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## Comparison of buffered and unbuffered local anaesthesia for inguinal hernia repair: a prospective study

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**Abstract** Bicarbonate buffered local anaesthetic solutions are known to reduce the pain of infiltration. However, its efficacy in reducing the pain of infiltration in patients undergoing inguinal hernia repair has never been tested. This study aims to test the efficacy of bicarbonate buffered solution in reducing the pain of infiltration and pain for the total surgical procedure in a series of patients undergoing elective inguinal hernia repair. Forty consecutive male patients with unilateral, reducible inguinal hernias were studied prospectively. All patients underwent surgery under local anaesthesia, the first 20 with unbuffered solution and the next 20 using buffered solution. Pain scores were obtained for the infiltration in the anaesthetic room and for the total surgical procedure. In addition, satisfaction scores were obtained at the end of the procedure. The mean pain score for the initial infiltration of unbuffered anaesthetic was 3.00 (range 0–5), and for the buffered anaesthetic it was 1.45 (range 0–4),  $P=0.02$ . The mean pain score for the entire procedure for the unbuffered group was 3.05 (range 0–6), and for the buffered group it was 1.45 (range 0–5),  $P=0.02$ . The patient satisfaction rate was higher with the buffered solution compared to unbuffered solution ( $P<0.05$ ). There were no complications reported with either solution. Buffered local anaesthetic solution significantly reduces the perceived pain of inguinal hernia repair, both during the infiltration and during the procedure itself. It is safe to administer and it results in a high rate of patient satisfaction.

**Keywords** Local anaesthesia · Buffered · Unbuffered · Inguinal hernia

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### Introduction

Surgical repair of groin hernias is one of the most commonly performed procedures in the Western world [1]. Several randomised and retrospective studies have shown that inguinal hernia repair under local anaesthesia results in less postoperative analgesic requirements and side-effects, reduced hospital stay, lower costs and shorter recovery times [2–5]. However, one of the commonly perceived problems of local anaesthesia is the pain of infiltration. This has been likened to a burning, stinging sensation, and can be extreme enough for patients to be dissatisfied with the procedure [6] and decline further local anaesthetic surgery [7].

Several strategies were suggested previously to reduce the amount of pain at infiltration including warming the local anaesthetic agent to body temperature [8, 9] slow administration of the local anaesthetic [10], withdrawing the needle while injecting [11], and application of topical anaesthetic ointment [12] but with little success.

The pain associated with local anaesthetic infiltration is mostly due to the hydrogen ion concentration which imparts an acidic nature to local anaesthetic solutions [13, 14]. Recent randomised trials have confirmed the efficacy of buffered local anaesthetic mixture with bicarbonate in reducing the amount of pain perceived during a variety of operations [7, 15]. This applies especially to the amide group of local anaesthetics such as lignocaine and bupivacaine. An addition of 8.4% sodium bicarbonate to local anaesthetic solution regardless of the presence of adrenaline buffers the solution without risk of precipitation [16].

Several authors have used bicarbonate buffered local anaesthetic solution for local anaesthetic inguinal hernia repair [17–20], but to date no study has compared this with unbuffered local anaesthetic solution in reducing the pain of infiltration during inguinal hernia repair. One of the commonly encountered problems during local anaesthetic inguinal hernia repair is the shortage of

local anaesthetic solution, especially in obese patients, who require large volumes. We have developed a large volume mixture of 100 ml of buffered local anaesthetic with adrenaline to counter this problem. The purpose of this study was to assess the difference in pain scores and the patient satisfaction for local anaesthetic inguinal hernia repair both during infiltration and the surgical procedure using buffered and unbuffered local anaesthetic solution.

## Methods

Forty consecutive male patients with unilateral, reducible inguinal hernias were recruited into the study. The first 20 patients underwent surgery under local anaesthesia using unbuffered local anaesthetic solution. The remaining 20 patients underwent surgery using a buffered local anaesthetic solution. All patients had a tension-free Lichtenstein inguinal hernia repair without pre-medication or sedation, and were monitored during surgery by pulse oximetry. A member of the operating theatre staff accompanied the patient throughout the procedure.

The local anaesthetic mixture consisted of:

20 ml of 2% lignocaine with 1:200,000 adrenaline (Hamel, UK)

30 ml of 0.5% bupivacaine with 1:200,000 adrenaline (Astrazeneca, UK)

50 ml of 0.9% saline

This results in a total volume of 100 ml (400 mg of Lignocaine and 150 mg of Bupivacaine based on a 70 kg man). (The maximum dose of lignocaine with adrenaline is 7 mg/kg, and of bupivacaine with adrenaline is 3 mg/kg). To buffer the lignocaine, 6 ml of 8.4% sodium bicarbonate (Fresenius, UK) was added, giving a pH of 7.0.

1.5 g of intravenous cefuroxime was administered in the anaesthetic room to all patients. In the anaesthetic room, approximately 20 ml of the local anaesthetic mixture was infiltrated along the line of incision in the subcutaneous plane, around the pubic tubercle and the deep ring. The patients were asked to give a pain score (0 representing no pain, and 10 representing the worst pain they can possibly imagine) for the initial injection in the anaesthetic room.

A skin and external oblique aponeurosis incision was then performed, after which subaponeurotic infiltration of the mixture deep to the external oblique layer was undertaken. Further infiltration was performed into the spermatic cord avoiding the testicular vessels, nerves and the vas deferens. The sac was either reduced or excised according to the surgeon's preference and Lichtenstein repair was performed. In all cases, the mesh was soaked in iodine antiseptic prior to the tension-free mesh repair. At the end of the procedure, patients were asked to give a pain score for the whole procedure. In addition, satisfaction scores were obtained for the total procedure.

The patients were planned for discharge later the same day provided they were not living alone.

## Results

We recruited patients into the study by taking 40 consecutive patients who were on the waiting list for unilateral inguinal hernia repair under local anaesthetic. The median age of the study group was 68 years (range 29–83). The median body mass index (BMI) of the study group was 30 (range 20.9–34.6).

The mean pain score for the initial infiltration of non-buffered anaesthetic was 3.00 (range 0–5), and for the buffered anaesthetic it was 1.45 (range 0–4),  $P=0.02$  (Fig. 1). The mean pain score for the entire procedure for the unbuffered group was 3.05 (range 0–6), and for the buffered group it was 1.45 (range 0–5),  $P=0.02$  (Fig. 2). The results are further summarised in Table 1. The  $P$  values were calculated using the Wilcoxon rank test.

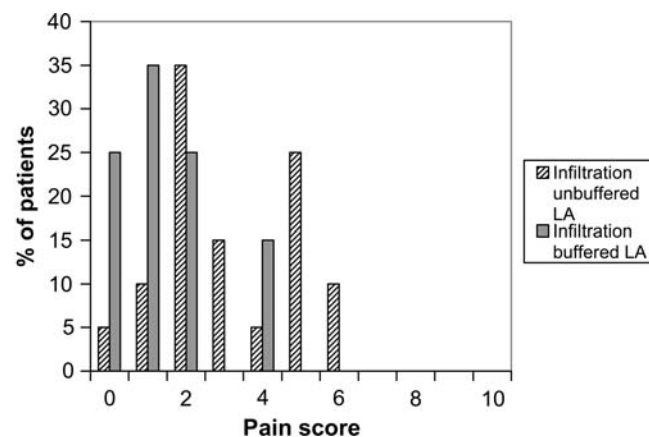


Fig. 1 Bar chart showing the percentage of pain scores for the infiltration of local anaesthesia in the unbuffered and buffered groups

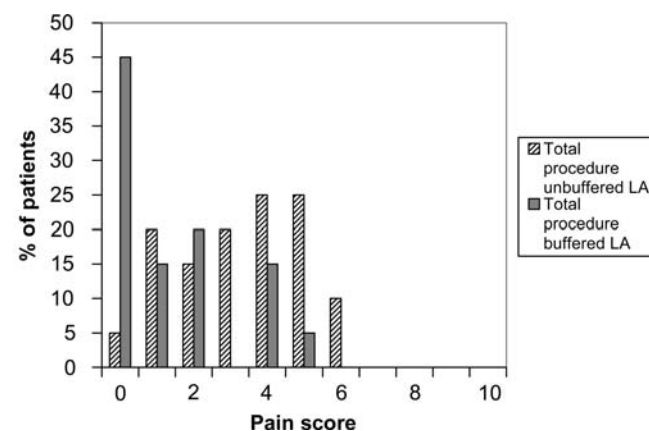


Fig. 2 Bar chart showing the percentage of pain scores for the entire procedure for the unbuffered and buffered group

**Table 1** The pain scores for the infiltration of local anaesthetic and for the entire procedure for both the unbuffered and buffered groups of patients

Pain score	Infiltration of unbuffered LA (%)	Infiltration of buffered LA (%)	Total procedure unbuffered LA (%)	Total procedure buffered LA (%)
0	5 ( <i>n</i> =1)	25 ( <i>n</i> =5)	5 ( <i>n</i> =1)	40 ( <i>n</i> =8)
1	10 ( <i>n</i> =2)	35 ( <i>n</i> =7)	20 ( <i>n</i> =4)	15 ( <i>n</i> =3)
2	35 ( <i>n</i> =7)	25 ( <i>n</i> =5)	15 ( <i>n</i> =3)	25 ( <i>n</i> =5)
3	15 ( <i>n</i> =3)	0	20 ( <i>n</i> =4)	0
4	5 ( <i>n</i> =1)	15 ( <i>n</i> =3)	15 ( <i>n</i> =3)	15 ( <i>n</i> =3)
5	25 ( <i>n</i> =5)	0	15 ( <i>n</i> =3)	5 ( <i>n</i> =1)
6	5 ( <i>n</i> =1)	0	10 ( <i>n</i> =2)	0

The number of patients who were highly satisfied with the procedure was higher in the buffered group compared to the unbuffered group 12 versus 3 ( $P < 0.05$ ). One patient in the unbuffered group was dissatisfied with the procedure.

## Discussion

This study demonstrates that addition of sodium bicarbonate to buffer local anaesthetic solution significantly reduces the perceived pain of inguinal hernia repair, both during the administration of the local anaesthetic solution and during the procedure itself. Buffered local anaesthetic solution is associated with a higher level of patient satisfaction.

Since Mackay et al. [21] first reported the efficacy of buffered lidocaine in reducing the pain of infiltration, several studies have shown that such solutions decrease the pain of administration without decreasing the onset of duration of anaesthesia [22–26]. Local anaesthetics work by diffusing through the perineural sheath and attaching to sodium channels. Only the non-ionised fraction of the drug is able to cross the nerve membrane. Commercial preparations of anaesthetics are marketed at a pH of 6 for maximum solubility and stability, and at this pH only 1% of the drug is non-ionised [13]. The addition of adrenaline to local anaesthetics further increases the acidity and decreases the non-ionised fraction. By neutralising the solution with sodium bicarbonate to a pH of 7, closer to the pKa of the drug, the fraction of non-ionised molecules increases to 11%. This reduction of pH reduces the tissue irritation associated with infiltration of a more acidic compound and also the onset of analgesia can be more rapid [27, 28]. Interestingly, some studies have shown that nociceptors may be less sensitive to the non-ionised form [21] thereby reducing the pain of infiltration.

A recent study [15] has shown that buffered lignocaine reduces the pain of infiltration but no significant difference was found in the pain scores for the whole procedures. In contrast, results from our study have shown that buffered solution not only reduces the pain of infiltration but also the perceived pain for the whole procedure, specifically for inguinal hernia repair.

Specialist hernia centres performing regular local anaesthetic hernia repairs routinely administer intravenous sedatives (midazolam) during local anaesthetic

inguinal hernia repair [18, 29]. In this study, none of the patients in either group received any form of sedation facilitating accurate estimation of pain scores at infiltration and for the total procedure.

Despite receiving widespread acceptance overseas, local anaesthetic inguinal hernia repair is not popular with surgeons in the UK. Previous studies have shown that only 5–10% of inguinal hernia repairs are performed under local anaesthesia with the majority of repairs being performed either under general or regional anaesthesia [30–33]. The majority of local anaesthetic hernia repairs are being performed either in private specialist hernia centres [18] or district general hospitals with established hernia service [29]. In the published literature, the use of buffered local anaesthetic solution for inguinal hernia repair is limited only to such centres.

Previous studies have reported higher patient satisfaction rates with local anaesthetic inguinal hernia repair [1, 2, 34]. However, one study [35] has reported a patient dissatisfaction rate of 8% following local anaesthetic inguinal hernia repair, mainly due to intraoperative discomfort or pain and it has been suggested that a large dose ilioinguinal–iliohypogastric block in combination with stepwise infiltration might result in reduced intraoperative discomfort. We feel the large volume of the local anaesthetic mixture used in our study has achieved this objective. The number of patients with higher satisfaction scores was greater in the buffered group compared to the non-buffered group.

Previous studies have used sparing amounts of local anaesthetic solution due to the potential to produce systemic toxicity with large volumes of local anaesthetic [3, 5]. The local anaesthetic mixture used in this study allowed us to use large quantities of the solution especially necessary for obese patients (the median BMI of the study group was 30).

In summary, this study demonstrates that buffered local anaesthetic solution significantly reduces the perceived pain of inguinal hernia repair. The use of large volume buffered local anaesthetic solution is safe and effective for repair of inguinal hernias in both obese and non-obese patients and more widespread use is recommended.

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