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THE USE OF LAT GEL IN LACERATION MANAGEMENT IN THE EMERGENCY DEPARTMENT

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PREFACE

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ABSTRACT (English)

Introduction: LAT gel is a topical anaesthetic agent that consists of lidocaine, adrenaline and tetracaine. It may be applied to non-intact skin and is used to anaesthetize lacerations. Applying LAT gel is easier and less painful than local infiltration, which is the most commonly used method to anaesthetize lacerations in adults.

Objective: The objective of this study is twofold. First, this study aims to determine whether LAT gel allows the management of lacerations without the need for additional anaesthesia (lidocaine infiltration) in adults and adolescents. Consequently, it wants to point out whether LAT gel is a safe and effective alternative compared to infiltrative anaesthesia. As a second objective, we want to define an adult population in which LAT gel can provide an advantage compared to infiltrative anaesthesia.

Materials and methods: We have used a retrospective study of ED records of patients with a laceration who had LAT gel applied at triage. Patients under the age of 9 years are excluded as well as patients under the influence of alcohol and/or drugs and patients who got Kalinox[®] as additional sedation.

Results: 88 patients had LAT gel applied, of which 21 (23.9%) patients needed additional anaesthesia. In the group who needed additional anaesthesia, the length of the wound is significantly longer than in the group who did not need additional anaesthesia (3.14 cm vs 2.06 cm respectively, $p=0.004$). Small lacerations (0-2 cm) needed significantly less additional anaesthesia than moderate large lacerations (4.1-7 cm) ($p=0.002$). Lacerations located on the extremities/trunk/fingers/toes needed significantly more additional anaesthesia compared to lacerations located on the head ($p=0.045$). No adverse events were noted.

Discussion and conclusion: LAT gel is a safe and effective alternative compared to infiltrative anaesthesia for laceration management in adults. The application of LAT gel is very suitable for uncomplicated lacerations located on the head and for small lacerations (<4 cm). In addition, LAT gel can be used in small uncomplicated lacerations located on fingers and toes.

ABSTRACT (Nederlands)

Introductie: LAT gel is een topisch anaestheticum bestaande uit adrenaline, lidocaïne en tetracaïne. Dit anaestheticum mag aangebracht worden op de niet-intacte huid en wordt gebruikt om snijwonden te verdoven en zo pijnvrij te kunnen hechten. Het aanbrengen van LAT gel is eenvoudiger en minder pijnlijk dan een lokale infiltratie met lidocaïne. We onderzoeken of LAT gel een evenwaardig alternatief kan betekenen ten op zichte van een lidocaïne-injectie, de huidige standaard voor het verdoven van snijwonden. Daarnaast proberen een populatie te definiëren waarbij het gebruik van LAT gel een meerwaarde kan betekenen ten opzichte van infiltratieve anesthesie.

Methode en materialen: Een retrospectieve studie werd uitgevoerd op de spoedgevallen dienst van het Universitair Ziekenhuis Gent. De patiëntendossiers van patiënten die zich aangemeld hebben met een snijwonde en die LAT gel aangebracht kregen tijdens triage, werden bestudeerd. Patiënten jonger dan 9 jaar, patiënten onder invloed van alcohol en/of drugs en patiënten die Kalinox[®] als extra sedativa kregen toegediend werden geëxcludeerd.

Resultaten: 88 patiënten werden behandeld met LAT gel, slechts 21 (23.9%) patiënten hadden extra verdoving nodig. In de groep die extra verdoving nodig hadden was de lengte van de wonde significant groter dan in de groep die geen extra verdoving nodig had. (3.14 cm vs 2.06 cm, respectievelijk, $p=0.004$). Kleine snijwonden (0-2cm) hebben significant minder extra verdoving nodig dan middelmatig grote snijwonden (4.1-7cm) ($p = 0.002$). Snijwonden gelokaliseerd ter hoogte van het hoofd hadden significant minder verdoving nodig dan snijwonden gelokaliseerd ter hoogte van de vingers, tenen, romp en extremiteiten ($p=0.045$). Er werden geen complicaties genoteerd.

Discussie en conclusie: LAT gel is een veilige en effectief alternatief ten opzichte van infiltratieve anesthesie om snijwonden te verdoven bij volwassenen. Vooral ongecompliceerde wonden gelokaliseerd ter hoogte van het hoofd en wonden kleiner dan 4 cm zijn een uitstekende indicatie voor het gebruik van LAT gel. Daarnaast kan LAT gel ook gebruikt worden voor kleine, ongecompliceerde snijwonden ter hoogte van de vingers en tenen.

INTRODUCTION

Traumatic lacerations are a common problem faced at emergency departments (ED).¹ In 2012, 1,093 patients were treated for lacerations at the emergency department of the Ghent University Hospital, which is 3.6% of all ED visits. In this manuscript, the use of LAT (acronym for lidocaine, adrenaline and tetracaine) gel, a topical anaesthetic, in the management of lacerations in the ED will be studied.

First, the general concepts of laceration management will be discussed in order to demonstrate the importance of adequate anaesthesia. In the second part of this introduction, the current most commonly used topical anaesthetic agents will be covered, discussing their advantages and disadvantages. Finally, the objective of this study will be formulated.

1. General concepts of laceration management in the emergency department

The goals of laceration treatment are threefold: performing a meticulous wound closure which restores function, preventing wound infection and achieving a functional and aesthetically acceptable scar.¹ Singer et al.² found that these three goals correspond to the patients' expectations and priorities.

The majority of lacerations heal without complications, regardless of any kind of management. Although the occurrence of wound infection is not high, 2,6% according to a study performed by Quinn et al.³, there is still a chance that improper management will lead to an increased likelihood of wound infection, patient discomfort and patient dissatisfaction.

The most predictive factors for infections identified in several studies^{3, 4} are the location, length, and configuration of the wound, the presence of a foreign body and visible contamination.

The goals of laceration management can be obtained by means of: reducing wound contamination by thorough cleaning and irrigation, debridement of devitalised tissue, restoring perfusion in poorly perfused wounds, establishing a well-approximated skin closure, and good aftercare of the closed wound.¹

1.1. Evaluation of the patient

1.1.1. Medical history of the patient

Proper wound management starts with a detailed patient history to identify risk factors and conditions that may have an influence on wound healing and that may increase the risk of infection.

Several patient factors that have been identified in a prospective study by Cruise and Foord⁵, not only have adverse effects on wound healing, but also increase the wound infection rate. Older and younger age, diabetes mellitus, chronic renal failure, obesity, malnutrition, and the use of immunosuppressive medications agents are all considered risk factors.⁵ Impaired wound healing can also be caused by inherited and acquired connective tissue disorders such as Ehlers-Danlos syndrome, Marfan's syndrome, osteogenesis imperfecta and protein and vitamin C deficiencies.¹

A detailed history of allergic reactions to anaesthetics, antibiotics and latex is necessary as these probably will be used during wound management.

1.1.2. Tetanus status

The tetanus immunisation status needs to be determined for all patients with wounds. Proper immunisation plays the most important role in tetanus prophylaxis. Generally, it is recommended by the Advisory Committee on Immunization Practices (ACIP)⁶ that adults are vaccinated with tetanus toxoid every 10 years.

In addition to tetanus immunisation, human tetanus immune globulin is indicated in case of markedly contaminated wounds and one of the following scenarios:

- a) When the number of previous doses administered is less than three.
- b) When the number of previous doses is unknown.
- c) When there is no history of tetanus toxoid in the previous five years.

Markedly contaminated wounds not only are wounds that are contaminated with dirt, feces, soil or saliva, but also refers to puncture wounds, avulsions and wounds resulting from missiles, crushing, burns or frostbite.⁶

1.1.3. Screening examination

Lacerations are often the result of systemic problems or illnesses. For example, syncope can result in a laceration, meaning that the cause of the syncope needs to be identified. Also, a scalp laceration caused by a blunt trauma can be associated with an intracranial injury. Therefore, it is necessary to perform a full examination, a patient history and a trauma-oriented neurological examination in addition to the wound assessment.

1.2. Evaluation of the laceration

1.2.1. Mechanism

A history of the mechanism of injury is essential to help identify the presence of potential wound contaminations and foreign bodies. The studies by Hollander et al.⁴ and Quinn et al.³ shows that the presence of foreign bodies will increase the risk of infection, especially when retained. Foreign bodies are common in puncture wounds, wounds associated with broken glass and motor vehicle collisions.⁷ The most commonly retained foreign body is glass.⁸

The likelihood of wound infection also depends on the type of forces applied at the time of injury. The most common mechanism for traumatic wounds is caused by blunt force.⁹ When this is the case, the skin is crushed against underlying bone and tears or splits because of the subsequent tension. Sharp objects, on the other hand, produce shear forces that cut the skin cleanly. Crush injuries have the tendency to cause more tissue devitalisation and are thus more prone to infection compared to wounds resulting from sharp objects.^{4, 10}

Finally, bite wounds are at high risk for wound infection and should be managed differently compared to other lacerations.⁴ The management of bite wounds will not be discussed here.

1.2.2. Time of the injury

Most wounds should have primary closure to reduce the patient's discomfort, to improve the rate of healing as well as cosmetic outcomes.

Controversy exists over when or if to close wounds that are delayed in presentation to the ED. Previous studies have always suggested that there is a direct relation between the time from the injury to the closure of the laceration and the risk of subsequent infection, but that the length of this 'golden period' is highly variable (3-24 hours).¹¹ A more recent study by Quinn et al.³ suggests that this 'golden period' is not that important as previously thought and that such a period no longer exists. This is probably due to improvements in irrigation and decontamination techniques in the past 30 years.^{3, 11}

Even though there is no real evidence of a golden period, every wound should be evaluated individually before closing it. The acceptable time interval for laceration repair depends on each individual situation. Factors that need to be considered whether or not to close a wound primarily are: the cause of the wound, the location of the wound, the degree of contamination and the patient's predisposing medical conditions.^{3, 4}

When wounds are not closed primarily, because of a high risk of infection, delayed primary closure should be considered after three to five days. Within this time span, the risk of infection decreases.¹

1.2.3. Location

The anatomical location of the laceration helps predict the risk of infection and the cosmetic outcome. Wounds located on the highly vascularised face or scalp are less likely to be infected, regardless of the intensity of cleaning, than wounds in less vascularised areas such as the lower extremities.^{3, 12}

The location of the wound contributes to the cosmetic outcome of the scar by affecting static and dynamic skin tensions. Lacerations over joints are more susceptible to the development of wider scars. On the other hand, lacerations located on the lines of minimal skin tension are less prone to scar formation.¹³

1.3. Examination of the laceration

Proper wound examination should always be performed under optimal lighting conditions with minimal bleeding.¹ An examination under poor lighting conditions or an examination during which parts of the wound are obscured by blood, can result in underdetection of foreign bodies and in missing injuries of important structures such as tendons, nerves, and vascular structures.¹ To minimise the risk of not detecting an injury to a vital structure, it is recommended that all wound examinations start with a neurovascular examination of pulses, motor function, and sensation distal to the laceration.¹

The use of gloves is necessary during the whole procedure of wound examination, preparation and treatment. Currently, the most common practice is to use nonsterile gloves during the wound examination and preparation and sterile gloves for surgical repair. A prospective study by Perelman et al.¹⁴ shows that there is no increased incidence in post-repair infection rates when repairing wounds while using nonsterile gloves. The study therefore proves that clean, nonsterile, boxed gloves can be safely used with common-sense cleanliness to repair uncomplicated traumatic lacerations without increasing the risk of wound infections.¹⁴ Yet, for medicolegal reasons, sterile gloves and a sterile technique are preferred during surgical repair.

1.4. Local anaesthesia

Effective anaesthesia of a wound is essential in the management of lacerations. It improves the patient's cooperation during wound preparation and closure. In addition, it allows the physician to perform a thorough exploration, irrigation, and debridement and it enables a well-approximated wound closure. The main goal is to provide effective local anaesthesia with minimal pain and distortion of the tissue. The ideal anaesthetic method, as defined by Achar et al.¹⁵, gives 100 percent analgesia, has a rapid onset of action, works on intact and non-intact skin without systemic side effects, and causes neither pain nor toxicity.

There are several methods available to obtain local anaesthesia in lacerations, including intradermal infiltration, field or nerve block and topical anaesthesia. Unfortunately, none of these methods meet all of the above criteria.

The choice of anaesthetic agent and the method of application must be tailored for each individual patient. Apart from patient factors (age, comorbidities, fear of injections, allergy and sensitivity to catecholamines), the type, location, size and depth of the laceration, the estimated length of time for repair, the need for hemostasis, and the method of closure are variables that are considered.

In the case of very young patients, uncooperative patients or complicated laceration repair, procedural sedation may be required.

1.4.1. Anaesthetic agents

Based on their chemical structure, local anaesthetic agents can be classified in two major classes: amides and esters. Ester and amide local anaesthetics differ mainly in their mechanism of metabolism and in their allergic potential.¹⁶

The most commonly used anaesthetic agent for local infiltration is lidocaine, an amide. Other anaesthetic agents that are commonly used for infiltration are mepivacaine, prilocaine and bupivacaine.

1.4.1.1. Allergy

Some patients may report having had an allergic reaction to a local anaesthetic in the past. Careful review usually reveals that what they were experiencing, was either a vasovagal response associated with the painful injection, reactions due to minor toxicity of the anaesthetic agent or cardiac palpitations due to epinephrine.¹⁶ When there is a proof of an allergy to a specific local anaesthetic, the patient can be treated with an agent of the other class because there is little cross-reactivity between the two classes.¹

True allergic reactions to local anaesthetic agents are rare and are often due to preservatives (methylparaben) used in multi-dose vials or antioxidants (sulfites).¹⁶ An alternative is the use of pure agents without preservatives such as single-use lidocaine (cardiac lidocaine). Another valid method is the use of alternative anaesthetic agents such as diphenhydramine or benzyl alcohol.¹

1.4.1.2.Toxicity

The most common cause of systemic toxicity is inadvertent injection of an anaesthetic agent in a vessel causing a bolus effect on the heart or brain. Other causes are when the maximum dose is exceeded or in case of an idiosyncratic response.

The two organ systems that are affected the most by excessive systemic absorption of local anaesthetic agents, are the central nervous system (CNS) and the cardiovascular system.^{16, 17}

The early signs and symptoms of CNS toxicity induced by local anaesthetic agents resemble vasovagal responses such as metallic taste, tinnitus, tingling lips, vertigo and confusion and are followed by tremors and shivering. Ultimately, generalized seizures and respiratory arrest may occur.

The effects on the cardiovascular system are caused secondarily by the blockade of the sodium channels in the cardiac conduction system. At low doses, local anaesthetics cause systemic vasoconstriction and raise blood pressure. At high doses, local anaesthetics may cause negative inotropic effects on the heart as well as heart block.

1.4.1.3.Addition of epinephrine

Adding a vasoconstricting agent such as epinephrine to a local anaesthetic has several benefits. It helps to control local bleeding, it prolongs the duration of action of the anaesthetic agent and it allows a higher safe dose to be administered because of less vascular diffusion.

The vasoconstriction will cause blanching of the skin, which can be useful as a visual indicator of the extent of the anaesthetized area.¹⁸

It is found to be safe to use epinephrine in the digits, nose and ears of patients without small vessel disease.^{19, 20}

1.4.2. Local infiltration

The most common form of anaesthesia for lacerations is administered by local infiltration. This method is the most reliable one, but the disadvantage is that the injection is painful and that it subjects the practitioner to the risk of a needle stick injury. Another disadvantage is the distortion of tissue planes caused by the needle. Additionally, the injection of the anaesthetic solution disrupts tissue and makes suturing slightly more difficult, entailing an increased risk of scarring.²¹

1.4.2.1.Reducing pain during infiltration

Pain from local anaesthetic injections occurs with both the insertion of the needle and the infiltration of the anaesthetic agent. Various methods have been investigated to reduce the pain associated with local infiltration.

The use of sodium bicarbonate to buffer the local anaesthetic agent results in more rapid and less painful onset of the anaesthetic agent. Buffering the solution accelerates the diffusion of the local anaesthetic into the nerve fibres with a faster time of onset.¹⁸

Alternatively, using warm anaesthetic solutions reduces the pain of injection whether the solution is buffered or not.²² The combination of both buffering and warming the local anaesthetic agent causes the least pain.^{18, 22}

Other methods that have been described to reduce the pain are¹⁸:

- The use of small diameter needles.
- Injecting slowly and steadily.
- Injecting through the edges of the wound instead of through the intact skin (if the wound is not contaminated).
- Subcutaneous injection instead of intradermal injection.
- Pretreating the wound with topical anaesthesia.
- Cooling the skin with ice.
- Distracting the patient.

1.4.3. Regional anaesthesia: field and nerve block

Field block and nerve block are methods for regional anaesthesia that can be used for: large wounds or for multiple lacerations that otherwise would require large, potentially toxic doses of local anaesthetics; wounds in which undesirable tissue distortion would be caused by local infiltration; when large areas of skin must be scrubbed or debrided; and wounds in which local infiltration would be particularly painful.^{1, 13}

Field block anaesthesia is produced by subcutaneous injection of a local anaesthetic agent in order to anaesthetize the region distal to the injection site.

Local anaesthetics can also be injected with a high degree of spatial accuracy in order to make contact with nerves that supply the affected area, which will induce a nerve block. For this approach, skill and knowledge of anatomy are necessary to achieve a high success rate and to avoid complications in nerve block anaesthesia. One of the most common locations where nerve blocks are used for laceration repair, are the digits.

1.4.4. Topical anaesthesia

The application of topical anaesthetics, which is non-invasive, has been investigated as an alternative to infiltration of anaesthetics. It avoids the use of needles and thus the risk of a needle stick injury and it also enables a painless application. Another advantage of topical anaesthesia in laceration repair is that the wound margins are not distorted. This method is often preferred by patients who are afraid of needles or unable to tolerate them.¹ Especially regarding children it offers many advantages.

The ideal topical anaesthetic would be painless and easy to apply, would provide rapid and effective anaesthesia for a reasonable length of time and would have minimal side effects.²³ Examples of such topical anaesthetics are a combination of tetracaine, adrenaline and cocaine (TAC), a combination of lidocaine, adrenaline and tetracaine (LAT) or a eutectic mixture of local anaesthetics (EMLA).

The use of topical anaesthesia and the different topical anaesthetic agents will be discussed more thoroughly below in part 2 of this introduction.

1.5. Wound preparation

Wound preparation is, together with anaesthesia, the most important step in the treatment of lacerations. It prepares the wound for closure and consists of irrigation, debridement, hair removal, exploration and hemostasis. All of this will lead to an optimal condition to close the wound with minimal risk of wound infection and maximum cosmetic outcome of the wound.

1.5.1. Hemostasis

Bleeding control is necessary to facilitate an adequate visualisation of anatomical structures and to assess for the presence of obvious contamination and devitalised tissue. Applying direct pressure for 15 to 20 minutes with a gauze pad or a pressure bandage can nearly always control external bleeding.

If the wound persists to bleed despite continuous direct pressure, a sphygmomanometer may be placed proximal to the wound.¹

An alternative with digital lacerations is the use of a tightly fitting sterile glove to achieve hemostasis.

Vasoconstrictors, such as epinephrine, can be used as adjuncts to the local anaesthetics. They reduce bleeding within the laceration and facilitate exploration and wound closure as described above.

1.5.2. Hair removal

Wounds in well-perfused locations, such as scalp and face, can be closed without hair removal and with no increase in the wound infection rate.²⁴ Still it is better to remove the hair surrounding a laceration as hair can interfere with wound closure. It can act as a foreign body when entangled in the wound and it can also increase the risk of wound infection.

Shaving hair should be avoided as this damages the hair follicles, which are normally colonised by bacteria, thereby increasing the risk of infection.¹ A better alternative is to clip the hair with a scissor or to use saline to part the hair away from the wound edges.

As regards eyebrow hair, removing the hair may result in abnormal regrowth. Also, its presence serves as a guide for exact approximation of wound edges during laceration repair.¹

1.5.3. Skin disinfection

Disinfecting intact skin around the wound or ‘scrubbing ‘ with an antiseptic agent (povidone-iodine or chlorhexidine) is common practice. The agents suppress bacterial growth on intact skin, but they impair host defenses and enhance bacterial growth in the wound itself.²⁵ Skin disinfectants should therefore only be applied on the intact skin from the wound edges outward. The main purposes of this procedure are to disinfect the surrounding skin, to remove any visible contamination and dried blood, and to create a visibly clean wound.²⁶

1.5.4. Irrigation

Mechanical forces are commonly used to decontaminate the wound and to remove bacteria and other particles that have retained on the wound surface by adhesive forces. The most commonly used mechanical force is irrigation.²⁷ Effective irrigation reduces the risk of wound infection by decreasing bacterial count and removing debris and foreign bodies. However, irrigation may not be necessary for all low-risk wounds, particularly for simple uncontaminated wounds in well-vascularised areas.¹

Low-pressure irrigation is sufficient for uncontaminated wounds and is achieved by washing slowly and gently. High-pressure irrigation should be used for contaminated wounds especially when they are located in areas of the body associated with higher risk of infection.

High-pressure irrigation can be achieved by the combination of any syringe with an 18-gauge catheter.²⁸

Normal saline is commonly used as irrigation solution for wounds. Tap water irrigation is an acceptable alternative for healthy patients with clean wounds and in settings where the water quality is assured. Tap water is as safe and efficacious as normal saline.²⁹ Antiseptic solutions such as povidone-iodine, chlorhexidine and hydrogen peroxide are sometimes used in contaminated wounds but should be avoided as some of them may be toxic to wound tissue, have little action against bacteria, disturb wound healing, or have other adverse effects.²⁵

Wound soaking is not effective to clean contaminated wounds. On the contrary, it increases the bacterial count within the wound, although it has some effect on removing gross contaminants from the skin surrounding the wound.³⁰

Finally, scrubbing the wound with a surgical sponge is also discouraged as this causes more trauma unless the wound is severely contaminated.²⁶

1.5.5. Debridement

As regards the management of contaminated wounds, debridement of nonviable tissue has been considered to be equally or more important than irrigation.³¹ Debridement implies the removal of devitalised tissue, which if retained, impairs the wound's ability to resist infection. Any devitalised tissues such as fat, muscle, and skin have the capacity to enhance bacterial infection.³² Besides removing foreign particles and devitalised tissue, debridement also creates a clean wound edge that facilitates wound closure.

The most commonly used methods of debridement in the ED are surgical excision, high-pressure irrigation, wet-to-dry dressings and autolytic debridement.³³ The most effective of those techniques is surgical excision. The advantage of this method is that it turns a contaminated wound into a clean surgical wound.

Wounds that are heavily contaminated or wounds which contain a large amount of nonviable tissue, may need a large amount of tissue removal and will require a more delayed wound closure.²⁶

1.5.6. Exploration and foreign body removal

A thorough exploration of the wound ensures that all foreign bodies are identified and that injuries to important structures are visible (nerves, vessels, tendons). Failing to identify foreign bodies may lead to complications such as inflammation, increased risk of infection, delayed wound healing and loss of function.

Visual wound inspection is the most important method to detect foreign bodies.⁷ Nevertheless, direct wound inspection may fail to detect all foreign bodies, particularly if the base of the wound cannot be seen. Radiological evaluation can be helpful if the foreign body is radiopaque such as metal, rocks and some types of glass.^{4,27}

The decision to extract the foreign body should be based on the type of object, the location, the overall risk of infection and the risk of complications associated with the removal. An inert foreign body, such as glass or metal, that is not located in a critical area and that will cause no irritation, may be left in place if unable to be removed. Irritant material such as wooden splinters should always be removed, as they can be a source of infection.²⁷

1.6. Wound closure

The ideal wound closure technique defined by Hollander et al.¹ would have the following characteristics:

- It allows a meticulous wound closure.
- It is applied easily and rapidly.
- It is painless.
- It is of low risk to the practitioner.
- It is inexpensive.
- It results in minimal scarring with a low infection rate.

There are four commonly available methods to provide an accurate and secure approximation of the skin edges: sutures, adhesive tapes, staples and tissue adhesives. Ideally, the choice should be based on each individual patient as well as on wound characteristics. One of the most important factors that need to be considered when choosing a wound closure method is the amount of tension on the wound. The tissue should be held in apposition until the tensile strength of the wound is sufficient to withstand stress.³⁴

1.6.1. Sutures

Sutures remain the most commonly used method for wound closure. They are not only the strongest method of all, but they also allow the most accurate approximation of the wound edges and they have the lowest dehiscence rate.³⁴ The disadvantage of sutures is that it is time-consuming, that it has the greatest tissue reactivity and that it is the most operator-dependent of all wound closure methods.³⁴

1.6.2. Staples

Stapling is the fastest method of skin closure; it is not only relatively easy to use, but it is also cost-effective.³⁴ Staples are associated with the lowest rate of foreign body reaction. The disadvantage is that stapling does not allow a precise approximation of the wound edges.³⁴ They should be avoided for lacerations in the face, neck, hands, or feet. Staples are most appropriate for linear wounds located on the scalp and trunk and for extremities when it is important to save time. The cosmetic outcome and the infection rates are comparable to sutures.³⁴

1.6.3. Tissue adhesive

Tissue adhesives or skin glues, such as octyl cyanoacrylate, allow a rapid and painless wound closure. Anaesthesia is unnecessary unless painful irrigation, debridement or exploration of the wound is expected. Tissue adhesives should only be used topically and should not be placed within the wound or between the wound margins. They can only be used in high-tension areas when deeper sutures are placed to relieve tension on the skin edges. They should not be used, however, over areas of high tension or repetitive movements, such as over joints. The single use of tissue adhesives is mostly limited to short, pediatric and facial lacerations.^{27, 35} They provide an excellent cosmetic result in comparison with sutures.³⁵

1.6.4. Adhesive tapes

Adhesive tapes are the least reactive and the most cost-effective of all wound closure methods.³⁶ The application is simple, rapid and painless. No anaesthesia is needed, except if wound irrigation, debridement or exploration is required. Their use is limited to linear wounds that are subjected to minimal static and dynamic tension. Tapes alone cannot maintain the wound integrity in areas subject to tension. They are seldom recommended for primary wound closure because of their high rates of dehiscence and they cannot be applied in hair-bearing areas. They are often used in combination with dermal sutures, which decrease the wound tension.¹

1.7. Post-repair wound care

Post-repair wound care starts after laceration repair in the ED and continues after discharge until the wound is totally healed. Post-repair care optimises healing and minimalises complications.

Wound care should be tailored to both the type of wound and the type of wound closure.³⁴ Sutured and stapled lacerations should be covered with a protective, non-adherent dressing for at least 24 to 48 hours. Maintaining a moist wound environment increases the speed of re-epithelisation in sutured and stapled wounds. This does not mean that it decreases wound infection rates when compared to wounds exposed to open air.³⁷

Topical antibiotics provide a warm and moist environment that is beneficial to wound healing but it does not reduce the infection rate in uncomplicated wounds. The use of prophylactic oral antibiotic should be considered on the basis of the following factors: the degree of contamination, the mechanism of the injury, and the presence or absence of host predisposition to infection. It should be used in most human, dog, and cat bites and for intraoral lacerations, open fractures, and exposed joints or tendons.^{1, 13} Antibiotics with coverage against gram-positive organisms are adequate for most wounds. Broader coverage can be necessary in open fractures or in bite wounds. Patients are recommended to keep their wounds clean and dry and they should observe the wound for signs of infection, such as erythema, warmth, swelling and drainage.

Non-absorbable sutures and staples over most areas should be removed after approximately 7 to 10 days. Facial sutures should be removed sooner (within 3 to 5 days). Sutures and staples subject to high tensions (joints, hands) should be left for 10 to 14 days.

Wounds can also develop hyperpigmentation when exposed to the sun. As a consequence, all wounds need to be protected with a sun-blocking agent for at least 6 to 12 months after injury.²⁷

2. Topical anaesthesia

Topical application of anaesthetics, which is non-invasive, has been studied as an alternative to infiltration of anaesthetics. Patients who are afraid of needles or unable to tolerate them, often prefer this method.¹ The majority of studies, which have investigated the use of topical anaesthesia, have researched formulations of TAC (tetracaine, adrenaline (epinephrine), cocaine), LAT (lidocaine, adrenaline (epinephrine) and tetracaine), or a eutectic mixture of local anaesthetics (EMLA). Other formulas have been studied less frequently and will be mentioned briefly below. Table 1 provides a summary of commonly used topical anaesthetics in minor laceration repair based on currently available literature.

Table 1: Characteristics of commonly used topical anaesthetics in minor laceration repair. Data from Kundu.²¹

Anaesthetic agent	Method of application	Onset/duration	Effectiveness	Complications
TAC	1 ml/cm laceration, applied to wound with cotton or gauze for 10 to 30 minutes	Onset: effective 10-30 minutes after application. Duration: not established.	May be as effective as lidocaine for lacerations on face and scalp	Rare severe toxicity, including seizures and sudden cardiac death
LAT	1 ml/cm laceration, applied directly to wound for 15 to 30 minutes	Onset: 20 – 30 minutes after application. Duration: not established.	Similar to TAC for face and scalp lacerations	No severe adverse effects reported.
EMLA	Thick layer (1 to 2g per 10cm ²) applied to intact skin with covering patch of Tegaderm	Onset: must be left on for 1 to 2 hours. Duration: 0.5 to 2 hours.	Variable, depending on duration of application.	Contact dermatitis, methemo-globinemia (very rare)

2.1. TAC

TAC is a mixture of tetracaine (0.5%), adrenaline (1:2000) and cocaine (11.8%). It is the first topical anaesthetic mixture introduced by Pryor et al.³⁸ that has shown to be effective for repair of non-mucosal lacerations to the face and scalp.^{38, 39} Tetracaine and cocaine provide the local anaesthetic effect. Cocaine and adrenaline cause local vasoconstriction which minimizes the bleeding from the wound and decreases systemic absorption and toxicity. Several studies^{23, 38, 40} have found that TAC provides anaesthesia that is equal to that of lidocaine infiltration for suturing facial laceration repair in children. A study by Hegenbarth et al.²³ has shown that there is no statistically significant difference in wound complication rates in lacerations anaesthetized with TAC compared to lidocaine infiltration.

However, improper use of TAC has been associated with serious adverse events including seizures, cardiac arrest and death secondary to absorption of the cocaine component.⁴¹ The use of TAC is no longer recommended by literature because of general concern due to the toxicity, high cost and federal regulatory issues involving medication containing cocaine.²¹

2.2. LAT

LAT is a mixture of lidocaine, adrenaline (epinephrine) and tetracaine. It exploits the rapid onset of lidocaine and the long duration of tetracaine and it has been the most widely studied cocaine-free formulation.

LAT was first introduced by Ernst et al.⁴² in 1995 as a safer and cheaper alternative for topical anaesthesia compared to TAC. The use of LAT has proved to be as effective as TAC in various studies.⁴²⁻⁴⁴ The exclusion of cocaine not only reduces the risk of toxicity, but also makes the product cheaper and free from the regulations surrounding controlled drugs.⁴²

A non-blinded RCT by Ernst et al.⁴⁵ has disclosed that LAT gel was equally efficacious as infiltrated lidocaine containing epinephrine and bicarbonate. According to a prospective, randomized double blind study by Adler et al.⁴⁶, LAT significantly reduces the number of patients requiring infiltrative anaesthetic for suturing lacerations. The same study has shown a trend in pain reduction for those who require further anaesthesia with infiltration.⁴⁶

The use of LAT significantly reduces the need for general anaesthesia in children with traumatic lacerations.⁴⁷ Solution and gel formulations of LAT have provided comparable analgesic efficacy.⁴⁸

Contraindications for the application of LAT gel are: wounds located on nose, ear, genitalia and mucous membranes; burn wounds, bite wounds and large abrasions and allergy to one of the constituents of the gel.

Up till now, no serious complications have been reported. A case of a unilaterally dilated pupil has been described by Gala.⁴⁹ LAT gel is found to be safe to use for simple finger lacerations.⁵⁰

2.3. EMLA

A eutectic mixture of local anaesthetics (EMLA) is the first found eutectic agent that can be used for dermal anaesthesia on intact skin.²¹ Eutectic mixtures are liquid and melt at lower temperatures than any of their components, which permits higher concentrations of anaesthetics.²¹ EMLA is a combination of lidocaine 2.5% and prilocaine 2.5%.⁵¹

EMLA has been studied to reduce the pain of several procedures such as phlebotomy⁵², intramuscular injection⁵³, peripheral intravenous cannulation⁵⁴, skin allergy testing⁵⁵ and lumbar puncture.⁵⁶

Zempsky and Karasic⁵¹ have compared the efficacy of EMLA with TAC for repairing extremity lacerations. According to this study, 85 percent of children whose lacerations were treated with EMLA required no further anaesthesia before suturing versus 45 percent in the TAC group.⁵¹ But the time of onset of adequate anaesthesia was significantly longer in the EMLA group compared to the TAC group (55 versus 29 minutes, $p < 0.01$). On average it takes 1 hour for EMLA to provide sufficient anaesthesia, this can be seen as the major disadvantage for the use of EMLA in the ED. In addition, EMLA is only licensed for use on intact and non-mucosal skin.²¹

EMLA has been associated with occasional adverse reactions, including blanching and redness at the application site. A more serious but rare complication is methemoglobinemia.²¹

2.4. Other formulations

In an attempt to avoid the issues regarding the use of cocaine, several other alternative combinations, besides LAT, have been studied.

Smith et al.⁵⁷ have compared four non-cocaine-based topical anaesthetics (bupivacaine, mepivacaine, etidocaine and prilocaine combined with noradrenaline) with TAC. Of these four topical anaesthetics, bupivacaine appears to have the best performance. It is found to be as effective as TAC and to be particularly effective on face and scalp. Mepivacaine, etidocaine and prilocaine are found to be generally less effective than TAC.⁵⁷ Another study by Smith et al.⁵⁸ has compared topical mepivacaine-noradrenaline (MN) with infiltrated local anaesthetic. According to their study, the latter provides better analgesia than MN.⁵⁸

Other examples of cocaine-free topical formulas that have been studied are lidocaine-epinephrine (LE), prilocaine-phenylephrine (PP), tetracaine-phenylephrine (TP) and tetracaine-lidocaine-phenylephrine (TLP).⁵⁹

2.5. Advantages and disadvantages of topical anaesthesia

The advantages of the use of topical anaesthesia are the elimination of needle use and consequently the problems associated with the pain of injection.¹ The use of a topical anaesthetic enables painless anaesthesia, which results in improved patient comfort and increased cooperation and satisfaction. It also eliminates the risk of an accidental needle stick injury and therefore it could increase health worker safety within the ED.¹ Other possible advantages of topical anaesthesia include a reduction in tissue plane distortion, the promotion of accurate laceration repair, convenience of use, ease of disposal and a reduction in drug loading.¹

In a study by Priestley et al.⁶⁰ the application of a topical anaesthetic at triage has shown to significantly reduce the time in the ED for repair of simple lacerations.⁶⁰ In the same study, no complications are experienced in the case of prolonged exposure to the anaesthetic, lasting as long as 2 hours.⁶⁰

The majority of studies highlight poor success rate of topical anaesthesia in wounds located on trunk and extremities in comparison to scalp and facial wounds.^{23, 60, 61} These studies also emphasize that topical anaesthetics have a poor success rate if their application is limited to a single layer as opposed to a sequentially layered application.

There are a number of other disadvantages to the use of topical anaesthesia, especially when compared to the use of lidocaine infiltration. These include the messiness of application and removal and the inadequate depth of penetration that can be achieved into intact skin.^{62, 63} Topical anaesthetic solutions may leak out of the laceration with loss of anaesthetic volume and risk of contamination of mucous membranes and ocular surfaces.⁴⁸ A gel form of this anaesthetic reduces these risks and is equally efficacious as a solution.⁴⁸

The major disadvantage of the use of topical anaesthesia is the extended application period and the delayed onset of anaesthesia (30-90 minutes) compared to 45-90 seconds resulting from lidocaine infiltration.

3. Objectives

Lacerations are a common problem encountered at the emergency department. In order to ensure proper wound evaluation and management, the majority of the lacerations needs some form of anaesthesia. Injection of a local anaesthetic is the most common and reliable method but this method is associated with significant pain, discomfort and tissue distortion. Alternative methods of local anaesthetic administration include topical application. Topical anaesthesia provides many benefits including reduced pain, improved patient cooperation and decreased tissue distortion. Next to TAC (tetracaine, adrenaline and cocaine), LAT (lidocaine, adrenaline and tetracaine) is one of the most studied topical anaesthetic agents used for laceration management. TAC contains cocaine, which results in several disadvantages such as its potential serious adverse effects, its high cost and inconvenience for storage as it is a controlled drug. In order to provide a safer topical anaesthetic, a combination of lidocaine, adrenaline and tetracaine has been evaluated as an alternative to TAC. LAT has been found as effective as TAC in providing topical anaesthesia. It is also safer and cheaper. Unsurprisingly, literature points out that LAT is strongly preferred to TAC. The use of LAT in laceration management has been studied extensively in relation to children but less in relation to adults.

The objective of this study is to determine whether LAT gel enables the management of lacerations without the need for additional anaesthesia (lidocaine infiltration) in adults and adolescents. In other words, this study attempts to demonstrate the non-inferiority of LAT gel as a safe and effective local anaesthetic in laceration management. As a second objective, we want to define an adult population for which LAT gel can provide an advantage compared to infiltrative anaesthesia.

MATERIALS AND METHODS

1. Study design, setting and population

This is a retrospective study carried out in the Emergency Department (ED) of the Ghent University Hospital. The ED treated 31,544 patients in 2013. The data were obtained from a quality audit project introduced in the ED of Ghent University Hospital. This project is part of a general pain protocol that was implemented at the ED a couple of years ago. The quality audit project for the use of LAT (lidocaine, adrenaline and tetracaine) gel was first introduced for children only. In 2013 it was expanded to adolescents and adults. The study has been approved by the ethical committee of the Ghent University Hospital.

2. Data collection

A retrospective review of ED records (audit data) has been performed, over a 3 month period, of patients who attended the ED with traumatic lacerations and whose lacerations were treated with LAT gel according to a new protocol.

Only patients aged 9 years or older are included in our study since we assume that from this age they are able to differentiate between their fear and an actual pain sensation. Patients under the influence of alcohol/drugs as well as patients who had Kalinox[®] as additional sedation are excluded, since this can interfere with their pain sensation.

The data obtained include: patient demographics (date of birth, sex), wound characteristics (location of the wound and length), need of extra local lidocaine (Linisol[®] 2%) infiltration, time of LAT gel application, time of needle probing, time of treatment, kind of treatment given, and VAS (visual analogue scale) pain scores during needle probing and after treatment.

3. Methods

3.1. LAT gel

LAT gel is a compounded product that is prepared by the pharmacy of the Ghent University Hospital. It is available in coded, sterile 3 ml syringes. The main constituents are lidocaine 4%, adrenaline 1:1000 and tetracaine 0.5%.

LAT gel is prepared by combining the following components: lidocaine, epinephrine bitartrate, tetracaine hydrochloride, sodium metabisulfate, edetate disodium, sterile water, propylene glycol, polyethylene glycol 4000 and polyethylene glycol 1500/300.

As a result, the gel remains stable for 3 months if refrigerated and shielded from light. When the colour of the gel becomes red, which is a sign of epinephrine oxidation, it should be discarded. The gel is prepared in a sterile environment so no problems associated with wound infections can occur.



Figure 1: A coded 3 ml syringe with LAT gel prepared by the Pharmacy of the Ghent University Hospital

3.2. Protocol

A written departmental protocol has been implemented in the emergency department for the use of LAT gel in traumatic lacerations. All nurses and physicians were informed and trained. The protocol includes indications for the use of LAT gel on wounds that probably would require sutures or staples. Contraindications for the application of the gel are: wounds located on nose, ear, genitalia and mucous membranes; burn wounds, bite wounds and large abrasions; allergy to one of the constituents of the gel. If the triage nurse suspects the involvement of tendons and nerves, the protocol is not applicable as well as for lacerations larger than 7 cm. LAT gel is applied at triage by the triage nurse. The dose of the gel is 0.5 ml/cm, up to a maximum of 1 ml/kg. The gel is applied directly into the wound using a non-absorbent gauze and is covered with an adherent dressing. The gel needs to stay on the wound up to 30 minutes. After at least 30 minutes, needle probing is performed with a 23-gauge needle to check if the wound is anaesthetized sufficiently. If so, the physician could start wound preparation (wound cleaning, irrigation, debridement, exploration, ...) and wound closure. If the wound was not sufficiently anaesthetized, extra anaesthesia (lidocaine infiltration) is given. The visual analogue scale (VAS) scores are obtained during needle probing and during treatment. Together with this new protocol (appendix 1), an evaluation form (appendix 2) is included in the patient record.

4. Data analysis

The data were processed by means of a spreadsheet application (Excel, Microsoft Corporation, Redmond, USA) and imported into SPSS version 21 (SPSS IBM, New York, USA) for statistical analysis. Each variable was assessed on the basis of a Shapiro-Wilk test (normality test) and a QQ plot to check if the values have a normal distribution. Since no normally distributed variables were found, only non-parametric tests are used. Descriptive statistics are used to characterize the study population. Continuous variables are reported as means (\pm SD). Categorical data are reported as frequency (percent) of occurrence. To compare categorical variables, the chi-squared test was used. Continuous and categorical variables are compared with the use of the non-parametric Mann-Whitney U test or the Kruskal Wallis test. For all tests, the statistical significance was set at a level of 0.05.

RESULTS

For this study, the data of 124 patients have been collected who attended the ED with a laceration and had LAT gel applied at triage according to the new implemented protocol. Seventeen patients (13.7%) were under the influence of alcohol and/or drugs and are therefore excluded from the research, as this can interfere with their pain sensation. For the same reason, 8 patients who were treated with Kalinox[®] as sedation are excluded. Children younger than 9 years old are excluded, due to their inability to differentiate between their fear and an actual pain sensation. Another 4 patients are excluded due to outliers. As a result, the study population consists of 88 patients. (Figure 2)

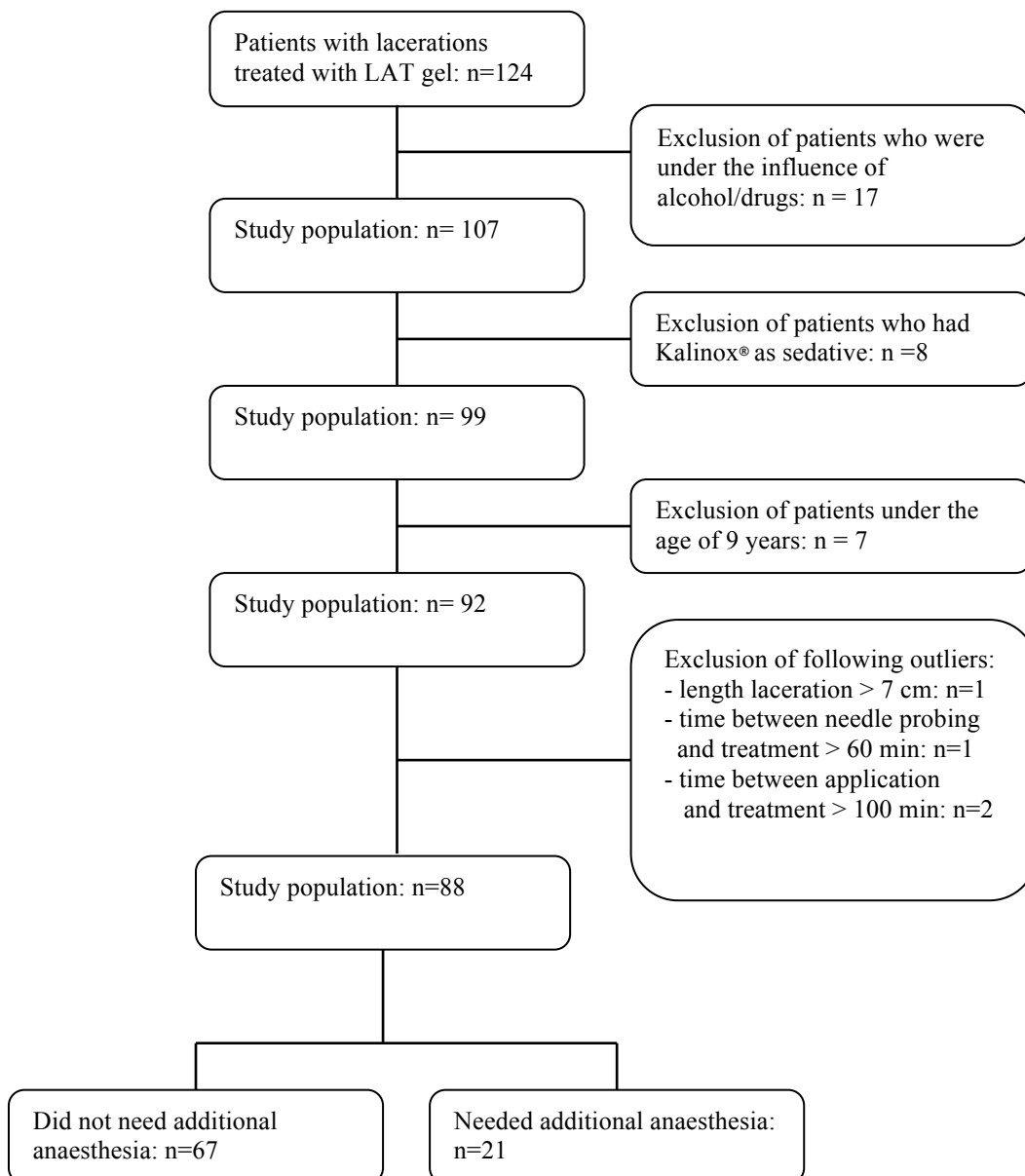


Figure 2: Study population flow diagram.

1. Study population

The mean age of the study population is 37 years (SD±20) and ranges between 9 years and 95 years with a median of 31 years. The population consists of 28 (31.8%) females and 60 (68.2%) males.

Of all 88 lacerations, 33 (37.5%) of them are located on the head (including scalp, forehead, face, chin and lip), 25 (28.4%) on the extremities and trunk (including hands, lower and upper limbs, knees, feet and trunk) and 30 (34.1%) are located on the fingers and toes.

The length of the lacerations ranges from 0.5 cm to 6.0 cm. The mean (±SD) length is 2.3 (± 1.4) centimetres.

We have transformed 'length of the laceration', a continuous variable, into a categorical variable to make it a clinically more practical variable. The three created categories are: small laceration (0-2 cm), moderate laceration (2.1 cm – 4 cm) and moderate large laceration (4.1 cm – 7 cm). In our study, there are 53 (60.2%) small lacerations, 27 (30.7%) moderate lacerations and 8 (9.1%) moderate large lacerations.

Seventy-two (81.8%) lacerations were sutured, 8 (9.1%) stapled and 8 (9.1%) had the treatment 'others' which includes the following treatments: tissue glue, skin tape or wound care only.

Additional anaesthesia (lidocaine infiltration) was needed for 21 (23.9%) patients. No additional anaesthesia was needed for 67 (76%) patients.

The mean (±SD) time between the time of LAT gel application and needle probing was 41 (±12) minutes. The mean (±SD) time between the time of application and the time of treatment was 51 (±18) minutes.

Table 2 provides a summary of the characteristics of the study population.

Table 2: Summary study population: demographic characteristics, laceration characteristics, treatment, additional anaesthesia and time intervals. Continuous variables are reported as mean \pm SD, categorical variables as frequency of occurrence (%)

Characteristic	Study population n (%)
Age- mean \pm SD (years)	37 (\pm 20)
Sex	
Male	60 (68.2%)
Female	28 (31.8%)
Length of laceration – mean \pm SD (cm)	2.3 (\pm 1.4)
Length - categorical	
Small laceration (0-2cm)	53 (60.2%)
Moderate laceration (2.1-4cm)	27 (30.7%)
Moderate large laceration (4.1-7cm)	8 (9.1%)
Location of the laceration	
Head	33 (37.5%)
Extremities/trunk	25 (28.4%)
Fingers/toes	30 (34.1%)
Treatment	
Sutures	72 (81.8%)
Staples	8 (9.1%)
Others	8 (9.1%)
Additional anaesthesia needed	
Yes	21 (23.9%)
No	67 (76.1%)
Time between application and needle probing – mean \pm SD (minutes)	41 (\pm 12)
Time between application and treatment – mean \pm SD (minutes)	51 (\pm 18)

2. Need for additional anaesthesia

In our study, the need for additional anaesthesia is considered a measure for the efficacy of LAT gel. In the study population, 21 (23.9%) patients needed additional anaesthesia (Linisol[®] 2% infiltration), while 67 (76.1%) patients did not need additional anaesthesia after needle probing or during treatment.

A summary of the characteristics of both groups is given in table 10.

2.1. Demographics

The mean (\pm SD) age in the group who did not need additional anaesthesia is 36 (\pm 21) years and ranges between 9 and 95 years. The median age is 30 years. The group consists of 21 (31.3%) females and 46 (68.7%) males.

The mean age in the group who needed additional anaesthesia is 39 (SD \pm 4) years and ranges between 10 and 80 years. The median age is 36 years. The group consists of 7 (33.3%) females and 14 (66.7%) males.

No significant differences in age and sex were found between both groups. (Table 10)

2.2. Location of the laceration

In the group who did not need additional anaesthesia, 29 (43.3%) lacerations were located on the head, 15 (22.4%) on the extremities and trunk and 23 (34.3%) on fingers and toes.

In the group who needed additional anaesthesia, 4 (19%) lacerations were located on the head, 10 (47.6%) on the extremities and trunk and 7 (33.3%) on fingers and toes.

In order to compare both groups, a χ^2 -test was conducted, which results in a p-value of 0.047.

There is a significant difference in location of the lacerations between both groups. (Table 3)

Table 3: Cross tabulation for the need of additional anaesthesia versus the location of the laceration. P-value =0.047.

			Need of additional anaesthesia		Total
			No	Yes	
Location of the laceration	Head	Count	29	4	33
		% within Location of the laceration	87.9%	12.1%	100.0%
		% within Need of additional anaesthesia	43.3%	19.0%	37.5%
	Extremities and trunk	Count	15	10	25
		% within Location of the laceration	60.0%	40.0%	100.0%
		% within Need of additional anaesthesia	22.4%	47.6%	28.4%
	Fingers and toes	Count	23	7	30
		% within Location of the laceration	76.7%	23.3%	100.0%
		% within Need of additional anaesthesia	34.3%	33.3%	34.1%
Total	Count	67	21	88	
	% within Location of the laceration	76.1%	23.9%	100.0%	
	% within Need of additional anaesthesia	100.0%	100.0%	100.0%	

Of the 33 lacerations located on the head, only 4 (12.1%) needed additional anaesthesia. Twenty-five lacerations were located on the extremities and trunk, of which 10 (40%) needed additional anaesthesia. Of the 30 lacerations located on the fingers and toes, 7 (23.3%) needed additional anaesthesia. (Figure 3, Table 3)

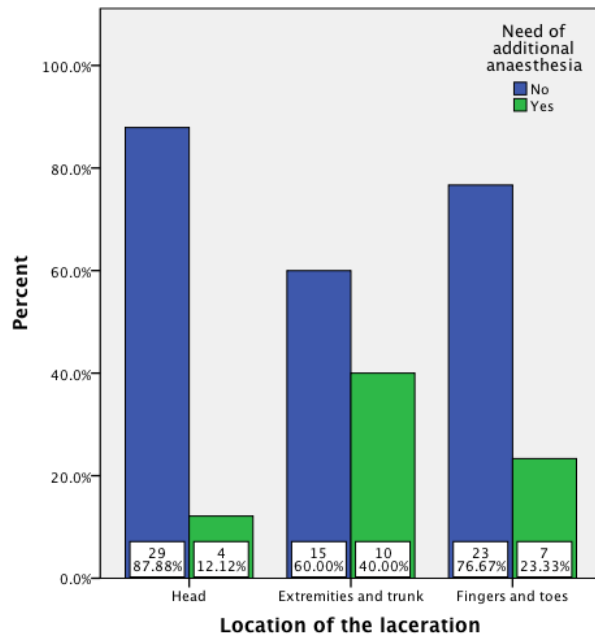


Figure 3: Distribution location of the lacerations in both groups (additional anaesthesia/ no additional anaesthesia). Categorical variables are given as frequency of occurrence (%).

In order to compare lacerations located on the head with lacerations located on extremities/trunk/fingers/toes, a new variable has been created. The new variable contains 2 groups: lacerations located on the head and a group ‘others’, which includes extremities/trunk/fingers/toes. A χ^2 -test was used to compare both groups. Lacerations located on the head need significantly less additional anaesthesia than lacerations located on extremities/trunk/fingers/toes ($p=0.045$). (Figure 4)

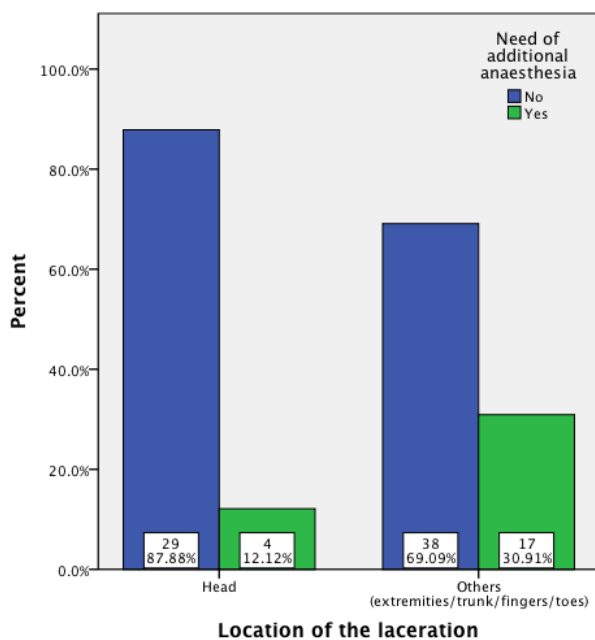


Figure 4: Distribution of the location of the laceration for both groups (additional anaesthesia/ no additional anaesthesia). Categorical variable is given as frequency of occurrence (%). P- value = 0.045.

The LAT gel efficacy based on the location of the wound has been analyzed to determine whether LAT has a greater reduction of pain if applied on lacerations located on the head rather than lacerations located on the extremities, trunk, fingers and toes.

The VAS pain scores on needle probing of the laceration are significantly lower when located on the head compared to lacerations located on the extremities/trunk (means \pm SD of 0.97 ± 1.47 versus 1.92 ± 1.58 respectively, $p=0.008$).

Additionally, the VAS pain scores on needle probing of the laceration are significantly lower when located on the head compared to lacerations located on the fingers/toes (means \pm SD of 0.97 ± 1.47 vs 3.00 ± 1.92 respectively, $p < 0.001$).

The VAS pain scores on needle probing of the laceration are also significantly lower when located on the extremities and trunk compared to lacerations located on fingers and toes (means \pm SD of 1.92 ± 1.58 vs 3.00 ± 1.92 respectively, $p=0.031$). (Table 4, table 5, figure 5)

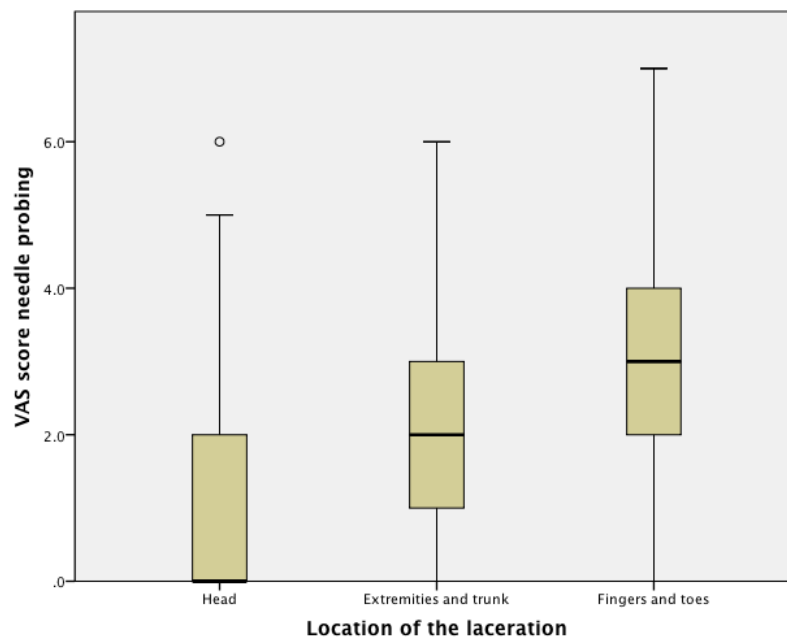


Figure 5: Boxplot showing visual analogue scale (VAS) pain scores on needle probing by location of the laceration. VAS values: median head = 0, median extremities/trunk = 1, median fingers/toes = 3. Kruskal Wallis test p-value = 0.001.

Table 4: VAS scores on needle probing by location of the laceration given as median and median \pm SD

Location of the laceration	VAS needle probing -median	VAS needle probing -mean (\pm SD)
Head	0	0.97 (± 1.47)
Extremities and trunk	1	1.92 (± 1.58)
Fingers and toes	3	3.00 (± 1.92)

Table 5: Comparison between the different locations of the lacerations for the need of additional anaesthesia using a Mann Whitney U test.

VAS scores on needle probing	P value
Head vs extremities and trunk	0.008
Extremities and trunk vs fingers and toes	0.031
Head vs fingers and toes	0.001

2.3. Length

The mean (\pm SD) length of the lacerations in the group who did not need additional anaesthesia, is 2.1 (\pm 1.22) centimetres, ranging between 0.5 and 6 centimetres. The median is then 2 centimetres.

The mean (\pm SD) length of the lacerations in the group who needed additional anaesthesia, is 3.1 (\pm 1.62) centimetres, ranging between 0.5 and 6 cm. The median is 2.5 cm.

The non-parametric Mann Whitney U test was used to compare both groups, which gives a p value of 0.004. There is a statistical difference in length of the lacerations between both groups. (Figure 5)

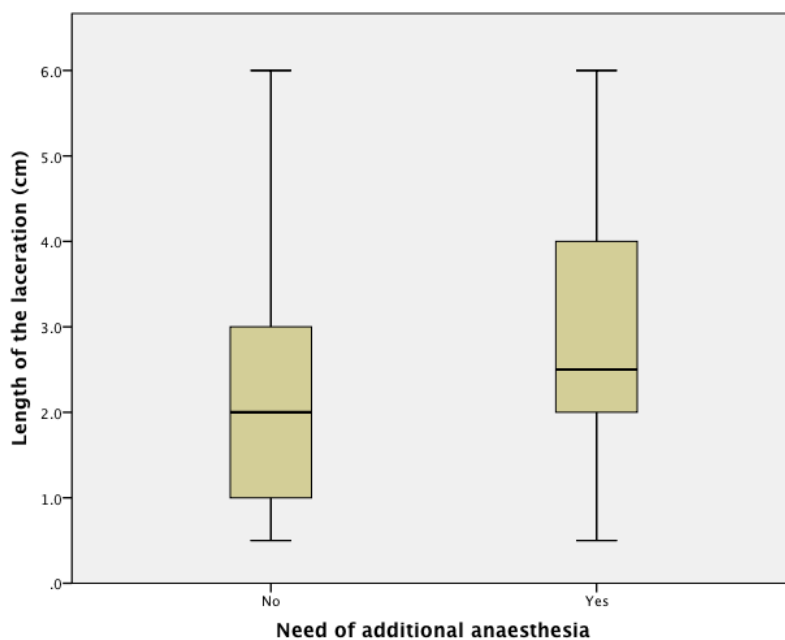


Figure 5: Boxplot showing the distribution of the length of laceration (cm) for both groups (additional anaesthesia / no additional anaesthesia). Median group no additional anaesthesia needed = 2cm. Median group additional anaesthesia needed = 2.5 cm. P value = 0.004.

2.4. Length – categorical

As stated above, the continuous variable length was transformed into a categorical variable to make the variable length more clinically practical. The categories are: small laceration (0-2 cm), moderate laceration (2.1-4 cm) and moderate large laceration (4.1-7 cm).

No additional anaesthesia was needed in 45 (84.9%) of the 53 small lacerations, in 19 (70.4%) of the 27 moderate lacerations and in 3 (37.5%) of the 8 moderate large lacerations. Respectively, this is 67.2%, 28.4% and 2.4% of all 67 lacerations in the group who did not need additional anaesthesia. (Table 7, figure 6)

Additional anaesthesia was needed in 8 (15.1%) small lacerations, 8 (29.6%) moderate lacerations and 5 (62.5%) moderate large lacerations. Respectively, this is 38.1%, 38.1% and 23.8% of all 21 lacerations in the group who needed additional anaesthesia. (Table 6 and figure 6)

A χ^2 -test was conducted to compare both groups, which results in a p value of 0.003 and thus a significant difference between the different length categories of the lacerations.

Table 6: Cross tabulation for the length of the laceration as categorical variable versus the need of additional anaesthesia. P-value = 0.003.

			Need of additional anaesthesia		Total
			No	Yes	
Length of the laceration-categorical	Small laceration (0-2cm)	Count	45	8	53
		% within Length - categorical	84.9%	15.1%	100.0%
		% within Need of additional anaesthesia	67.2%	38.1%	60.2%
	Moderate laceration (2.1-4cm)	Count	19	8	27
		% within Length - categorical	70.4%	29.6%	100.0%
		% within Need of additional anaesthesia	28.4%	38.1%	30.7%
	Moderate large laceration (4.1-7cm)	Count	3	5	8
		% within Length - categorical	37.5%	62.5%	100.0%
		% within Need of additional anaesthesia	4.5%	23.8%	9.1%
Total	Count	67	21	88	
	% within Length - categorical	76.1%	23.9%	100.0%	
	% within Need of additional anaesthesia	100.0%	100.0%	100.0%	

Small lacerations have been compared with moderate large lacerations and this comparison points out that small lacerations need significantly less additional anaesthesia than moderate large lacerations ($p=0.002$). (Table 6) Small and moderate lacerations together needed significantly less additional anaesthesia when compared to moderate large lacerations ($p=0.007$). (Table 7)

Table 7: Cross tabulation: comparison between the different length categories for the need of additional anaesthesia using χ^2 -test.

	P value
Small lacerations vs moderate lacerations	0.124
Small lacerations vs moderate large lacerations	0.002
Moderate lacerations vs moderate large lacerations	0.091

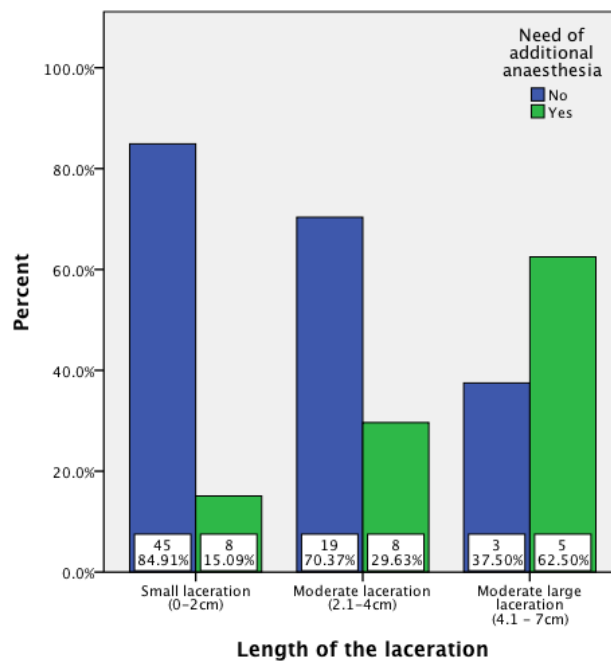


Figure 6: Distribution of length of the laceration for both groups (additional anaesthesia/no additional anaesthesia). Categorical variable is given as frequency of occurrence (%).

Of the 8 small lacerations that needed additional anaesthesia 2 (25%) are located on the head, 2 (25%) on the extremities and trunk and 4 (50%) are located on the fingers/toes. In the group with moderate lacerations, on a total of 27 lacerations, 8 (29.6%) needed additional anaesthesia. 1 laceration (12.5%) is located on the head, 4 (50%) on the extremities/trunk and 3 (37,5%) on the fingers/toes. Of the 5 moderate large lacerations that needed additional anaesthesia, 1 (20%) is located on the head and 4 (80%) are located on the extremities/trunk. (Table 8)

Table 8: Cross-tabulation for the location of the laceration versus the length of laceration as categorical variable for both groups (additional anaesthesia/ no additional anaesthesia).

	Location of the laceration			
	Head	Extremities/trunk	Fingers/ toes	Total
Additional anaesthesia needed				
Small laceration (0-2cm)	2 (25%)	2 (25%)	4 (50%)	8 (100%)
Moderate laceration (2.1-4cm)	1 (12.5%)	4 (50%)	3 (37.5%)	8 (100%)
Moderate large laceration (4.1-7cm)	1 (20%)	4 (80%)	0	5 (100%)
Total	4	10	7	21
No additional anaesthesia needed				
Small laceration (0-2cm)	16 (35.6%)	9 (20%)	20 (44.4%)	45 (100%)
Moderate laceration (2.1-4cm)	12 (63.2%)	4 (21.1%)	3 (15.8%)	19 (100%)
Moderate large laceration (4.1-7cm)	1 (33.3%)	2 (66.7%)	0	3 (100%)
Total	29	15	23	67

2.5. Visual analogue scale pain scores

A first visual analogue scale (VAS) pain score was taken during needle probing, which gives an idea of the anaesthetic efficacy of LAT gel.

The mean (\pm SD) VAS score during needle probing is 1.18 (\pm 1.79) in the group who did not need additional anaesthesia. This score ranges between 0 and 7, with a median of 1.

In the group that needed additional anaesthesia, the mean (\pm SD) VAS score is 2.81 (\pm 1.81).

In this group, the VAS score ranges between 0 and 7 with a median of 2.

We have compared both groups using the non-parametric Mann Whitney U test, which gives a p value of 0.005. (Figure 7)

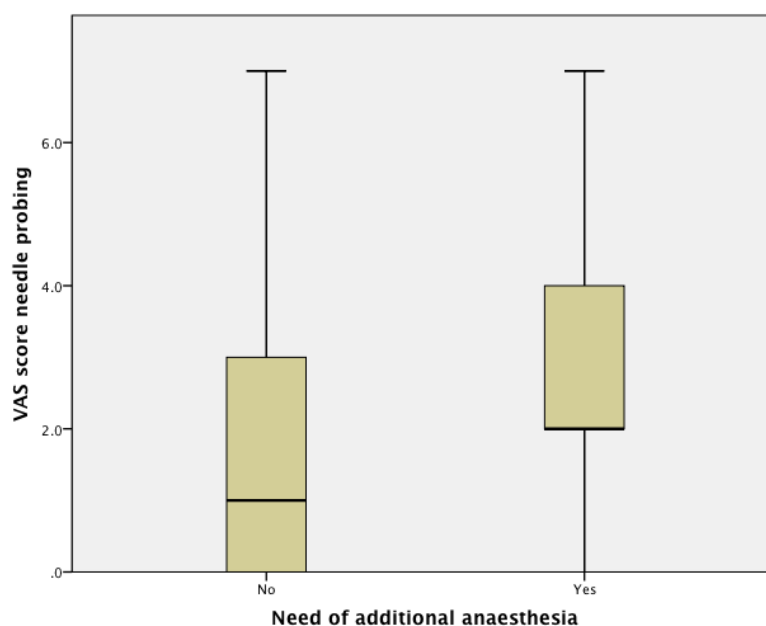


Figure 7: Boxplot showing VAS score values on needle probing for both groups (additional anaesthesia / no additional anaesthesia). Median no additional anaesthesia = 1, median additional anaesthesia = 2. P-value = 0.005.

A second VAS pain score was taken immediately after treatment, which gives an idea of the pain during treatment.

In the group who did not need additional anaesthesia, the mean (\pm SD) VAS score after treatment is 2.68 (\pm 2.23). The VAS score ranges between 0 and 7 with a median of 2.

In the group who needed additional anaesthesia, the mean (\pm SD) VAS score after treatment is 0.91 (\pm 1.81). The score ranges between 0 and 7 with a median of 0.

Both groups were compared by a non-parametric Mann Whitney U test, which gives a p value of <0.001 . (Figure 8)

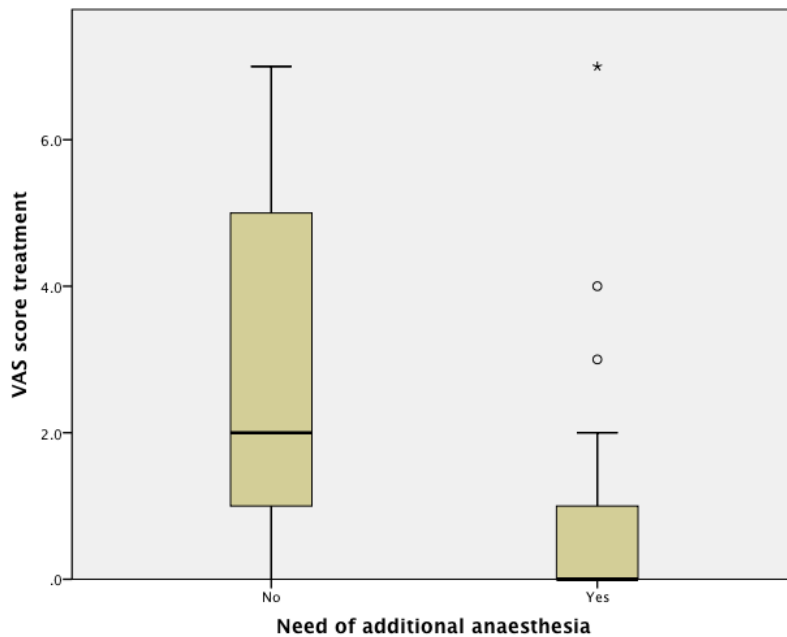


Figure 8: Boxplot showing VAS score values after treatment for both groups (additional anaesthesia /no additional anaesthesia). Median no additional anaesthesia = 2, median additional anaesthesia = 0. P value < 0.001

2.6. Intervals

The mean (\pm SD) interval between the time of application and the time of needle probing was 42 (\pm 12) minutes in the group who did not need additional anaesthesia, ranging from 28 to 85 minutes with a median of 38 minutes.

In the group who needed additional anaesthesia on the other hand, the mean (\pm SD) interval was 40 (\pm 13) minutes, ranging between 25 and 85 minutes with a median of 36 minutes.

The non-parametric Mann Whitney U test was used to compare both groups, resulting in a p value of 0.608. (Figure 9)

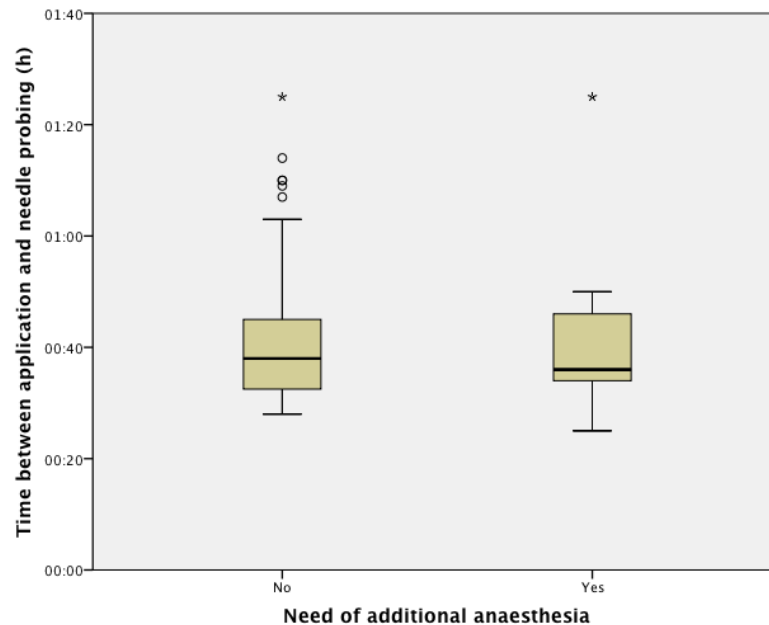


Figure 9: Boxplot showing the time between application and needle probing for both groups (additional anaesthesia / no additional anaesthesia). Median no additional anaesthesia = 38 minutes. Median additional anaesthesia = 36 minutes. P value = 0.608

The mean (\pm SD) interval between the time of application and the time of treatment was 51 (\pm 18) minutes in the group who did not need additional anaesthesia. This interval ranges between 30 and 100 minutes with a median of 36 minutes.

In the group who needed additional anaesthesia, the mean (\pm SD) interval was 51 (\pm 17) minutes, ranging between 30 and 85 minutes with a median of 46 minutes.

The non-parametric Mann Whitney U test was used to compare both groups, which gives a p value of 0.447. (Figure 10)

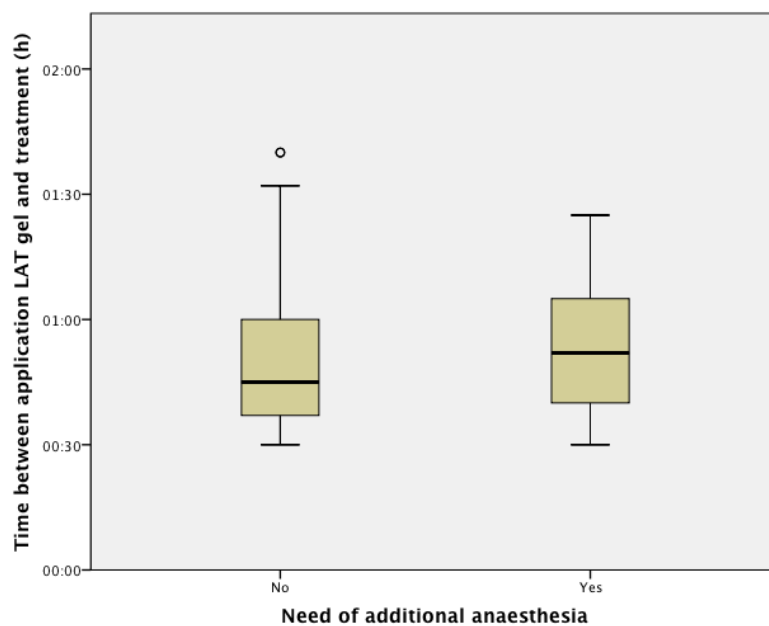


Figure 10: Boxplot showing time between application LAT gel and treatment for both groups (additional anaesthesia / no additional anaesthesia). Median no additional anaesthesia = 36 minutes, median additional anaesthesia = 46 minutes. P value = 0.447

2.7. Treatment

No additional anaesthesia was needed for lacerations treated by means of staples or other treatments (wound care only, skin tape or skin glue). Additional anaesthesia was needed in 21 (29.2%) lacerations of the in total 72 lacerations who had sutures as treatment.

A χ^2 -test was conducted, in order to compare both groups (additional anaesthesia/ no additional anaesthesia) and a significant difference is found for the treatment of lacerations between both groups ($p=0.047$). (Table 9, figure 11)

Table 7: Crosstabulation: Treatment given for both groups (additional anaesthesia/ no additional anaesthesia). P value = 0.047.

			Need of additional anaesthesia		Total
			No	Yes	
Treatment	Others	Count	8	0	8
		% within Treatment	100.0%	0.0%	100.0%
		% within Need of additional anaesthesia	11.9%	0.0%	9.1%
	Sutures	Count	51	21	72
		% within Treatment	70.8%	29.2%	100.0%
		% within Need of additional anaesthesia	76.1%	100.0%	81.8%
	Staples	Count	8	0	8
		% within Treatment	100.0%	0.0%	100.0%
		% within Need of additional anaesthesia	11.9%	0.0%	9.1%
Total	Count	67	21	88	
	% within Treatment	76.1%	23.9%	100.0%	
	% within Need of additional anaesthesia	100.0%	100.0%	100.0%	

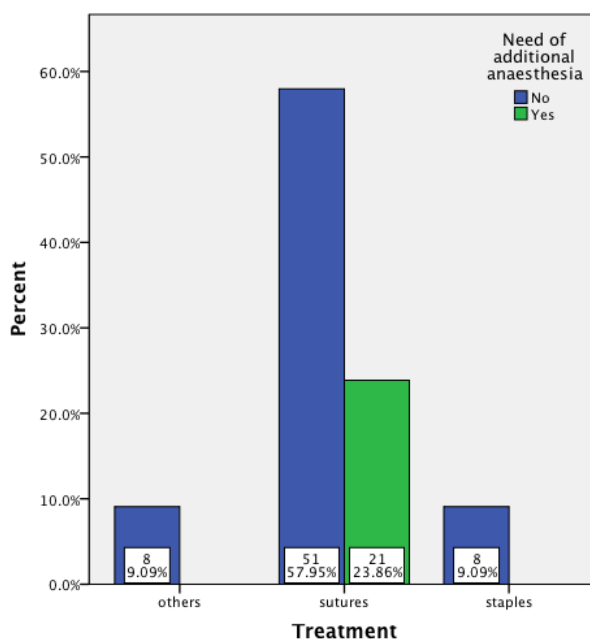


Figure 11: Distribution for treatment of the laceration for both groups (additional anaesthesia/ no additional anaesthesia). The categorical variable 'treatment' is given as frequency of occurrence (%). P- value = 0.047

Table 8: Characteristics of both groups (additional anaesthesia/no additional anaesthesia). The p-values are calculated with the χ^2 -test or the Mann Whitney U test.

	Additional anaesthesia needed n = 21 (23.9%)	No additional anaesthesia needed n = 67 (76.1%)	p-value
Age – mean \pm SD (years)	38 (\pm 18)	36 (\pm 21)	0.315
Sex			0.864
Male (n)	14 (66.7%)	46 (68.7%)	
Female (n)	7 (33.3%)	21 (31.3%)	
Length – mean \pm SD (centimetres)	3.1 (\pm 1.6)	2.1 (\pm 1.2)	0.004
Length categorical			0.003
Small laceration (0-2cm)	8 (38.1%)	45 (67.2%)	
Moderate laceration (2.1-4cm)	8 (38.1%)	19 (28.4%)	
Moderate large laceration (4.1-7cm)	5 (23.8%)	3 (4.5%)	
Location of the laceration			0.048
Head	4 (19%)	29 (43.3%)	
Extremities/trunk	10 (47.6%)	15 (22.4%)	
Fingers/toes	7 (33.3%)	23 (34.3%)	
Treatment			0.047
Sutures	21 (100%)	51 (76.1%)	
Staples	0 (0%)	8 (11.9%)	
Others	0(0%)	8 (11.9%)	
VAS needle probing- mean \pm SD	2.81 (\pm 1.81)	1.64 (\pm 1.79)	0.005
VAS treatment - mean \pm SD	0.91 (\pm 1.81)	2.68 (\pm 2.23)	<0.001
Time between application and needle probing – mean \pm SD (minutes)	40 (\pm 13)	42 (\pm 12)	0.608
Time between application and treatment – mean \pm SD (minutes)	51 (\pm 17)	51 (\pm 18)	0.447

DISCUSSION AND LIMITATIONS

Traumatic lacerations are one of the most common injuries managed in the emergency department (ED) and affect patients of all ages.¹ Adequate local anaesthesia is needed in order to provide proper care. The most common practice, in the ED of the Ghent University Hospital, to anaesthetize a laceration in adults is by injecting lidocaine (Linisol® 2%) into the area around the laceration, through the wound edges, or proximal to the wound to block the sensory nerves that supply the area.

Even though local infiltration and nerve blocks usually provide adequate anaesthesia, these procedures are painful and may provoke anxiety and resistance on the side of the patient.²³ This may result in an uncooperative patient, resulting in difficulties in treating the laceration properly. Furthermore, the injection of local anaesthesia causes a degree of tissue distortion that may interfere with obtaining an optimal cosmetic result.

The application of topical anaesthesia offers the advantage of being painless, thereby decreasing the patient's anxiety about suturing. In addition, it reduces tissue distortion and it eliminates the risk of a needle stick injury.

In this study, we have used the need for additional anaesthesia as primary outcome. Although the visual analogue scale (VAS) is proven to be a valid and reliable method to measure acute pain⁶⁴, we have not considered it a suitable primary outcome for this study. Since this is a retrospective study, we cannot be sure that the VAS scores have always been obtained correctly and in the same manner. In addition, we do not have a VAS score before the application of LAT gel. Therefore, it is not possible to measure the amount of pain reduction caused by LAT gel. Finally, we have to deal with inter- and intra-observer variability and with patient-related factors. For these reasons, the need for additional anaesthesia seems a more suitable primary outcome variable for our study.

In a prospective, randomized double-blinded study by Adler et al.,⁴⁶ LAT gel appears to significantly reduce the number of patients requiring infiltrative anaesthesia for suturing lacerations. In their study, 30 patients were treated with LAT gel, of which 13 (43.3%) required additional anaesthesia. In our study, of the 88 patients who had LAT gel applied at triage, only 21 (23.9%) patients needed additional anaesthesia.

Singer and Stark⁶⁵ state that even when additional infiltrative anaesthesia is needed, the infiltration is less painful compared to lacerations that are not pretreated with LAT gel. The lacerations are also more adequately anaesthetized when pretreated with LAT gel.⁶⁵ These statements could not be assessed in our study due to lack of information.

The VAS scores on needle probing are significantly higher in the group who needed additional anaesthesia ($p=0.005$). Nevertheless in both groups the ranges are the same (0.5-7) which means that some patients have reported to have a high VAS pain score but that they did not receive additional anaesthesia. There are several possible explanations for this. One explanation can be that the patient did not request additional anaesthesia because he was able to withstand the pain. Another possible explanation is that the physicians did not find it useful to give additional anaesthesia as this may imply the same amount of needle sticks. Further research is needed to explore other possible reasons.

The VAS scores after treatment are significantly lower in the group who had additional anaesthesia compared to the group who did not have additional anaesthesia ($p<0.001$). This may correspond to the statement made by Singer and Stark⁶⁵, mentioned previously, that lacerations are more adequately anaesthetized when pretreated with LAT gel. We cannot be absolutely certain about this, however, as there is no control group to compare with. This control group would have only had lidocaine infiltration.

The location of the laceration seems to play an important role in the efficacy of the LAT gel. In this study, lacerations located on the head needed significantly ($p=0.045$) less additional anaesthesia than lacerations located on extremities, trunk, fingers and toes. Also, the VAS pain scores on needle probing of the laceration are significantly lower when located on the head compared to lacerations located on the extremities/trunk ($p=0.008$) and fingers/toes ($p=0.001$). The same finding, namely that topical anaesthetics are more effective when lacerations are located on the face and scalp than in other areas, has been stated by Hegenbarth et al.²³ A possible explanation may be the relatively high vascularity of the lacerations located on the face and scalp, which results in a better absorption of the gel. Another explanation, suggested by White et al.⁶⁶, is that a narrow zone of anaesthesia around the laceration edges is sufficient for suturing most facial lacerations, so that less extensive anaesthesia is required. Another possible explanation is that the size of the sutures, used for lacerations located on the head, is smaller compared to sutures used for other areas.

Fingers are usually anaesthetized by a digital nerve block, a method which has been reported as being very painful, highly uncomfortable and not always 100% successful.⁶⁷ A prospective study by White et al.⁵⁰ states that LAT gel appears to be a safe and effective method to provide anaesthesia for the repair of simple finger lacerations in children. In particular, lacerations located on the dorsal surface of the finger could be a good indication for LAT gel as they have a reported success rate of 68.8%.⁵⁰ No signs of digital ischemia were noted.⁵⁰ In our study, only 7 (23.3%) of the 30 patients who had a laceration located on fingers or toes,

needed additional anaesthesia. In 23 (76.6%) patients, the anaesthetic effect of LAT gel was sufficient to suture the laceration without needing additional anaesthesia.

Therefore, it can be claimed that the use of LAT gel appears to be a safe and effective alternative to provide anaesthesia in small, uncomplicated lacerations located on fingers and toes compared to the painful digital nerve block.

Gaufberg et al.⁶⁸ state that, as the blood circulation on the trunk and extremities is relatively poor compared to the face and scalp, local tissue absorption of single-layered topical anaesthesia in these areas is limited. Using 'sequential layered application' of topical anaesthetics can overcome this relatively poor absorption in these areas.⁶⁸ We have not been able to investigate this method but it is definitely worth exploring. Further studies may be useful in order to extend the use and refine the application of topical anaesthetics.

The length of the wound appears to be a prognostic factor in the efficacy of LAT gel. It seems that LAT gel has a better anaesthetic effect in smaller lacerations. In our study, only 8 (15.1%) of the 53 small lacerations (0-2 cm) needed additional anaesthesia and 8 (29.6%) of the 27 moderate lacerations (2.1-4 cm). Large moderate lacerations (4.1-7 cm) needed more additional anaesthesia (62.5%). The use of the sequential layered technique may also offer a solution in these moderate large wounds, as has been studied by Gaufberg et al.⁶⁸

Caution should be taken not to exceed the maximum dose. The generally accepted maximum limit for the use of injectable lidocaine with epinephrine is 7 mg/kg. Although substantially less lidocaine is absorbed when used topically, the same maximum dose limit should be used for the use of LAT gel.⁶⁸ In the ED of the Ghent University Hospital, the maximum dosage for LAT gel is set at 1 ml/kg and 0.5 ml/cm laceration. No complications have been reported in our study group.

A possible benefit of applying LAT gel on lacerations at triage is the decrease in the patient's length of stay at the ED. Priestley et al.⁶⁰ have shown that the application of a topical anaesthetic at triage results in a significant reduction in the total treatment time of approximately 30 minutes. In addition, application of LAT gel at triage may be associated with improved patient satisfaction as the patient feels like being promptly cared for. And most likely, it is also associated with a reduction of patient distress while waiting to be treated by a physician. Although the waiting time to be treated by a physician is not reduced, the patients' perception of care starting on arrival is likely to be associated with improved satisfaction.⁶⁰ The patients' perception of waiting times combined with information delivery and the patients' perception of the staff's caring and attitude towards them, have proven to be predictive of

overall patient satisfaction. These may be more important determinants of patient satisfaction than overall waiting time.⁶⁹ Singer and Stark⁶⁵ report that triage nurses are able to identify wounds likely to require closure and apply topical wound anaesthesia. As a result, lacerations are ready to be treated when a physician is available, which results again in a reduction of treatment time.

The use of LAT gel necessitates an interval of at least 30 minutes between the time of application and the time of treatment. In the ED of the Ghent University Hospital, this interval is not longer than the minimum time between presentation at triage and the closure of the wound when the protocol is not implemented. The duration of the effect of LAT gel has not yet been fully described. Schilling et al.⁴⁴ note a mean time (\pm SD) of 19.23 (\pm 10.81) minutes for the duration of effective anaesthesia during suturing given by LAT gel in patients who experienced complete anaesthesia. Further research is needed to determine the duration of the anaesthetic effect of LAT gel.

In our study, only lacerations that were treated with sutures, needed additional anaesthesia. A possible explanation may be that stapling a laceration is a very quick method. Even when the laceration is not sufficiently anaesthetized by LAT gel, additional anaesthesia is not needed, as it is a pain of short duration. Other treatments such as skin tape and skin glue are a lot less painful.

The application of LAT gel to lacerations is painless and comfortable for the patient and it also requires a minimum amount of time and effort. Even if lacerations do not need to be closed, topical anaesthesia allows relatively painless wound exploration and irrigation, which are required for most wounds. However, not all locations allow for an easy application of the gel. Fixating LAT gel on the scalp with a occlusive dressing, for example, can only be obtained by clipping the surrounding hair or by using a bandage. It is easier to apply LAT gel on linear, simple lacerations that are located on a hair-free, uniform skin area such as the forehead. It is important that the LAT gel is able to touch the wound edges. In other words, the blood clots should be removed before application. In case of a skin flap, the LAT gel should be administered under the skin flap in order to achieve full contact between the wound and the gel and thus to obtain an adequately anaesthetized laceration.

The efficacy of LAT gel depends on the application technique and is therefore operator-dependent. In our study, all nurses were trained to apply the LAT gel in the same manner according to the implemented protocol. As a result, this bias is reduced to a minimum, but it should still be taken into account.

Limitations

The most important limitation of our study is the fact that it is a retrospective study and that it therefore is exposed to bias. Although all nurses and physicians of the ED were trained to follow the implemented protocol, we cannot be completely sure whether the protocol was followed properly or not. Since there was no follow-up, we have no information available about the wound infection rate and the cosmetic outcome. Another limitation is the lack of information. For instance, we do not have information about VAS scores before application of the LAT gel, the amount of time to achieve adequate anaesthesia, the depth of laceration, the number of sutures or the staples placed. A final limitation of this study is the relatively small sample size of our study group and the lack of a control group, for example a pre-protocol group.

CONCLUSION

LAT gel appears to be a safe and effective method to anaesthetize lacerations in adults. The ideal lacerations for the use of LAT gel seem to be uncomplicated lacerations < 4 cm and lacerations located on the head (face/scalp). The gel can also be used in uncomplicated small lacerations located on the digits as an alternative to a (painful) digital nerve block. In larger wounds, LAT gel can be used as pretreatment to make the infiltrative anaesthesia less painful and to achieve more adequate anaesthesia. LAT gel can also be used to make wound exploration, irrigation and debridement more comfortable. In addition, application of LAT gel at triage may improve patient satisfaction because the patients feel that they are treated immediately. Further research may be useful in order to extend the use of LAT gel. Possible interesting study objectives are the duration of effect of the LAT gel or the exploration of the sequential layer technique for large lacerations and lacerations located on trunk and extremities. Finally, research in order to find different formulations of LAT gel may improve the absorption rate and decrease the time of onset.

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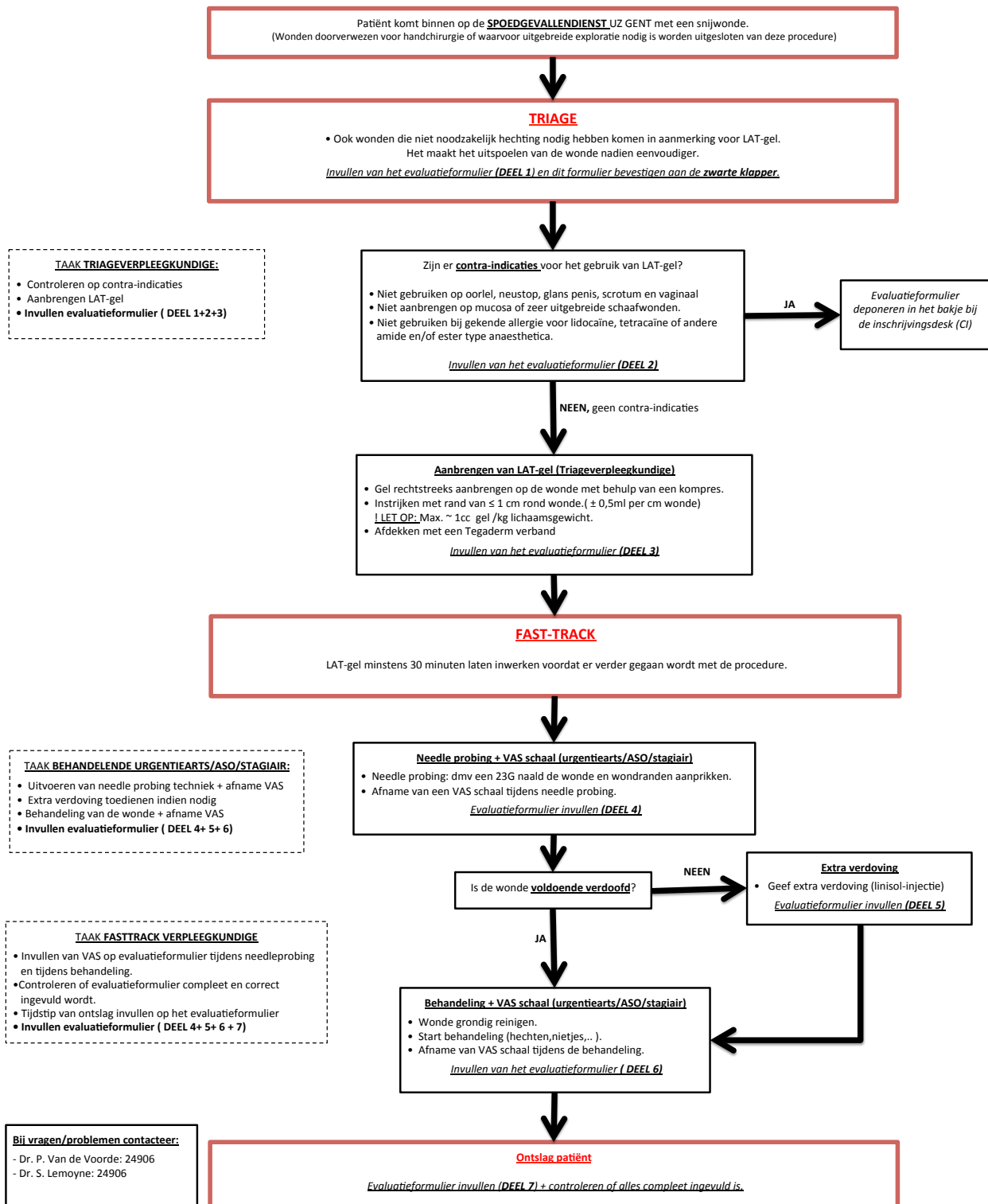
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APPENDIX I: Implemented protocol

STANDAARDPROCEDURE: AANBRENGEN EN EVALUATIE VAN LAT-GEL

Deze standaardprocedure geldt voor kinderen en volwassenen.



NA ONTSLAG EVALUATIEFORMULIER DEPONEREN IN HET BAKJE BIJ DE INSCRIVINGSDESK (C)

EVALUATIEFORMULIER LAT-GEL

Datum:.....

TRIAGE

DEEL 1

Naam patiënt:

Geboortedatum:..... Geslacht: M F

Tijdstip van eerste inspectie wonde:.....

Plaats van de wonde:

- hoofdhuid vingers onderste lidmaat tenen
- voorhoofd lip bovenste lidmaat voeten
- gelaat hand knie romp
- kin

Lengte van de wonde:.....

DEEL 2

Contra-indicaties voor LAT-gel? Ja Neen

- Indien ja, welke?
- Locatie (oorlel, neustop, penis, scrotum, vaginaal)
 - Allergie (lidocaïne, tetracaïne, amide/ester anasthetica)
 - Mucosa
 - Zeer uitgebreide (schaaf)wonde

DEEL 3

LAT-gel aangebracht: Ja Neen

Tijdstip LAT-gel aangebracht:.....

Naam triageverpleegkundige:.....

Aanvullende opmerkingen triageverpleegkundige:.....
.....
.....
.....

FASTTRACK

DEEL 4

Is de patiënt onder invloed? JA NEEN

Glasgow comaschaal: 15 14-13 12-9 8-3

Resultaat VAS tijdens needleprobing met 23G naald (0-10):.....

Tijdstip needleprobing:.....

DEEL 5

Extra verdoving noodzakelijk: Ja Nee

Indien ja: op aangeven van patiënt. Reden:.....

op aangeven van arts. Reden:.....

Hoeveelheid extra verdoving (Linisol) toegediend: ml

DEEL 6

Behandeling:

Hechting

Steristrips

Wondzorg alleen

Huidnietjes

Huidlijm

Andere

Hechtingsdraad (dikte):.....

Tijdstip van de behandeling:.....

Resultaat VAS tijdens hechting (0-10):.....

Vlotheid procedure (arts): Zeer vlot Vlot Voldoende Onvoldoende

Complicaties:.....

.....

Aanvullende opmerkingen (arts/verpleegkundige):.....

.....

.....

Naam urgentiearts/ASO/stagiair:.....

Naam fasttrack-verpleegkundige:.....

DEEL 7

Tijdstip van ontslag uit de spoedgevallendienst:

Aanvullende opmerkingen:

.....

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