Evaluation of Ultrasound-guided Genitofemoral Nerve Block Combined with Ilioinguinal/iliohypogastric Nerve Block during Inguinal Hernia Repair in the Elderly*

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Summary: To evaluate the anesthetic effect of ultrasound-guided (USG) ilioinguinal/iliohypogastric nerve (II/IHN) block combined with genital branch of genitofemoral nerve (GFN) block in the elderly undergoing inguinal hernia repair, 54 old patients (aged 60–96years, ASA I–III) with indirect hernia were enrolled and scheduled for unilateral tension-free herniorrhaphy. Patients were grouped randomly to receive either USG II/IHN plus GFN block (Group G) or USG II/IHN block alone (Group I). The intraoperative visual analogue scale (VAS) scores were recorded at skin incision, at spermatic cord/round ligament traction and at sac ligation. The resting and dynamic VAS scores were recorded postoperatively. The requirements of extra sedatives and analgesics for intra- and postoperative analgesia were assessed. Occurrence of complications of the block, postoperative nausea and vomiting and femoral nerve palsy was also reported. Both groups showed similar sensory block. When stretching spermatic cord/round ligament, the patients in group G had significantly lower VAS scores than in group I. And group G used much fewer adjuvant sedatives and analgesics to achieve adequate anaesthesia. In addition, group G was presented with better intraoperative anaesthesia and lower postoperative dynamic VAS scores at all time points tested. No significant difference was found in the postoperative requirement of rescue medication. Both groups showed no complications related to the block and group G reported no femoral nerve palsy. The addition of GFN block to II/IHN block improves the quality of perioperative anesthesia and analgesia in the elderly and reduces the consumption of extra sedatives and analgesics during the surgery.

Key words: ilioinguinal nerve; iliohypogastric nerve; genital branch of genitofemoral nerve; nerve block; inguinal hernia

Hernia surgery is one of the most commonly performed surgery procedures in the elderly. Surgical repair was mainly performed under spinal or general anesthesia[1]. However, traditional anesthesia is often challenged with age, owing to a generalized decline in physiologic reserve. Function decompensation of co-existing diseases, such as pulmonary and cardiovascular diseases, and reduced capacity to withstand surgery associated stress further put the elderly at higher risks in perioperative complications. In addition, anticoagulation treatment, which is commonly used in the elderly with cardiovascular disease, is usually contraindicated in spinal anesthesia. And high dosage of opioid employed in general anesthesia may predispose patients to more nausea and vomiting postoperatively.

Ultrasound-guided nerve block is emerging as a useful option. It provides analgesia during the intra- and post-operative period and avoids the potential complications inherent to general or neuraxial anaesthesia in patients with multiple pathologies. Therefore it has gained attention as a safe way to provide analgesia in geriatric patients in certain cases[2]. Ilioinguinal/iliohypogastric nerve (II/IHN) block is a validated anesthetic technique for inguinal hernia repair. Ultrasound-guided II/IHN block has been reported to provide long duration of analgesia[3, 4], reduce analgesic opioid consumption and post-operative pain[2, 5].

However, it has been shown that this technique provided insufficient analgesia for pain control intraoperatively, especially for visceral paintriggered by traction[6]. And most patients have to be supplemented with deep sedation or even opioids[7]. Nevertheless, high-dosage of opioids may prevent the elderly from enhanced recovery after surgery (ERAS).

As the inguinal region may also receive sensory innervation from the genital branch of genitofemoral nerve (GFN)[8], the addiction of GFN block has been suggested to improve the quality of analgesia for surgery in this area[9]. This randomized study is aimed to evaluate the efficacy of ultrasound-guided GFN block plus II/IHN block in old patients undergoing inguinal hernia repair. Our results revealed that the addition of GFN block to II/IHN block improves the quality of perioperative anesthesia and analgesia in the elderly. It reduces the consumption of extra sedatives and analgesics during the surgery as well.

1 MATERIALS AND METHODS

1.1 General Information

The study was conducted at Wuhan Fourth Hospital of Huazhong University of Science and Technology, in the period between January to November 2018. After Institutional Ethic Committee approved (No. KY2018-050-02) and informed consent was given, 54 old patients (aged 60 to 96 years, ASA I–III, 52 males and 2 females) undergoing unilateral open tension-free hemiorrhaphy were enrolled. Patients with allergy to local anesthetics or contraindications for regional anesthesia were excluded. Blood pressure and blood glucose had been controlled to normal level in patients with hypertension or diabetes before the surgery. Using a computer-generated list, the patients were randomized to receive either ultrasound-guided II/IHN combined with GFN block (group G) or ultrasound-guided II/IHN block alone (group I). All the surgical procedures were performed by the same surgeons, according to the Lichten stein's technique (open repair of inguinal hernia with amesh).

1.2 Anesthetic Procedures

Before procedure, a peripheral intravenous access was established and flubiprofen (50 mg) and sufentanil (5 μg) were administered intravenously for preemptive analgesia. All patients received supplemental oxygen vianasal cannula (2 L/min). Standard monitoring with continuous electrocardiogram, invasive blood pressure measurement and pulseoximetry was performed. In addition, arterial blood gas was tested before anesthesia. The color Doppler ultrasound (Mindray M7) was from Shenzhen Mindray Bio-Medical Electronics Company (China). A 80 mm, 22-G UniPlex NanoLine® needle (Pajunk, Germany) was employed for anesthetics application. In very obese patients, a 100 mm, G21 UniPlex needle was used alternatively.

The patient was placed in a supine position. After skin disinfection with povidone-iodine solution, a linear ultrasound transducer probe of high frequency (6–12 MHz) was placed lateral and superior to the anterior superior iliac spine (ASIS) (fig. 1A). The probe was covered by a sterile plastic transducer sheath and a sterile gel was applied on the skin. The transducer was moved over the line joining the ASIS and umbilicus to scan ilioinguinal (II) and iliohypogastric (IH) nerves. The three muscular layers of the abdominal wall appeared near to the iliac crest. The II and IH nerves would be found in the fascia, plane between the transversus abdominis and internal oblique muscular layers, appearing adjacent to the iliac crest (fig. 1B). The nerves are usually in close proximity to each other and appear as a hypoechoic oval structure. The deep iliac circumflex artery which is close to the two nerves in the same fascial layer can be identified as pulsatile structures and confirmed with the use of color Doppler. A skin wheel was made by injecting 1% lidocaine intracutaneously, medially to the transducer. The UniPlex needle was inserted in-plane, from medial to lateral with the entry point of transducer facing
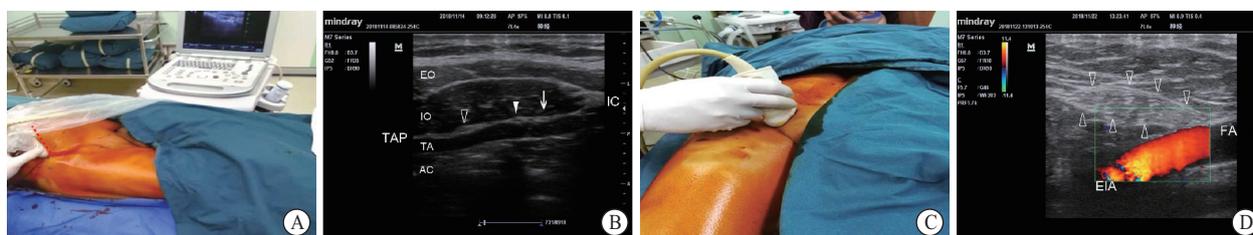

Fig. 1 The probe position and ultrasound images in GFN block combined with II/IHN block
A: In II/IHN block, the probe is placed over the line joining the anterior superior iliac spine and umbilicus (indicated by a dash line). B: Ultrasound images show the three layers of the muscles and the fascial layer, with the II nerve (line arrow) closer to the iliac crest and IH nerve medial to the II (solid arrow head). Sometimes a third nerve appears but is much farther from the iliac crest, which is the 12th intercostal nerve (hollow arrow head). EO: external oblique muscle; IO: internal oblique muscle; TA: transversus abdominis muscle; AC: abdominal cavity, TAP: transversus abdominis plane, IC: iliac crest. C: In GFN block, the probe is placed in the upper medial thigh adjacent to the inguinal ligament. D: with color Doppler, the inguinal canal (surrounded with hollow arrow heads) can be viewed above the external iliac artery at the level where the vessel becomes into femoral artery. EIA: external iliac artery; FA: femoral artery

the navel. The needle placement was confirmed by injection of 1 mL normal saline or local anesthetic (LA). To make sure the LA was spread in the split fascial plane, the needle was propelled or withdrawn 1 or 2 mm when necessary. We administered 0.5% ropivacaine at a volume of 0.25mL/kg, and observed the spread of the LA between the internal oblique and transversus abdominis muscles. The solution encircled the II and IH nerves and appeared as a distinct hypoechoic structure.

We then performed blockade of the genital branch of the GFN in patients of group G. The transducer was placed transversely, 2–3 cm below the inguinal ligament in the medial thigh. After locating the femoral artery, the probe was rotated 90 degree and placed along the long axis of this artery (fig. 1C). Then the probe was moved cephalad over the femoral artery, to identify the level at which external iliac artery becomes into the femoral artery (corresponding approximately to the internal inguinal ring). Once the external iliac artery was identified, the inguinal canal was viewed medial and superficial to the iliac artery as an oval, soft tissue structure (fig. 1D). This contains the spermatic cord in men and the round ligament in women. In males, testicular arteries may be identified in the spermatic cord and confirmed with the use of color Doppler. The needle was inserted out-of-plane or in-plane, depositing 5 mL of 0.5% ropivacaine within and outside of the spermatic cord in men; in women, LA was injected around the round ligament only. Hydrodissection with saline should be utilized to confirm adequate spread within the inguinal canal or within the cord.

During the surgery, additional analgesics (sufentanil and butorphanol, the latter showing little respiratory inhibition) or sedatives (midazolam) might be used in some patients to achieve adequate analgesia. After the surgery, patients were escorted to post-anesthesia care unit (PACU) for a 2-h stay. At the PACU and the ward, in case of VAS score >4, intramuscular injection (im.) of tramadol 100 mg was administered as rescue medication.

1.3 Data Extraction

Cutaneous sensory block in the inguinal region was assessed 30 min after the loco-regional anesthesia using a cold and pinprick stimulus. Sensory block was evaluated by a 4-point score (0=normal sensory; 1=numbness to cold stimulus; 2=numbness to pinprick stimulus; 3=numbness to both cold and pinprick stimulus). Nerve block was defined as effective if grade 2 or above was achieved. The visual analogue scale (VAS) scores were recorded immediately after skin incision, at spermatic cord/round ligament traction and at sac ligation, from 0 (no pain) to 10 (worst pain imaginable). Analgesic effects were rated, using a four grade scale: Good=adequate anesthesia and pain free; Acceptable=inadequate analgesia, mild to

moderate pain, and pain is relieved after intravenous administration of additional analgesic; Poor=inadequate analgesia, severe pain, additional analgesics cannot relieve the pain and patients have to be changed to general anesthesia to complete the surgery. Number of patients changed to general anesthesia, requirement for additional analgesia and sedation and the application of rescue medications after surgery were recorded. Postoperative VAS scores, both resting VAS and dynamic VAS scores (induced by coughing), were registered at different time intervals after surgery (2, 6 and12 h). Occurrence of complications of the block, postoperative nausea and vomiting and femoral nerve palsy were also reported.

The sample size estimation was conducted using the software G*Power. Based on our preliminary study, the effect size used for this assessment was 0.7. And by assuming a type 2 error protection of 0.05 and a power of 0.80, 26 patients in each group were required for appropriate study power.

1.4 Statistical Analysis

Statistical analysis was performed using SPSS statistical software 19.0 for Windows (SPSS, Inc., USA). Continuous variables were expressed as mean±SD. After evaluating data for normality and homoscedasticity, means were compared using t-test for independent samples. Qualitative or categorical variables are presented as absolute numbers (%). Proportions were compared using Fisher's exact test or χ^2-test. The ranked data were analyzed by the rank sum test. A P-value <0.05 was considered statistically significant.

2 RESULTS

Fifty-four patients were enrolled in this study. Among them 27 received II–IH nerve block alone (Group I) and 27 had II–IH plus genitofemoral nerve blocks (Group G). The regional block exerted poor analgesic effect in two subjects in group G and three subjects in group I. These five patients were not included in the following analysis as they turned to undergo general anesthesia for the surgery. Baseline patient characteristics at inclusion were similar between the two groups. No significant differences were found in gender, age, weight, and the duration of both surgery and anesthesia (table 1). Cutaneous sensory block in the inguinal region was assessed 30 min after the nerve block. All the patients achieved nerve block of grade 2 or above, indicating an effective nerve block. The degree of sensory block was identical in the two groups (all P>0.05) (table 2).

During the surgery, the VAS score showed no significant difference in the two groups when recorded immediately after skin incision and at the sac ligation. However, at the spermatic cord/round ligament traction, the VAS scores in group I significantly increased as

Table 1 Patient characteristics

Group	n	Gender (male/female)	Age (years)	Weight (kg)	Time of block manipulation (min)	Time of surgery (min)
G	27	27/0	73.9±9.0	65.9±7.3	15.6±4.0	70.8±26.3
I	27	25/2	73.4±7.9	64.4±7.3	10.9±2.8	70.0±23.0

Values are expressed as numbers or mean±SD.

compared to group G (*P*<0.05, table 3). Additional sedatives or opioids were applied intravenously for pain relief. Drugs involved are listed in table 4. And patients' respiration activities were closely monitored to prevent respiratory depression.

Significant difference was detected in the number of patients needing additional opioids or sedatives to obtain adequate anesthesia between the two groups (table 4, 7.4% in group G *vs.* 59.3% in group I for sufentanil; 7.4% in group G *vs.* 37% in group I for butorphanol; 3.7% in group G *vs.* 22% in group I for midazolam; all *P*<0.05). In addition, statistical difference was found in the number of patients needing antihypertensive drug nicardipine, which was used to control blood pressure when pain occurred, with an incidence of 4 of 27 in group G compared with 11 of 27 in Group I (*P*<0.05).

Intraoperative analgesic effects of reginal block was rated and summarized in table 5. In group G, the proportion of the patients that achieved good analgesic effect was significantly higher than that in group I (25/29 *vs.* 8/30). On the contrary, most of patients in group I achieved acceptable analgesic effect.

Postoperative pain control measures were effective. The resting VAS was similar in the two groups 2, 6 and 12 h after the surgery and consistently <4 in both groups (all *P*>0.05) (table 6). However, at all time points, the VAS induced by coughing were significantly lower in group G than in group I (table 7).

Totally seven patients needed rescue analgesia (100 mg tramadol, im.) to relieve pain 10–12 h post operation, 3 in group G (11.1%) and 4 in the group I (14.8%). There was no statistical difference in the incidence. After 2-h stay in the PACU, the patients in both groups could walk independently without complain of discomfort about the surgical area. No complications, such as hematomas, intestinal perforation, allergic reactions, postoperative nausea and vomiting, were reported in either of the two groups. In group G, no patient developed femoral nerve block during the study period. Only one patient in each group reported urinary retention, which was relieved 2 h later by walking. The patients in both groups were discharged 3–7 days later uneventfully.

3 DISCUSSION

Our data demonstrates that an ultrasound guided GFN block combined with II/IHN block exhibits higher intraoperative analgesia effect and better postoperative

Table 2 Assessment of cutaneous sensory block (*n*)

Group	0	1	2	3
G (*n*=27)	0	0	3	24
I (*n*=27)	0	0	4	23

Values are expressed as numbers. 0=normal sense; 1=numbness to cold stimulus; 2=numbness to pinprick stimulus; 3=numbness to both cold and pinprick stimulus

Table 3 VAS scores at different time points during the surgery

Group	After skin incision	At spermatic cord/round ligament traction	At sac ligation
G (*n*=27)	1.5±0.8	2.0±1.0	1.9±0.7
I (*n*=27)	1.7±0.8	4.7±1.5	2.4±0.8
P	0.686	0.001	0.515

Values are expressed as mean±SD.

Table 4 Intraoperative requirement for additional analgesia and sedation [*n* (%)]

Group	Sufentanil	Butorphanol	Midazolam
G (*n*=27)	2 (7.4%)	2 (7.4%)	1 (3.7%)
I (*n*=27)	16 (59.3%)	10 (37.0%)	6 (22.2%)
P	0.001	0.007	0.015

Table 5 Ratings for analgesic effects of reginal block (*n*)

Group	Good	Acceptable	Poor
G (*n*=29)	25	2	2
I (*n*=30)	8	19	3
P	0.017	0.001	–

Five patients with poor analgesic effect (2 in group G and 3 in group I) were not included in the statistical analyses of the present study, as they turned to general anesthesia to complete the surgery.

Table 6 Resting VAS scores after surgery

Group	n	2 h	6 h	12 h
G	27	2.0±0.6	1.9±0.7	3.1±0.6
I	27	2.1±0.6	2.0±0.5	3.1±0.9

Values are expressed as mean±SD.

Table 7 VAS scores induced by coughing after surgery

Group	n	2 h	6 h	12 h
G	27	2.3±0.7	2.3±0.7	3.3±0.7
I	27	4.1±1.2	4.6±1.1	5.3±1.1
P		0.025	0.021	0.002

Values are expressed as mean±SD.

pain control than the ultrasound guided II/IHN block alone, when performing inguinal hernia repair in the elderly.

The incidence of inguinal hernia increases with age, especially in men through the fifth to seventh decade of life[10]. In the elderly population, the balance between the formation and degradation of collagen is

shifted. Collagen degeneration weakens the strength and stability of the collagen fibers in abdominal area, increasing the risk of developing an inguinal hernia[11, 12]. In addition, increased intra-abdominal pressure with advancing age is another risk factor, which could be resulted from excess body weight, constipation, chronic bronchitis and chronic corpulmonale.

General and spinal anesthesia are two commonly used techniques for inguinal hernia surgery. However, given that comorbidities in lung and heart frequently occurred, elderly patients are often discouraged from general anesthesia due to the high risk of complications. Moreover, general anesthesia exerts comparatively greater adverse effects on the elderly than on the younger brain, manifested by the higher prevalence of postoperative delirium and cognitive dysfunction[13]. With regard to spinal anesthesia, both lumbar and epidural anesthesia may induce a high incidence of intraoperative hypotension in the elderly. And postoperative nausea, vomiting and urinary retention occur frequently as well, delaying the rehabilitation after surgery.

Peripheral nerve blockades are a good alternative in high-risk patients, mainly because they provide anesthesia and analgesia in the selected area and maintain stable hemodynamics which may fluctuate considerably in general and neuraxial anesthesia. The technique requires good knowledge of the local anatomy of the target area. However, the existing landmark-based techniques rely on blind infiltration of local anesthetic through different layers. The disadvantages are well understandable, including injection into wrong abdominal plane, inadvertent femoral nerve block and intestinal puncture[14, 15].

Ultrasound guidance has dramatically improved the safety and success rate of nerve blockades. Ultrasound guided II/IHN block is a validated anesthetic technique for inguinal hernia repair[3, 4]. Nevertheless, II/IHN blocks are not suitable for visceral pain and patients who are sensitive to spermic cord handling during the surgery. Several studies demonstrated that incomplete effect of II/IHN blockade may be due to the contribution of GFN to the innervation of inguinal area[16, 17].

The inguinal area primarily receives sensory innervation from II, IH and GF nerves, which have been collectively called "border nerves"[18]. The II and IH nerves originate from the anterior rami of T12 and L1 nerve roots, and run in parallel through the psoas major muscle. Both nerves can be found consistently (90%) between the transversus abdominis and internal oblique muscles[8]. The GFN originates from L1 and L2 nerve roots and divides into two branches above the inguinal ligament. The femoral branch innervates the femoral triangle. The genital branch gets into the inguinal canal and lies immediately lateral to the spermatic cord (round ligament in females). It supplies sensory fibers to the scrotum (mons pubis and labium majus in females) and possibly the upper, inner, and medial thigh[16]. Therefore, it is plausible to assume that the additional block of genital branch of the GFN would be more effective than II/IHN block alone in cases receiving incision in inguinal region. Indeed, in the present study, additional block of the GFN showed more intense anesthetic effect than II/IHN block alone during the surgery, evidenced by the decreased VAS scores in spermatic cord/round ligament and sac handling (table 3), the reduced usage of opioids or sedatives (table 4), and higher proportions in patients with good analgesic effects. Apart from providing optimal intraoperative conditions, our result also showed postoperative analgesia was more effective in the GFN block group at each time point tested (table 7). Therefore, it facilitates old patients for early ambulation and enhances recovery after surgery.

The genital branch is difficult to visualize directly unless a high frequency probe (up to 18 MHz) is used. Moreover, previous studies[16, 19] have reported a high rate of anatomic variability of the genital branch of the GF nerve, with respect to its communication between nerves, penetration of fascial layers and dominance patterns[18]. It is noteworthy that the local anesthetic should be infiltrated in both the spermatic cord and surrounding tissue in order to cover all anatomical variations of the nerve. Therefore, in the present study we infiltrated the inguinal canal and deposit 5 mL LA both inside and outside the spermatic cord (round ligament in females).

To the best of our knowledge, no side effects have been reported due to the injection of LA inside the inguinal canal. Although we did not observe any complications after GFN block in this study, possible adverse effects such as cord haematoma should be kept in mind[20].

Some studies have evaluated the efficacy of II and IH nerve blocks combined with GF nerve block[9, 21, 22]. Sasaoka et al[9] were the first authors to use this technique under blind condition in children during inguinal hernia repair and reported lower opioid requirements during surgery. However, they suggested that the benefit of the additional GFN block was limited only to the time of sac traction and did not observe benefits in postoperative pain. Later, using an ultrasound guided procedure, Frassanito et al[21] reported the combination of GFN block and II/IHN block reduced doses of intraoperative additional LA and improved postoperative analgesia during inguinal herniarepair in adults. Similar results were reported by Wipfli et al[22], who showed the efficacy of blind GFN block in reducing intraoperative opioid requirement and improving postoperative analgesia in 20 adult patients undergoing scrotal surgery.

Apart from serving as an anesthetic technique, GFN block can be used as a therapeutic procedure in groin pain. Shanthanna reported a successful treatment of genitofemoral neuralgia by an ultrasound guided local anesthetic injection of genitofemoral nerve leading to long term pain relief[23]. Other studies showed that this techniqueis were also effective to relieve chronic pelvic pain[24] and intractable orchalgia[25]. Furthermore, ultrasound guided nerve block could be combined with general or spinal anesthesia, as a part of multimodal analgesia program.

In summary, the addition of GFN block enhances the effect of II and IH nerve block, thus achieving complete anesthesia for the elderly undergoing inguinal hernia repair. It reduces intraoperative discomfort and consumption of additional opioids, lowers postoperative pain and incidence of unexpected femoral nerve block. Ultrasound allows for controlled administration and greatly enhances the technical ability to perform precise localization and injection. Therefore, ultrasound-guided local anesthetic technique is a good alternative in high-risk or old patients.

Conflict of Interest Statement

The authors declare no conflicts of interest in this study.

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