

Reduced pain when injecting lidocaine

Pain on injection of lidocaine is often considered a necessary evil, but it can be reduced by simple means.

Surgical interventions, also those of a more extensive nature, are increasingly performed under local anaesthesia. For patients undergoing minor surgery it is often the anaesthesia itself that is the most painful part of procedure. The pain is due to the perforation of the skin, the injected liquid activating stretch receptors in the deeper tissues, and the chemical composition of the injected substance.

It is possible to reduce the pain due to the anaesthesia itself. There is no reason *not* to remove or reduce the burning, stabbing sensation that the patient experiences. This can be achieved by simple means and is particularly important in the treatment of children.

Buffering

Buffering lidocaine with sodium bicarbonate 0.5 mmol/ml at a ratio of 9:1 is the commonest method of reducing injection pain. Lidocaine is sold as an acidic solution in order to lengthen its shelf-life, but a low pH stimulates the nociceptors in the tissues. By buffering the solution the pH can be increased from around 6.55 to 7.30 (1). This shortens shelf-life, but the solution can still be kept at room temperature for a week without reducing the effect of the lidocaine (2).

A meta-analysis from 2009 reviewed 12 studies (3). It concluded that increasing the pH of the lidocaine reduced pain on injection. In a recent study 32 volunteers were injected with 4.5 ml of both buffered and unbuffered lidocaine in the subcutaneous fat of the abdomen (1). Altogether 20 of them stated that the buffered solution was less painful, while eight preferred the unbuffered lidocaine.

Lidocaine with adrenaline (epinephrine) has an even lower pH than pure lidocaine. If this is used, there is probably even more reason to buffer the solution. The effect of the adrenaline in the solution will, however, be reduced by 25 % per week (4).

Buffering takes very little extra time if the vials of sodium bicarbonate are routinely stored together with the lidocaine. If small quantities of lidocaine are to be used frequently, a practical approach is to remove 2 ml of the lidocaine from the 20 ml vial and replace it with 2 ml of sodium bicarbonate 0.5 mmol/ml. When a greater amount of lidocaine is needed, 2 ml of sodium bicarbonate can first be drawn up into a 20 ml

syringe, which is then filled with the lidocaine solution.

Heating

A literature review concluded that there was significantly less pain when injecting lidocaine if the solution had been heated to body temperature than if it was used at room temperature (5). This was true for both buffered and unbuffered solutions.

In a recently published Norwegian study, 36 volunteers were given three injections of 4.5 ml unbuffered lidocaine subcutaneously in the abdomen (6). One injection was taken from the refrigerator, the second was at room temperature, and the third had been heated to around 38 °C. Nine participants preferred the refrigerated solution, nine the solution at room temperature, while 17 stated that the warm lidocaine was least painful.

The solubility of lidocaine increases with rising temperature (7). It is possible that this increases the rapidity of its effect. Lidocaine can be warmed to 70 °C without deteriorating (8). It is a simple matter to warm the solution by placing the vial in an ordinary warmer for baby's feeding bottles.

Injection speed

The literature is inconsistent with regard to injection speed and pain. It has been suggested that reduced injection speed reduces the distension of the tissues because the injected fluid has more time to diffuse into the surrounding tissue, and that the free nerve endings have time to adapt to the increased pressure and therefore become less activated (4).

In two studies it was found that a slow injection speed – 0.03 ml/sec. – was significantly less painful than a rapid injection (9, 10), while a third study found no difference (11). In all three studies 1–2 ml were injected and the slow injection took 6–10 times longer than the rapid injection.

In a recently published study 36 volunteers were given three injections of 4.5 ml unbuffered lidocaine in the subcutaneous fat of the abdomen for 15 seconds, 30 seconds, and 45 seconds (12). Eight preferred the rapid injection, 15 the intermediate speed injection, and ten the slow injection. The differences were not statistically significant.

In a clinical setting it is not always feasible to increase the injection time by a factor of 6–10. It would, for instance, take 150 sec-

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MAIN MESSAGE

Pain on injection of lidocaine can be reduced

Buffering and warming of the lidocaine solution before injection are probably the simplest and most effective measures

Penetration of the skin at an angle of 90° and use of thin cannulas may also result in less pain

onds to inject 4.5 ml at a speed of 0.03 ml/sec. The surgeon will often lack the patience to spend so much time on the anaesthesia, particularly when a large amount of lidocaine is needed. It is probably not advisable to inject very quickly, but apart from this, injection speed does not appear to be of great significance for the experience of pain.

Cannula thickness

Most published studies examining the relationship between cannula thickness and pain have reported on the injection of very small amounts of liquid injected through very thin cannulas, such as in vaccinations, thrombosis prophylaxis, insulin injections etc. It has been found that very thin cannulas (30 G and 32 G) are less painful, but these studies are probably of limited relevance in a surgical setting. Even so, it is interesting that Palmon and co-workers, who injected 0.25 ml unbuffered or buffered lidocaine through 25 G or 30 G cannulas, concluded that buffering was of more importance than cannula thickness with regard to pain (13).

However, a clinical study of 84 patients undergoing carpal tunnel release found that local anaesthesia with a 27 G cannula was significantly less painful than with a 23 G cannula (14). In a more recent study, 3 ml of unbuffered lidocaine was injected subcutaneously in the abdomen of 36 volunteers with cannulas of thicknesses 0.8 mm (green, 21 G), 0.6 mm (blue, 23 G), and 0.4 mm (grey, 27 G) (15). The participants were asked to report on the entire procedure, not just the perforating of the skin. Altogether 21 stated that anaesthesia with the thinnest cannula was the least painful, six preferred the medium cannula, and seven the thickest. Two were undecided.

It therefore seems advisable to select a thin cannula if a large quantity of lidocaine is not to be injected. In normal orthopaedic and minor surgery this will usually indicate a 27 G cannula. From the literature one does, however, gain the impression that the importance of this is less than the importance of warming and buffering the lidocaine. It does seem acceptable to use a 23 G or 25 G cannula when a large amount of anaesthesia is to be injected.

Other measures

An angle of 90° between the cannula and the skin causes less pain because fewer pain receptors in the dermis are hit by the needle (4, 16). Also pinching, pressing on, or stretching the skin that is to be injected may reduce the pain sensation, possibly because the nerve impulses that this causes «closes the gate» for pain impulses (4, 17).

Cooling the area to be anaesthetized with

ice cubes for 2–5 minutes reduces the pain of the injection. Leff and co-workers randomized 100 patients who were to have surgery for a hernia under local anaesthesia (18). Half of them held a bag of ice cubes at a temperature of 4 °C against the area to be operated on for five minutes before anaesthesia. This reduced the mean pain score for the lidocaine injection from 6/10 to 2/10. Exactly how the cooling reduces this pain is unclear, but it has been suggested that vessel constriction and reduced nerve conductivity may play an important role (4, 17, 18).

The application of Emla cream (a combination of lidocaine and prilocaine) is useful before dermatological procedures and venopuncture (4). However, the anaesthesia only reaches 3 mm into the tissues after 60 minutes. It is therefore usually impractical to use Emla cream before infiltration anaesthesia. In one study 20 patients were injected with 0.1 ml lidocaine with adrenaline through a 30 G cannula after the injection site had been treated either with Emla cream for 52 minutes or with ice for 1–2 minutes (17). Both measures reduced injection pain significantly compared to injection in an area that had not been treated, but Emla cream was only slightly more effective than cooling with ice.

There have been a number of published reviews of how injection pain can be reduced. One is by Strazar and co-workers from a department with very extensive use of local anaesthesia (4). They perform around 95 % of all hand surgery, including major surgeries such as tendon transpositions, under local anaesthesia, and they routinely use buffered lidocaine with adrenaline. The addition of adrenaline is safe, also in fingers and toes (19). They have described what must be considered a gold standard when anaesthetising with lidocaine. Altogether 75 % of their patients only feel the initial prick of the needle through the skin (4).

They use 30 G cannulas for the face, and 27 G for other areas. The skin is penetrated at a 90° angle and the tip of the needle inserted into the subcutaneous fat layer. Here 0.2–0.5 ml is injected and the cannula held steady until it is no longer felt by the patient, when 2 ml is injected. Only after this do they inject to the sides. Injection is performed slowly while the needle is advanced under the skin. There should always be a zone of 5–10 mm of skin in front of the needle tip that is indurated by the injected fluid and blanched by the adrenaline. When larger areas need to be injected, new penetrations of the skin should always be at least 10 mm inside the area that is indurated and blanched, and therefore anaesthetised. In open wounds the injections are into the wound itself, rather than through the skin.

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