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Review

Tumescent anaesthesia

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ABSTRACT

Tumescent anaesthesia describes the practice of injecting a very dilute solution of local anaesthetic combined with epinephrine and sodium bicarbonate into tissue until it becomes firm and tense (tumescent). It was initially described in the field of liposuction but now surgical applications for the technique are widely varied ranging across vascular surgery, breast surgery, plastic surgery and ENT procedures. It is widely used in both hospital- and office-based environments and may form the sole method of anaesthesia for surgery. Advantages include a reduction in blood loss through both epinephrine-induced vasoconstriction as well as hydrostatic compression from the tumescent effect. Sodium bicarbonate reduces pain associated with the injection of an acidic local anaesthetic solution. Due to the unique pharmacokinetic profile of this technique lidocaine doses of 35 mg/kg bodyweight have been shown to be safe for liposuction procedures.

Tumescent lidocaine is absorbed very slowly from subcutaneous tissues producing lower, and more delayed, peak blood levels compared to other routes, as well as extended postoperative analgesia. Slow systemic absorption allows the rapid hepatic plasma clearance of lidocaine to maintain safe local anaesthetic blood levels. This slow absorption from subcutaneous tissue has been likened to a depot injection. Careful attention must be given to appropriate local anaesthetic dosage alterations in cases of co-administration with agents affecting hepatic drug clearance or conditions reducing liver blood supply. Adherence to these pharmacological principles has produced an exemplary safety record for this technique to date.

Introduction

Historically tumescent anaesthesia has been within the exclusive realm of liposuction, cosmesis and plastic surgery; however, it has slowly permeated through numerous specialties and is now widely practiced. Although perhaps most popular in liposuction, the scope of practice now extends to encompass many fields of plastic surgery, burn management, major breast surgery with occasional case series in pilonidal sinus and thyroid surgery.[1–6] It has a proven safety record with low complication rates even in populations in whom complications could be predicted; for example those patients with a high BMI.

Tumescent anaesthesia describes the practice of injecting a dilute solution of local anaesthetic combined with epinephrine and sodium bicarbonate into subcutaneous tissue until it becomes firm and tense (tumescent).[7] Tumescent solutions may occasionally be injected superficially into the dermis but are usually injected deeper into the subcutaneous tissues (hypodermoclysis). The surgical procedure may be facilitated by the dissection of tissue plains from the large volume of

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infiltrated solutions (hydrodissection). Blood loss is reduced via epinephrine-induced vasoconstriction together with the hydrostatic effects of large volume injection tamponading local blood vessels. Epinephrine also prolongs the block significantly resulting in excellent anaesthesia and postoperative analgesia. Sodium bicarbonate speeds the onset of the block and reduces pain associated with the injection of local anaesthetic.[1] Finally, local anaesthetics are known to possess bacteriostatic effects. These antibacterial effects are an additional advantage even though the necessary minimum inhibitory concentrations (MIC) are significantly higher than the typical concentrations of local anaesthetic used as part of a tumescent technique.[8]

There are several important pharmacological, pharmacokinetic and pharmacodynamic factors that need to be considered in the administration of tumescent anaesthesia leading to considerable interdisciplinary differences of opinion with respect to the maximum dose of local anaesthetic permissible. The dilution of local anaesthetic, addition of potent vasoconstrictors and pH adjustment will significantly affect overall efficacy and plasma levels. Pharmacological properties such as degree of protein binding, lipophilicity and toxidrome in overdose are also central in the choice of local anaesthetic.[9]

Tumescent anaesthesia is often used as the sole method of anaesthesia, but is also frequently combined with sedation, regional anaesthesia blocks and general anaesthesia. Apart from the excellent haemostasis achieved and prolonged analgesia, there are strong economic arguments in favour of tumescent anaesthesia. This mode of anaesthesia allows high volume surgical centres to manage a significant caseload on a day-care basis including in both hospital- and office-based environments.[10]

History and definitions

The tumescent anaesthetic technique was initially used to perform liposuction under local anaesthesia. It was presented in 1986 in Philadelphia at the Second World Congress on Liposuction, and first published in a peer-reviewed journal in 1987.[1] Early attempts at liposuction, known as the dry liposuction method used a blunt hollow cannula attached to suction. These procedures were marked by swelling, postoperative bruising and blood loss that could be up to 25% of the volume of the aspirate.[7] Liposuction evolved through the wet and then the super wet stages where increasing volumes of saline were injected into the adipose tissues before suctioning. Aspirate volumes using these techniques occasionally exceeded 4 L in one session under sedation or general anaesthesia. This approach was still associated with excessive blood loss of up to 10% of the aspirated volume. In tumescent liposuction the infiltration solution volume is often up to 4 times the volume of the aspirated fat. However with this method the addition of epinephrine to the saline infiltrate significantly reduces final blood loss down to 1% of the aspirated volume.[11]

Infiltration for liposuction is initially performed with a small needle followed by vented liposuction cannulas of various diameters. For other types of surgery infiltration is most often performed with narrow spinal needles in a fan-like systematic manner. The injection of tumescent anaesthesia for varicose vein surgery with ultrasound guidance reduces the incidence of intravascular injection as well as injury to adjacent nerves and arteries.[12,13] The tumescent solution may be injected by a simple spring loaded syringe with one way valves (Fig. 1) from pressurised infusion bags or by variable flow rate pumps.[14–17] Avoidance of excessive flow rates makes infiltration more comfortable for patients.

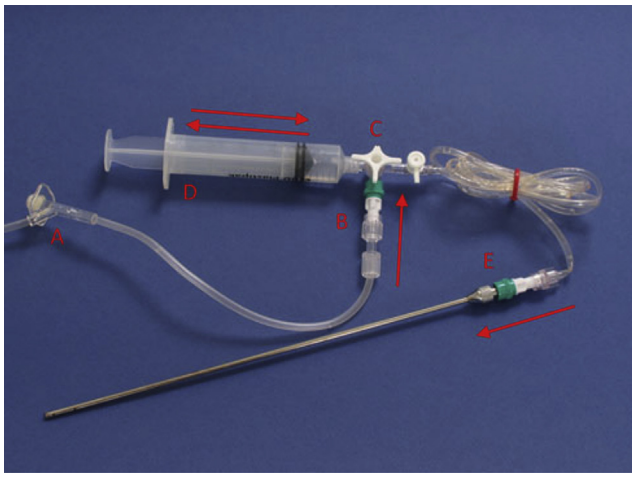

Fig. 1 – Example of three-way stopcock system for the administration of tumescent anaesthesia.[15]

Some authors have described tumescent anaesthesia as "a catchy name for field a block with diluted lidocaine solution, sufficient to distend overlying skin".[18] However the procedure has certain unique characteristics that distinguish it from a field block. The original classical description of tumescent anaesthesia by Dr Jeffrey Klein uses large volumes of saline to produce extremely dilute concentrations of lidocaine with added epinephrine and bicarbonate. This achieves the dual aims of performing liposuction entirely under local anaesthesia while at the same time significantly reducing blood loss.[19]

Applications of tumescent anaesthesia

Tumescent anaesthesia is most commonly used for dermatologic surgery, but with the increasing popularity of "minimal access minimally invasive" surgery, several other windows of opportunity have opened. One attractive feature of tumescent anaesthesia from a surgical perspective is that it can allow the safe conduct of a wide range of surgery in less resource intensive environments (e.g. office-based surgery conducted solely under local anaesthesia). Some examples of these applications are listed below:

1. Liposuction.[1]
2. Dermatologic surgery: dermabrasion, CO_2 laser resurfacing, chemical peels, facelift, Moh's micrographic surgical excisions (using the dermal tumescent technique with injection into the dermis as opposed to the subcutaneous tissue layer).[20]
3. Hair transplantation[21]
4. Mastectomy,[4] breast reduction surgery[22]
5. Burn excision and grafting[3]
6. Anaesthesia for Zoster dermatitis[23]