hours for liposomal bupivacaine versus 8 hours for bupivacaine alone.\(^{11}\) Another trial on hemorrhoidectomy showed liposomal bupivacaine injection to be superior to placebo (level I evidence).\(^{12}\)

One dental study\(^{14}\) showed that liposomal mepivacaine increased the duration of anesthesia and reduced the injection discomfort compared with nonliposomal mepivacaine with epinephrine in healthy volunteers (level I evidence).

**Evidence against the Value of Liposomal Anesthetics**

A dental study comparing 0.5% ropivacaine with 1:200,000 adrenaline, liposome-encapsulated...
0.5% ropivacaine, and 2% lignocaine with 1:100,000 adrenaline showed that the liposomal ropivacaine did not last as long in pain relief as the other 2 agents in duration of anesthesia (level I evidence). They concluded that in their model, the encapsulation of liposome did not improve the anesthetic efficacy of ropivacaine. The same authors concluded that liposomal-encapsulated ropivacaine formulations did not reduce the pain of insertion of a needle into the palatal mucosa either (level II evidence). Similarly, there is also level II evidence that prilocaine does not seem to benefit from liposomal encapsulation.

**Topical Liposomal Anesthetics**

A 2004 study of 4% topical liposomal lidocaine showed it to be not superior to EMLA cream (eutectic mixture of local anesthetics) (level III evidence). A trial of topical liposomal lidocaine for treating vascular lesions in the face revealed that topical 4% liposomal lidocaine cream had relatively minor vasoconstrictor effects when compared with a mixture 2.5% lidocaine and 2.5% prilocaine. Furthermore, liposomal lidocaine produced anesthesia in 30 minutes rather than the 60 minutes required for the nonliposomal cream (level III evidence).
For insertion of intravenous cannula pain, a 2005 trial concluded that use of topical liposomal lidocaine was associated with a higher intravenous cannulation success rate, less pain, shorter total procedure time, and minor dermal changes in children (level I evidence). However, 2 more recent trials of topical liposomal lidocaine cream did not show any decrease in venipuncture pain in neonates and children (level I evidence).21,22

HEAD AND NECK LOCAL ANESTHETIC IS ABSORBED MORE QUICKLY THAN IN THE THIGH FOR MORE RAPID ELEVATION OF HIGHER BLOOD LEVELS

In a prospective crossover trial, volunteers were injected with tumescent lidocaine 0.1% (7 mg/kg), NaHCO₃ 12.5 mEq/L, and epinephrine 1:1,000,000 first in the neck and then later in the thigh (level III evidence). The average time to reach peak lidocaine concentration after neck injection was 5.8 hours, whereas peak lidocaine concentration after thigh injection did not occur until 12.0 hours. This difference of 6.2 hours was significant ($P = 0.009$). The average peak serum concentration after neck injection was 16% greater than that after thigh injection.

Surgeons should be more careful about injecting close to toxic levels in areas of high vascularity such as the face. This may be more dangerous than in areas of lesser flow such as the thigh.
ONSET OF PEAK EPINEPHRINE VASOCONSTRICTION EFFECT IN HUMAN SKIN WITH LOCAL ANESTHESIA

It takes a mean of 26 minutes for epinephrine to reach its maximal vasoconstrictive effect when injected subcutaneously in human skin (level I evidence), not the 7 minutes as was frequently quoted from a study in pigs in multiple-choice question examinations. It is therefore wise to allow the epinephrine time to work to have a drier field. Injecting just before cutting will clearly result in a bloodier field than injecting the patient before they come into the operating room.

DURATION OF THE PAIN PART OF LOCAL ANESTHESIA FOR BUPIVACAINE AND ROPIVACAINE

In digital block finger anesthesia, the pain block of bupivacaine lasts only half as long (15 hours) as the return to normal sensation of touch and pressure (30 hours) (level I evidence). This is why patients can complain of pain after bupivacaine block even though they say they are still numb. Much of the literature discusses the length of duration of local anesthetic action without differentiating pain relief from touch and pressure numbness. The reader needs to become aware of how long the effect lasts for pain relief, not just how long they have an effect.

In carpal tunnel surgery under local anesthesia, the time to first postoperative pain was significantly shorter in the lidocaine group (5.58 hours) than ropivacaine group (9.17 hours) (level III evidence). Although the duration of pain relief is longer with long-acting local anesthetics such as bupivacaine and ropivacaine, having pain in a numb hand can be disconcerting for patients and annoying.

LIDOCAINE IN LIPOSUCTION

The addition of lidocaine to tumescent infiltration solution has been shown to significantly reduce pain up to 18 hours after surgery (level I evidence).
Interestingly, the authors found that the pain was only reduced in 0.5 of 10 points on a visual analogue scale of 0 to 10. They stated in the discussion that they were not using lidocaine routinely after the study because they felt that this level of clinical efficacy was not important enough.

A separate study (level I evidence) in which 3 very different concentrations of lidocaine were examined showed that there was no difference in the intraoperative lidocaine or MEGX (active metabolite of lidocaine, monoethylglycinexylidide) blood levels between any of the 3 groups. There was also no statistically significant difference between the 3 groups when comparing intraoperative inhalational gas requirement, postoperative morphine equivalence requirements, or subjective pain using the visual analog scale. These authors theorized that the use of any lidocaine may be unnecessary.

Another study revealed that 7.5% of the total lidocaine was aspirated in tumescent liposuction (level IV evidence).

**ROUTE OF LOCAL ANESTHETIC INJECTION**

Intravenous lidocaine and dexamethasone with 1 minute of venous occlusion can decrease the pain of propofol injection (level I evidence).

In one study on breast augmentation, ropivacaine injected by experienced anesthesia providers into the paravertebral space as a paravertebral block was more effective than ropivacaine injected by the operating surgeon (plastic surgeon) directly into the zone of surgical dissection (level II evidence). Paravertebral block improved intraoperative cooperation, reduced propofol requirement, and decreased average postoperative pain in the home environment. Only patients from the surgical infiltration group required rescue analgesics.

Intraoperative locally applied ketorolac and bupivacaine instilled in the wound significantly reduced pain and pain medication consumption for 5 days after surgery in women who had undergone primary breast augmentation (level I evidence).

**TRAMADOL AS A NEW LOCAL ANESTHETIC AGENT**

Tramadol (an opioid) with epinephrine has also been shown to be superior to prilocaine with epinephrine for circumcision (level III evidence). These are the only 2 studies with Tramadol we were able to locate at this time.

**TOPICAL LIDOCAINE**

MEGX (lidocaine breakdown product) can be almost as potent as lidocaine in terms of toxicity. Doubling the dose of 4% lidocaine from 2.5 g to 5 g resulted in double the serum levels of MEGX and a 50% increase in the serum lidocaine levels. The addition of an occlusive dressing resulted in a tripling of the serum lidocaine levels and a doubling of the serum MEGX levels. Topical lidocaine is a common form of anesthesia for a wealth of procedures across a large number of disciplines, including laser treatments.

Topically applied betacaine (placebo on one side, betacaine on the other) did not decrease the pain of needles for Botox injection, and only 1 of 40 patients believed the administration of analgesia was worth the trouble (level I evidence). This may be because topicals do not penetrate the skin to the subcutaneous tissue.

Topically applied EMLA was not found to be effective for full-thickness incisions in the ear (level III evidence).

Pretreatment with ablative laser can increase the absorption of 20% benzocaine, 6% lidocaine, and 4% tetracaine triple anesthetic cream for facial rejuvenation while maintaining safe blood serum levels (level III evidence).

**LOCAL ANESTHETIC INFILTRATION INTO DONOR SITES**

End of operation bupivacaine injection into the transverse rectus abdominis musculocutaneous flap donor site decreases opiate requirements in the 72 hours after surgery (level I evidence). A second study also showed that patients in whom bupivacaine (0.375%) was infused at 4 ml/h used less mean patient-controlled anesthesia narcotic during the first 2 postoperative days and transitioned earlier to oral narcotics than did control patients (level I evidence). Patients’ overall pain satisfaction scores were significantly better in the continuous infusion group than in the control group.

Ropivacaine injection into cleft palate incision sites revealed that postoperative pain scores at all the observational postoperative periods showed significantly favorable values in ropivacaine group than in control group (level III evidence).
INFRAORBITAL NERVE BLOCKS FOR RHINOPLASTY

Bilateral infraorbital nerve blocks decrease postoperative pain but do not reduce time to discharge following outpatient nasal surgery42 (level III evidence).

FINGER DIGITAL BLOCKS

Volunteers preferred the SIMPLE (Single Subcutaneous Injection in the Middle of the Proximal Phalanx with Lidocaine and Epinephrine) block to the commonly used 2 web space injection technique for digital blocks (level II evidence).43 The finger web space skin is just as sensitive as finger palmar skin to needle penetration (level I evidence),44 and 2 needles always hurt more than one, so the 2 web space injection technique for digital block should be abandoned. Lidocaine 2% with epinephrine SIMPLE blocks last twice as long (10 hours vs 5 hours) as without epinephrine45 (level II evidence). Epinephrine injection is safe in the finger.46

LOCAL ANESTHETIC PAIN PUMPS

Although local anesthetic pain pumps have shown some promise in other specialties,47 the literature does not reflect much enthusiasm for their use in plastic surgery.48 There is level I evidence that bupivacaine local anesthetic pain pump use in breast augmentation provided only marginal improvement in pain control compared with saline, and this advantage did not reach statistical significance.49

However, there is level I evidence that bupivacaine pump use in breast augmentation provided only marginal improvement in pain control compared with saline, and this advantage did not reach statistical significance.50 In TRAM flaps,48 there is also level I evidence that patients’ overall pain satisfaction scores were significantly better in the bupivacaine pump group than in the control group. However, there were no significant differences between groups with regard to overall abdominal pain intensity scores, total narcotic use, length of hospitalization, incidence of narcotic side effects, or milestones of surgical recovery.

There is level III evidence that pain pumps may be helpful in abdominoplasty.51 However, a larger level III evidence study showed no advantage to pain pumps in this operation.52

CONCLUSIONS

Large areas of local anesthetic can now be injected with minimal pain to decrease or eliminate the need for sedation in many plastic surgery operations. Usage of these techniques may well continue to expand because of increased patient safety, convenience, and satisfaction as well as decreased cost. Liposomal slow-release long-lasting local anesthetics provide prolonged relief after surgery, but more high-level evidence studies are required to tease out how much benefit there really is in plastic surgery.


