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ORIGINAL ARTICLE

Comparison of three concentrations of simplex lidocaine in local anesthesia for inguinal hernia mesh-repairs

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Abstract
Purpose The aim of the present randomized clinical study was to assess the efficacy of simplex lidocaine in local anesthesia for inguinal hernia mesh-repairs, compare analgesia of three different concentrations of lidocaine, and explore use of lower concentrations of lidocaine in local anesthesia for inguinal hernia mesh-repairs.
Methods A total of 102 consecutive patients undergoing inguinal hernia repairs were randomized to three groups: group A ($n = 34$) received solution with a lidocaine concentration of 8 mg/mL, group B ($n = 34$) received a lidocaine concentration of 5 mg/mL, and in group C ($n = 34$) the lidocaine level was reduced to 3.3 mg/mL. Intraoperative pain and pain at 24 h and 48 h postoperatively were assessed by means of a visual analogue scale. Volume and doses of lidocaine used in local anesthesia were strictly recorded.
Results The efficacy of simplex lidocaine in local anesthesia for inguinal hernia mesh-repairs was excellent, no patient required conversion to general anesthesia. The mean pain scores were not significantly different among the three groups.
Conclusions The local anesthesia technique was good with lidocaine alone in local anesthesia for inguinal hernia mesh-repairs. A concentration of 3.3 mg/mL lidocaine provided similar analgesia as 5 or 8 mg/mL lidocaine.

Keywords Inguinal hernia · Anesthesia · Local · Lidocaine · Randomized

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Introduction

Although large quantities of epidemiologic data have shown that general anesthesia and regional anesthesia are the preferred methods for inguinal hernia repairs in public hospitals [1–4], local anesthesia is almost always used in specialized hernia centers [5–7]. However, the choice of local anesthetic agents, their concentrations and doses may differ. Recently, mixtures of local anesthetic agents have become popular, but as lidocaine has a high dose limitation, and a quick action time, it is usually used alone in local anesthesia [8–11]. In our center, we have used lidocaine alone in more than 1,000 inguinal hernia repairs; almost all patients tolerated this anesthesia technique well. Concentrations of lidocaine used were 10 or 5 mg/mL. On one occasion, we used a lower concentration of lidocaine as a result of a mistake in the diluting process made by one scrub nurse, but the patient tolerated the local anesthesia well in this case too. This gave us a hint that a concentration of lidocaine of lower than 5 mg/mL can also provide comparable analgesia. The aim of this randomized study was to assess the efficacy of simplex lidocaine in local anesthesia for inguinal hernia mesh-repairs, compare three different concentrations of lidocaine, and determine a lower effective concentration of lidocaine for this purpose.

Patients and methods

Patients aged over 18 years with primary, unilateral inguinal hernia scheduled for selective tension-free hernia repair were eligible to participate in the study. Patients were excluded if the hernia was irreducible, recurrent, was a femoral hernia, or if they had a history of allergy to lidocaine.

A total of 102 consecutive patients were randomized to three groups using a computer-generated randomized sequence, to receive local anesthesia with one of the three concentrations of lidocaine: group A ($n = 34$) received solution with a lidocaine concentration of 8 mg/mL, group B ($n = 34$) received a lidocaine concentration of 5 mg/mL, and in group C ($n = 34$) the lidocaine level was reduced to 3.3 mg/mL.

Before anesthesia, ampules of simplex lidocaine (400 mg/20 mL) were diluted with 30, 60, 80 mL normal saline, respectively. Non invasive blood pressure (NIBP), electrocardiography, respiratory rate (RR), and oxygen saturation measured by pulse oximetry (SpO2) were monitored and recorded during the operation with an automatic device. All the operations were performed by a single experienced surgeon.

A step-by-step infiltration was provided with one of the three concentrations of lidocaine according to the randomized group. The incision was marked with a permanent pen on the medial half of the skin between the pubic tubercle and anterior superior iliac crest. The first injection of 10 mL lidocaine was given subdermally and then intradermally using the guidance of the skin marking; 5–10 mL lidocaine was then injected to the inguinal canal, and 5–10 mL to the pubic tubercle from the landmark on the body surface of the pubic tubercle; 10 mL lidocaine was administered into the inguinal canal at the midpoint of the skin marking. After skin and subcutaneous tissue dissection, 10–15 mL lidocaine was given under the external aponeurosis. After opening the external aponeurosis, a 10–15 mL dose of lidocaine was injected into the mesentery of the spermatic cord, neck of hernia sac and preperitoneal space at the internal inguinal ring. Extra lidocaine was also given in 3–10 mL portions when needed. The total volumes of lidocaine in milliliters were strictly recorded by the scrub nurse. All the hernias were repaired with light, composite meshes of Ultrapro Hernia System (Ethicon, Norderstedt, Germany).

The patients' pain experience was assessed on a 10 cm visual analogue scale (VAS) with 0 cm corresponding no pain and 10 cm the worst imaginable pain. Intraoperative pain was assessed immediately after surgery finished, and again at 24 and 48 h postoperatively.

The study was performed in accordance with the Helsinki-II declaration, and was approved by the Sichuan University, West China Hospital Ethics Committee. Patients gave written informed consent prior to the study. Data are presented as mean (SD) for continuous numerical data. $P < 0.05$ was considered significant. Statistical evaluation was done with the Kruskal–Wallis test and the one way ANOVA test where appropriate. All data analysis and statistical tests were performed with SPSS 17.0 for windows (http://www.spss.com).

Results

Of the 102 patients who were randomized to the study, all were included in the final analysis. Patient characteristics are shown in Table 1. There were no significant difference in numbers of patients, age, sex, type of hernias by Gilbert's classification, and BMI ($P < 0.05$). Simplex lidocaine provided good analgesia, none needed conversion to general anesthesia. Volume and doses of lidocaine used in operation are shown in Table 2. The mean doses of lidocaine used in Group C were significantly lower than in Groups A and B, and volume of lidocaine used was significantly larger than other two groups (Table 2). No toxic reaction occurred in any patient. The mean intraoperative pain scores were not significantly different among the three groups, and were also comparable at 24 and 48 h postoperatively (Table 3, Fig. 1).

Table 1 Patient characteristics

	Group A ($n = 34$)	Group B ($n = 34$)	Group C ($n = 34$)	P value
Age (years)	61 (18)	69 (13)	64 (18)	0.501
BMI	64.5 (8.5)	62.5 (8.7)	65.5 (10.2)	
Gender				0.357
Male	34	32	33	
Female	0	2	1	
Gilbert				0.159
I	2	1	1	
II	11	20	12	
III	17	12	16	
IV	1	1	1	
V	0	0	3	
VI	3	0	1	

Data are mean (SD)

BMI body mass index

Table 2 Volume and doses of lidocaine used in operation

	Group A	Group B	Group C	*P* value		
				A to B	B to C	A to C
Volume (mL)	38.0 (6.8)	52.2 (7.7)	58.5 (14.4)	0.000	0.000	0.000
Dose (mg)	303.9 (54.4)	261.2 (38.7)	193.1 (47.6)	0.000	0.013	0.000

Data are mean (SD)

Table 3 Intraoperative and postoperative visual analogue scale (VAS) scores

	Group A	Group B	Group C	*P* value		
				A to B	B to C	A to C
Intraoperatively	1.0 (1.0)	0.8 (1.1)	0.7 (0.9)	0.343	0.742	0.072
24 h postoperatively	2.3 (2.0)	1.9 (1.8)	2.0 (1.8)	0.905	0.714	0.415
48 h postoperatively	1.8 (1.8)	1.5 (1.4)	1.2 (1.3)	0.704	0.933	0.307

Data are mean (SD)

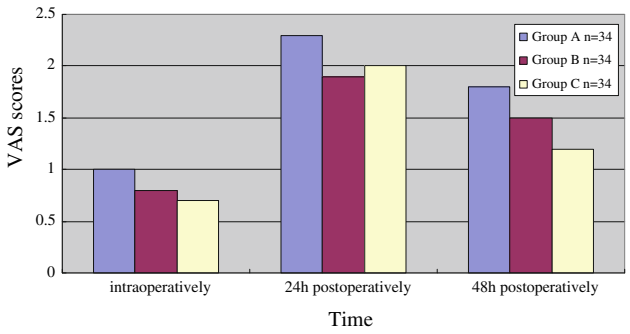

Fig. 1 Pain visual analogue scale (VAS) scores intraoperatively, 24 and 48 h postoperatively

Discussion

In the local anesthesia technique, we used lidocaine alone, without mixing with epinephrine or any other local anesthetic agents. All the patients tolerated the anesthesia technique well, and none required conversion to general anesthesia.

In recent years, mixtures of lidocaine and other local anesthetic agents (e.g., ropivacaine, bupivacaine) have been popular for inguinal hernia repairs [5, 12–14]. However, no prospective randomized control test has proved that mixtures of local anesthetic agents can provide better analgesia effect, and some advocate that there are no significant advantages to the use of mixtures [15]. Furthermore, Krikava and Jarkovsky et al. [16] found that cardiotoxicity in isolated rat heart increased in the presence of mixtures of bupivacaine and lidocaine compared to lidocaine alone. The action time of lidocaine is 1–2 h, and that of bupivacaine is 2–6 h. The mean operation time required for unilateral inguinal hernia repair in our center is 25 min, which is within the action time of lidocaine. The purpose of mixing local anesthetic agents was not primarily to relieve intraoperative pain, but rather to effect short-time postoperative pain. However, a patient's postoperative pain is not limited to 6 h, but lasts considerably longer. We therefore think that taking analgesics orally preoperatively and postoperatively may be better than using long-acting anesthetics intraoperatively. By doing this, analgesia can be both longer and better [17], and potential adverse effects such as neural and cardiac toxicity can be reduced.

Almost all of the currently reported concentrations of lidocaine in local anesthesia for inguinal hernia repairs were 5 mg/mL or higher. In our study, the lowest concentration of lidocaine used was 3.3 mg/mL. The results of our randomized trial showed that there was no significant difference in intraoperative or postoperative pain comparing the three different concentrations of lidocaine used (Table 3, Fig. 1), but the doses of lidocaine used in group C were significantly lower (Table 2). This shows that 3.3 mg/mL lidocaine can provide similar analgesia with less lidocaine, with results as good as with higher concentrations (5 and 8 mg/mL). The larger dose of lidocaine used for the preparation of higher concentrations therefore seems not to be required. As we all know, toxicity of lidocaine is associated with its dose and concentration. Although no patient in any of our three groups developed lidocaine toxicity, we believe that the likelihood of lidocaine toxicity would be least in the lowest dose group. For safety, we should use the lowest possible concentration of lidocaine; however, we did not know if 3.3 mg/mL was the lowest concentration we could really use. It is not clear from the literature whether doses even lower than ours might be applicable. New studies are needed to answer this question.

In local anesthesia techniques, some advocate high volume and low concentration anesthetics [18], and others report that low volume and high concentration anesthetics produce better analgesia effect [19]. In our study, the pain scores of the three groups were not significantly different, but the lower concentration of lidocaine (group C, 3.3 mg/mL) had specific advantages. The local anesthetic agents we used were simplex ampules of lidocaine (400 mg/20 mL) diluted

with normal saline. After dilution, the total volume of lidocaine in group A (8 mg/mL) was only 50 mL. Some patients who are more sensitive to pain sometimes need more lidocaine; the possibility that the volume of lidocaine would then be insufficient intraoperatively was then a concern. However, in group C, the volumes of lidocaine prepared were 100 mL, thus we can added lidocaine whenever the patient felt pain throughout the entire operation without worrying about its insufficiency. Moreover, at the lower concentration, the dose of lidocaine did not increase obviously with increasing volume. The mean volume of lidocaine used during operations in Group C was significant higher than in groups B and A, but the mean doses of lidocaine showed the opposite trend (Table 2), meaning that the anesthesia technique we used was not only high volume and low concentration, but also that low dose anesthetics provided excellent analgesia and were safer.

A further advantage of 3.3 mg/mL lidocaine attributed to its larger volume, as injection of the solution enables the tissue to become turgid, and the layer of dissection can be viewed more clearly [14]. As the potential for neural and vessel injury during surgery is thus reduced, this may contribute to decreasing the rate of chronic postoperative pain [20]. Moreover, injection into the mesentery of the spermatic cord and preperitoneal space at the internal inguinal ring make it easer to gain access to the preperitoneal space, reducing the degree of difficulty of the operation.

In conclusion, we think that local anesthesia with lidocaine alone is successful in inguinal hernia mesh-repairs, and that its effect is satisfactory with a concentration of 3.3 mg/mL, which provides analgesia as good as with concentrations of 5 and 8 mg/mL. Moreover, this technique is applicable not only to inguinal hernia mesh-repairs. It can be utilized during other hernia repairs [8, 9], and we use it routinely for umbilical, small incisional and epigastric hernia repairs.

References

1. Hair A, Duffy K, Mclean J, Taylor S, Smith S, Walker A, Mycintyre IMC, O'Dwer PJ (2000) Groin hernia repair in Scotland. Br J Surg 87:1722–1726
2. Nordin P, Haapaniemi S, van Der Linden W, Nilsson E (2004) Choice of anesthesia and risk of reoperation for recurrence in groin hernia repair. Ann Surg 240:187–192
3. Bay-Nielsen M, Kehlet H, Strand L, Malmstrøm J, Andersen FH, Wara P, Juul P (2001) Quality assessment of 26,304 herniorrhaphies in Denmark: a nationwide questionnaire study. Lancet 358:1124–1128
4. Kehlet H, Bay-Nielsen M (2005) Anaesthetic practice for groin hernia repair: a nationwide study in Denmark 1998–2003. Acta Anaesthesiol Scand 49:143–146
5. Amid PK, Schulman AG, Lichtenstein IL (1994) Local anesthesia for inguinal hernia repair: step-by-step procedure. Ann Surg 220:735–737
6. Glassow F (1976) Short-stay surgery (Shouldice technique for repair of inguinal hernia). Ann R Coll Surg 58:133–139
7. Callesen T, Bech K, Kehlet H (2001) One-thousand consecutive inguinal hernia repairs under unmonitored local anesthesia. Anesth Analg 93:1373–1376
8. Herszage L, Dimasi LL, Abait JA, Damia OPA, Giuseppucci P, Mitru CB (1999) Ambulatory surgery in abdominal wall pathology: 7 years experience. Ambul Surg 7:13–15
9. Herszage L (2004) Hernia surgery in the South American woodlands: a surgical adventure in Argentina. Hernia 8:306–310
10. Acevedo A, Leon J (2010) Ambulatory hernia surgery under local anesthesia is feasible and safe in obese patients. Hernia 14:57–62
11. Osarumwense O, Taiwu I, Amusan T (2010) Outcomes of giant inguinoscrotal hernia repair with local lidocaine anesthesia. Saudi Med J 31:53–58
12. Andersen FH, Nielsen K, Kehlet H (2005) Combined ilioinguinal blockade and local infiltration anaesthesia for groin hernia repair—a double-blind randomized study. Br J Anaesth 94:520–523
13. Kulacoglu H, Ozyaylali I, Yazicioglu D (2009) Factors determining the doses of local anesthetic agents in unilateral inguinal hernia repair. Hernia 13:511–516
14. Narita M, Sakano S, Okamoto S, Uemoto S, Yamamoto M (2009) Tumescent local anesthesia in inguinal herniorrhaphy with a PROLENE hernia system: original technique and results. Am J Surg 198:e27–e31
15. Covino BG, Wildsmith JAW (1998) Clinical pharmacology of local anesthetic agents. In: Cousins MJ, Bridenbaugh PO (eds) Neural blockade in clinical anesthesia and management of pain. Lippincott-Raven, Philadelphia, pp 97–128
16. Krikava I, Jarkovsky J, Stourac P, Novakova M, Sevcik P (2010) The effects of lidocaine on bupivacaine-induced cardiotoxicity in the isolated rat heart. Physiol Res 59:S65–S69
17. Kurukahvecioglu O, Karamercan A, Ege B, Koksal H, Anadol Z, Tezel E, Ersoy E (2007) Effect of meloxicam on postoperative pain relief after inguinal hernia repair with local anaesthesia. West Indian Med J 56:530–533
18. Pippa P, Cuomo P, Panchetti A, Scarchini M, Poggi G, D'Arienzo M (2006) High volume and low concentration of anaesthetic solution in the perivascular interscalene sheath determines quality of block and incidence of complications. Eur J Anaesthesiol 23:855–860
19. Taboada Muñiz M, Rodríguez J, Bermúdez M, Valiño C, Blanco N, Amor M, Aguirre P, Masid A, Cortes J, Alvarez J, Atanassoff PG (2008) Low volume and high concentration of local anesthetic is more efficacious than high volume and low concentration in Labat's sciatic nerve block: a prospective, randomized comparison. Anesth Analg 107:2085–2088
20. Alfieri S, Rotondi F, Di Giorgio A, Fumagalli U, Salzano A, Di Miceli D, Ridolfini MP, Sgagari A, Doglietto G (2006) Influence of preservation versus division of ilioinguinal, iliohypogastric, and genital nerves during open mesh herniorrhaphy: prospective multicentric study of chronic pain. Ann Surg 243:553–558