Complications following local anaesthesia

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Administration of local anesthetics is daily routine for most dental practitioners. Normally, the effect is achieved and no adverse effects are seen. However, complications, even very serious ones, can occur in daily practice.

Complications related to local anesthesia can be divided into two categories: peroperative and postoperative complications. Both can usually be be avoided by using the correct technique and dosage. However, if complications occur, the dentist should know how best to manage them.

In this review the most common complications are presented. The preventive measures as well as treatment possibilities are also shortly described.

In this review we present the most common peroperative and postoperative complications in local anaesthesia, as well as preventive measures and treatment possibilities.

Peroperative complications

Needle breakage

Needle breakage during local anaesthesia is becoming a less common complication than it was a few years ago. This is due to a larger awareness of the possible causes and methods for avoiding such complications. Reasons for needle breakage can be categorised into six different groups:

- weakness of the alloy,
- narrowness of the needle,
- reusage of the needle,
- incorrect technique,
- sudden movement of the patient (1) or practitioner, and
- manufacturing defects (2).

Metal alloys used nowadays in injection needles are flexible, stainless and more durable than previously. This has decreased the number of needle breakage, but has not entirely solved the problem. Flexibility and narrowness allow the needle to be penetrated softly into the tissue; however, the needle can brake more easily when bent or otherwise used incorrectly (3).

Reusage of needles among different patients should be history in contemporary dentistry; yet, this may happen during the same appointment when giving additional dosages of anaesthetics to the same patient. Repeated injections with the same needle cause fatigue of the structure, and the risk of needle fracture increases (4).

The practitioner should be careful and always check all needles for any deformations before injection.

False techniques include aggressive insertion of a needle into the tissue, sudden changes in the direction inside the tissue or a too deep penetration, all of which may lead to a broken hypodermic needle. If the needle goes up to its hub inside the tissue before getting bone contact, the dentist should check if the injection site is correct and the needle is long enough for achieving the target nerve. The hub is the most common point of needle fracture.

It is important to know adequate techniques for different areas in the mouth in order to be able to inject without bending the needle and inserting it too deeply. Aggressive movements and change of direction creates forces against the needle from its sides and can lead to a sudden break. Any movement that causes needle deflection should be avoided. Aggressive insertion can lead to sudden movements of the pa-

tient making the dentist unable to control the movements of the needle (1, 3-5).

Manufacturing defects seldom happens. However, they still do occur, and with large manufacturing lots defects are unavoidable. Dentists should always check all the instruments, also the injection needles, before using them. If there is any suspicion of inadequate product quality a new one should be used.

What to do when the needle breaks? – The first thing to do if the needle breaks is to stay calm and try to localise the broken hypodermic part left in the tissues. Tell the patient what has happened and try to relax and comfort him/her. Stabilise the patient's jaws so that he/she cannot move them in order that the needle fragment stays in place. If the patient moves the jaws and the muscles of the masticatory system, the tension of the tissues is released and the needle continues to penetrate the tissues and thus may cause pain (3). Movement of the needle fragment can cause trismus if impacted into muscles attaching to the styloid process. It would be useful to have a pair of forceps at hand if needed (3, 4). If possible try to take radiographs of the suspicious area. If you cannot remove the broken part yourself, refer the patient to the closest department of oral and maxillofacial surgery with possible radiographs and a report about the complication and how you tried to treat it. Be sure to inform the patient accordingly.

In the department of oral and maxillofacial surgery the patient is examined and the needle is removed surgically under general anaesthesia. This will provide complete immobility and muscle relaxation. Methods used to localise a hypodermic needle fragment are 3-D CT-scans, metal detectors, stereotactic techniques with guided needles, electromagnets and ultrasonographies (1, 2, 5). Antibiotics, analgesics and careful oral hygiene are indicated postoperatively (2).

Pain at injection

Pain during administration of the local anaesthetic solution can have many causes.

Factors depending on the solution are low pH-value that may irritate the tissue, and the temperature of the solution – warmer feeling more comfortable than cold. The cartridge can be warmed in the practitioners hand or in warm water before injection (6).

The practitioner-related factors relate to the technique used. Fast injections and high injection pressures cause rapid swelling of the tissue and pain. This can be avoided only by a slower injection. Aggressive insertion of the needle can tear soft tissues, blood vessels, nerves or periosteum and cause more pain and other complications. An inadequate injection site can lead to an intramuscular or intraneural injection. When the needle penetrates a nerve, the patient feels a sudden »electric shock« in the distal area of the nerve. Pain after intramuscular injection is due to fibrosis or inflammation inside the muscle (7).

Hypersensitivity and allergy

Hypersensitivity or allergy to local anaesthetic are very rare. It is estimated that less than 1% of all complications are caused by allergy (8, 9). Many of the complications suspected to be allergic are actually psychogenic reactions caused by fear of dental treatment. Another reason may also be the presence of adrenaline in local anaesthetic which can cause several general symptoms, including palpitation. Naturally, sometimes a patient may suffer from an allergic reaction. In such cases the allergen is usually an additive, for example bisulphite or paraben, which is used as preservative in injectable local anaesthetic formulation. Latex may also be a potential allergen. Some of the anaesthetic cartridges have latex rubber stoppers. During injection, latex can be released from stoppers and hence cause an allergic reaction to a latex-hypersensitive person (10).

Allergic reactions vary from a mild skin irritation or rash to an anaphylactic shock. The main signs and symptoms of anaphylactic shock are chest discomfort, urticaria, stomach pain and dyspnoea. An anaphylactic reaction can rapidly lead to a life-threatening condition due to air passage obstruction in association with laryngeal oedema (11). Therefore, it has to be treated immediately.

If such complications are observed, it is very important to determine their actual cause. Inadequate diagnosis and treatment can be life-threatening to the patient. Skin or intra-oral tests can be used to find a real allergen and help the patient in avoiding exposures to those agents (12, 13).

Overdosage and toxicity

Local anaesthetic toxicity in dental practice is rare. A toxic reaction can occur when the concentration of local anaesthetic in circulation increases too rapidly. When injecting into a highly vascular area there is a risk of an intravenous injection. In addition, overdosage may lead to intoxication (14).

The toxic effect is primarily directed to the central nervous system and cardiovascular system. Typical symptoms are restlessness, convulsion and loss of consciousness. More severe symptoms can be coma, respiratory arrest, increase in blood pressure and hearth rate and even vascular collapse and cardiac arrest (11, 15).

Toxic effects appear usually within five to ten minutes af-

ter injection, but if local anaesthetic is injected intravenously, responses may be immediate. Naturally, toxic reactions are more common in block anaesthesia than in infiltration anaesthesia (11).

Toxicity can also be produced by vasoconstrictors, such as adrenaline, in which case the possible symptoms are manifestations such as increase in fear and anxiety, tremors, headache and palpitations. Special caution should be exercised when a patient suffers from hyperthyroidism or hypertension (16, 17).

To avoid toxicity, dentists should keep in mind the maximum safe doses of anaesthetics. In children and elderly patients, safe levels of anaesthetics are lower than in the remaining population. For example, a maximum safe dose of lidocaine hydrocloride 20mg/ml with adrenaline 12.5 µg/ml for healthy adults is 10 ml which means 5.5 cartridges. For children the maximum dose is 4.4 mg/kg, which means in a child of 20 kg less than 2.5 cartridges of anaesthetic. Maximum doses of some injectable local anaesthetic are listed in Table 1 (18).

Old age results in a systemic catabolic condition which means, among other things, a decreased metabolism of local anaesthetics. The situation is the same in patients suffering from a liver insufficiency. The dosage of the local anaesthetic for these patients should be reduced. In addition, to avoid toxicity aspirating technique should be used before and during injection. In this manner an intravenous injection can be avoided – even though it has been noticed that an intravenous injection can occur without inducing positive aspiration (19). Therefore, it is important to monitor the patient for possible side effects during injection. Anaesthetics should always be injected slowly. In addition, slow injection helps the anaesthetic to remain in the target area rather than being flushed into distant sites (16).

Lack of effect

Sometimes the dentist faces a problem where the patient, despite a conventional anaesthesia, still feels pain during treatment. The problem is most common with block anaesthesia, especially in the lower jaw. Reasons of failure in dental local anaesthesia can be classified as 1) anatomical, 2) pathological, 3) psychological and 4) poor injection technique (20).

Anatomical reasons include accessory nerve supply, variation in foramen location, and abnormal course of the nerves. Bifid alveolar nerve or mandibular canal can also inhibit the wanted effect. Thick cortical plate of the mandibular alveolus precludes infiltration of anaesthetic and therefore infiltration anaesthesia is insufficient in the lower jaw. Teeth can be innervated by more than one nerve trunk. Maxillary molar teeth may have pulpal supply from the greater palatine nerve, and maxillary anterior teeth may receive innervation from the naso-palatine nerve. In the mandible, a long buccal or lingual nerve can sometimes provide innervation to molar pulp. The lingual nerve is usually blocked by conventional inferior alveolar block, but to anesthetise the buccal nerve an additional pulpal infiltration is required (21). To obtain an adequate anaesthesia it is important to know the anatomy of the nerve and its variations. In complicated situations radiographs can be used to help specify the situation of foramina or mandibular canal.

Table 1. Commercial dental local anaesthetic products. Maximum doses and preference products are valid for Finland. The maximum doses may differ in other Nordic countries.

Product name	Effective agent	Maximum dosage
Xylocain Dental adrenalin®	Lidocaine hydrochloride 20 mg/ml + adrenaline 12.5 µg/ml (1:80000)	For adults 10 ml (5.5 cartridges) For children 4.4 mg/kg (20 kg; less than 2.5 cartridges)
Ultracain D-Suprarenin®	Articaine hydrochloride 40 mg/ml + adrenaline 5 µg/ml (1:200000)	For adults 12.5 ml (7 cartridges) For children 5.0 mg/kg (20kg; less than 1.5 cartridges)
Ubistesin(r) Forte	Articaine hydrochloride 40 mg/ml + adrenaline 10 µg/ml	For adults 12.5 ml For children 0.175 ml/kg
Citanest Dental Octapressin®	Prilocaine hydrochloride 30 mg/ml + felypressin 0.54 µg/ml	For adults 10 ml (5.5 cartridges) For children 6.0 mg/kg (20 kg; 2 cartridges)

Pathological reasons for failure of anaesthesia are trismus, infection, inflammation and previous surgery or trauma. When mouth opening is limited it is impossible to use conventional techniques of inferior alveolar nerve block. Therefore, the so-called Akinosi (closed-mouth) technique is useful (20). If the pulp is inflamed, the low tissue pH is said to cause lack of effect of anaesthesia in that area. However, this does not explain failure in block anaesthesia, where the solution is injected 4 to 5 cm from the inflamed area. A possible reason is hyperalgesia; inflammation makes nerves more sensitive. A minimal stimulation can cause pain perception. In these patients, to obtain a sufficient anaesthesia more solution has to be injected, for example by combining block and infiltration anaesthesia. Supplemental intra-ligamentary or intra-osseous injection can be used if necessary (20, 21).

Psychological factors such as fear and anxiety can cause failure in local anaesthesia. To enable successful anaesthesia, relaxation of the patient is sometimes needed. The use of sedatives like benzodiazepines may be helpful (21).

The most common reason for insufficient anaesthesia is *poor technique.* In inferior alveolar block anaesthesia a common mistake is to inject the anaesthetic too soon on anterior ascending ramus as the needle point touches the lingual cortical bone anterior to the lingula. Another mistake is to inject inferior to the mandibular foramen. The solution can be directed away from a nerve if it is injected too rapidly and forcefully, which can also lead to insufficient anaesthesia (21).

The best way to reach adequate inferior alveolar nerve block is the direct technique, where the needle is inserted immediately medially to the pterygomandibular raphe in such a way that it approaches from the opposite side of the premolar region and bisects the thumbnail placed at the deepest portion of coronoid notch. The needle should be inserted to a depth of 15 to 25 mm. If conventional block fails, it has to be repeated. A useful technique is, for example, Gow-Gates' technique where the needle penetrates higher than with conventional block (20).

Table 2. How to avoid complications.

- Be careful
- Know the medical history of the patient (diseases, medications, allergy)
- Know the anatomy
- Right technique and instruments
  - bone contact
  - aspirate
  - do not inject against hard pressure
  - inject slowly
- Use the minimum necessary doses of anaesthetic
- Use sedatives if necessary

Postoperative complications

Haematoma

A haematoma is caused by penetrating the vessel with the needle or by an intravascular injection, both of which cause trauma to the affected blood vessel. Trauma causes bleeding into the tissue and the formation of a haematoma (14). Many areas intraorally are highly vascular and target nerves are accompanied by large vessels. Blood pressure in an artery that has been damaged has to be high enough for a large hematoma to occur. Different parts of the maxillary artery can be affected in the IAN-block, the second division block, the posterior superior alveolar nerve block and the infraorbital anaesthesia. Penetration of the anaesthetics to the orbital area can also cause temporary blindness and ocular paralysis.

It is important to learn adequate techniques, anatomical landmark and to avoid relocating the needle to different sides inside the tissue. Haematoma formation can be avoided by careful aspiration before injecting the anaesthetic and by gentle removal of the needle. Haematomas can be large, they can appear rapidly and be dramatic in appearance, especially in the infraorbital space. It is important to inform the patient and re-evaluate the possibilities of continuing the treatment (7, 22, 23).

Trismus

Trismus after anaesthesia is usually caused by intramuscular injection of the anaesthetics in the pterygomandibular space. It can even occur 2-5 days after inferior alveolar block anaesthesia. Affected muscles are usually either the lateral pterygoid muscle or the temporal muscle. Anaesthetic solutions are usually cytotoxic and can cause inflammation inside the affected muscle and trismus (14). Intramuscular injections can cause haematoma formation inside the muscle and fibrosis, which lead to trismus (24). Trismus can also follow multiple injections to the same area, by a large haematoma or infection close to the area. Needle fracture in the muscles inserting to styloid process can cause a painful and severe trismus. It usually disappears within a few days without the need for further treatment.

For treatment in severe cases, heat therapy, analgesics, soft diet, muscle relaxants or physiotherapy should be considered. Trismus caused by an infection always needs anti-

biotics or even a surgical intervention to heal (24). Awareness of the anatomical landmarks and muscles, careful insertion of the needle and bone contact before injecting are good methods for avoiding the painful trismus (22).

Postoperative paresthesia or neuralgia

One group of local complications in dental local anaesthesia include paresthesia, neuralgia and other neural complications. Inferior alveolar nerve block is the second-most common cause of permanently altered sensation of trigeminal nerve (the most common is third molar removal). However, these kinds of injuries are rare; about 4:100.000 (25, 26).

Paresthesia can for example result from nerve injury during needle insertion or withdrawal. A nerve injury can be caused by direct nerve trauma when the needle is penetrating the nerve or when the tip of the needle scratches the nerve. Trauma feels like an »electric shock« throughout the distribution of the involved nerve, and the patient may suddenly jerk his/her head or jaw. Injection must be ceased immediately if this occurs, and the needle must be replaced in a slightly different location when retrying injection (22, 27).

When contacting bone the tip of the nerve can be damaged with developing barbs in the needle which injure the nerve on withdrawal (25).

It is reported that haematoma after local anaesthetic administration has caused altered sensation. If the needle is injuring one of the smaller intraneural blood vessels a neurotoxic intraneural haematoma can occur, and iron and free radicals from the haematoma may affect the nerve (25, 28). The lingual nerve seems to be most commonly affected. When the mouth is wide open, the lingual nerve is held tightly in the tissues and cannot be deflected by the needle. Inferior alveolar, mental and buccal nerves can also be affected due to local anaesthesia. Of these, buccal nerve damage is the most rare. In addition to total or partial anaesthesia, altered sensation may be a deep, burning pain or flushing over the associated cheek. If chorda tympani is involved there may be alteration in taste sensation.

Paresthesia or neuralgia is usually transient, but may be permanent if anaesthetic solution is injected directly into the nerve. Therefore, injection against pressure must be avoided. Actually, it is very difficult to inject into a nerve because of the tight epineurium. Instead of that, when the needle has transfixed the lingual nerve after injection and is withdrawn through the nerve, a little amount of anaesthetic into the lumen and onto the needle can cause a chemical damage (25).

Following posterior alveolar nerve block, temporary blindness and diplopia has been reported. This probably is due to a spread of anaesthetic near the nerves innervating muscles of the eye, and/or even into contact with the optic nerve, and therefore disturbs the function of the nerve (27).

If a nerve is damaged due to dental local anaesthesia the best treatment is medical. Exploratory surgery has been unhelpful because there is usually not a total disruption of the nerve fibers, and the symptoms have occasionally become even worse after surgery. If dysesthesia is the main problem it should be treated by managing the pain (25).

The most important trick to avoid neural complications as well as nearly all complicatios relating to administration of local anesthetics is the right technique and a good knowledge of the anatomy of the trigeminal nerve and the adjacent anatomical structures.

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