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Application of three-dimensional spinal ultrasound-guided combined spinal-epidural anesthesia in elderly patients' surgery

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Abstract: **Objective** To compare the effectiveness and safety between three-dimensional spinal ultrasound-guided combined spinal-epidural anesthesia (CSEA)and traditional CSEA in elderly patients. **Methods** A total of 100 elderly patients undergoing CSEA in the Department of Anesthesiology at the People's Hospital of Honghu between April 2022 and December 2023 were selected and randomly divided into an ultrasound group (group U)and a control group(group C) according to the random number table method, with 50 patients in each group. The C group used the traditional palpation method to locate the puncture point, while the U group utilized the handheld ultrasound device Accuro for localization. Number of attempts required for successful punctures, first attempt success rate of one puncture, locating time, puncture time, number of puncture direction adjustments, puncture-related complications, and patient satisfaction were compared between the two groups. **Results** The number of successful punctures in group U was less than that in group C (Z = 3.851, P < 0.01), and the first attempt success rate was significantly higher than that in group C (92.0% *vs* 62.0%, χ^2=14.918, P< 0.01). Compared with group C, the locating time and total puncture time in group U were longer(P < 0.01), but the puncture time was shorter[(9.5(9.4, 9.7)min *vs* 10.4(10.2, 11.1)min, Z = 8.358, P < 0.01], and the number of puncture direction adjustments was less[2(1, 2)*vs* 2(2, 2), Z=2.993, P<0.01]. No complications occurred in group U, and 6 cases in group C developed paresthesia through puncture and catheter placement. The complication rate in group C was higher than that in group U (0 *vs* 12.0%, χ^2=4.433, P=0.035). There was no significant difference in patient satisfaction between the two groups(P>0.05). **Conclusion** Three-dimensional spinal ultrasound- guided CSEA can improve the first attempt success rate, reduce the incidence of complications in elderly patients, providing an evidence basis for the choice of clinical application.

Keywords: Three-dimensional spinal ultrasound; Combined spinal-epidural anesthesia; Intravertebral canal puncture; Location; Puncture

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Combined spinal-epidural anesthesia (CSEA) is a commonly used anesthetic technique for lower abdominal and lower limb surgeries. Its successful implementation not only determines the smooth progress of the surgical procedure but also directly influences postoperative recovery and patients' quality of life [1]. Clinically, the most commonly used puncture method is blind puncture, which involves identifying Tuffier's line or Jacoby's line by palpating bony landmarks such as the iliac crests and spinous processes, and then locating the puncture site based on these lines [2-3]. However, the landmark-based blind technique imposes high demands on patient positioning, puncture conditions, and operator proficiency. Its limitations become particularly evident in elderly patients, especially those with obesity, spinal deformities, calcification, or poorly defined surface landmarks [4]. Age-related physiological degeneration, including degenerative spinal changes, osteoporosis, and muscular atrophy, makes traditional palpation-based localization difficult, leading to a decreased success rate and a higher risk of complications such as hematoma, nerve injury, and infection. These complications not only prolong hospital stay and increase healthcare costs but may also exert long-term adverse effects on patients' quality of life [5]. Therefore, exploring more accurate, safer, and patient-friendly puncture techniques is of great clinical significance [6]. In recent years, the emergence of three-dimensional (3D) spinal ultrasound technology has provided a novel solution to this challenge [7]. With high-resolution imaging, it can clearly display bony structures of the spine—including spinous processes and intervertebral spaces—while allowing real-time monitoring of the puncture needle's trajectory to ensure advancement within the correct anatomical plane [8]. This technology has been widely validated in patients with difficult neuraxial access, such as obese individuals and parturients [9-11]. The advent of handheld puncture localization devices, such as the Accuro system, has further enhanced the convenience and efficiency of this approach. Its ability to automatically measure epidural space depth and provide insertion depth recommendations greatly reduces dependence on operator experience, enabling less-experienced physicians to achieve higher success rates in a shorter time [12-13]. Although 3D spinal ultrasound demonstrates great theoretical potential, its widespread clinical adoption still faces challenges [14-15]. To date,

clinical studies specifically investigating its application in elderly patients undergoing CSEA remain limited. Further data are needed to establish standardized technical protocols and to confirm its long-term clinical benefits [16]. Therefore, this study aimed to comprehensively evaluate the efficacy and safety of handheld ultrasound-guided CSEA in elderly patients through a prospectively designed randomized controlled trial, thereby providing evidence-based support for clinical decision-making and promoting standardized application of this technique to benefit more elderly surgical patients.

1. Materials and methods

1.1 General information

A total of 100 patients who underwent urological surgery under CSEA in the Department of Anesthesiology at Honghu People's Hospital between April 2022 and December 2023 were enrolled. Inclusion criteria: age >65 years; American Society of Anesthesiologists (ASA) physical status I–II; elective surgery. Exclusion criteria: contraindications to neuraxial anesthesia (e.g., oagulation disorders, infection at the puncture site, local anesthetic allergy); previous spinal surgery; or psychiatric disorders preventing cooperation. Elimination criterion: failure after three consecutive puncture attempts by the same operator. The study was approved by the Ethics Committee of Honghu People's Hospital (Approval No. HHRY202309), and all patients provided written informed consent prior to participation. Eligible patients were randomly assigned using a random number table into the ultrasound group (group U, n=50) or the control group (group C, n=50). There were no significant differences between groups in terms of age, height, weight, body mass index (BMI), or ASA classification (P>0.05) (**Table 1**).

1.2 Puncture methods

All patients underwent CSEA puncture and catheterization in the operating room. After entering the operating room, patients received oxygen via face mask, with continuous monitoring of electrocardiogram (ECG), blood pressure (BP), and pulse oxygen saturation (SpO2). A venous access was established. Once the patient's vital signs were confirmed stable and within the normal range, the same attending anesthesiologist performed neuraxial puncture and catheterization for CSEA. During CSEA, both groups of patients were placed in the left lateral decubitus position with flexed knees.

Group C: The traditional surface localization method was used. The puncture site at the L_{2-3} intervertebral space was identified by palpating the iliac crests and spinous processes (the intersection of the line connecting the highest points of the bilateral iliac crests with the spine corresponds to the L_{3-4} intervertebral space or L_4 spinous process). Blind puncture was performed using the loss-of-resistance technique.

Group U: The same physician used the handheld ultrasound device Accuro to perform localization with 3D spinal ultrasound technology. A blue icon on the ultrasound display indicated that the probe was at the spinous process level; an orange icon indicated the probe was at the intervertebral space level; a red dashed line indicated the probe was at the midline of the spine. The probe was adjusted, and the L2-3 intervertebral space and spinal midline were identified based on the alternating icons. When the indicator icon at the bottom of the display turned red and no spinous process image was visible on the ultrasound, the orange number displayed at this time was recorded as the predicted puncture depth. The positioner at the probe was then gently pressed to confirm and mark the optimal puncture site. CSEA was performed via a midline vertical approach under ultrasound guidance.

1.3 Outcome measures

Primary outcome: Number of puncture attempts required for success (defined as successful dural puncture without redirection after skin insertion). Secondary outcomes: (1) Number of needle redirections (number of times the needle was withdrawn to the subcutaneous level and redirected); (2) Localization time; (3) Puncture completion time (time from initial puncture to cerebrospinal fluid flow); (4) Total puncture time (time from localization to cerebrospinal fluid flow); (5) Patient and operator satisfaction; (6) Puncture-related complications (paresthesia during puncture or catheterization, dural puncture, postdural puncture headache, low back pain, or neurological symptoms).

1.4 Statistical analysis

All data were analyzed using SPSS 25.0 software. Normality was assessed using the Shapiro-Wilk test. Continuous variables with normal distribution were expressed as mean ± standard deviation ($\bar{x}\pm s$) and compared using independent-samples t-tests. Non-normally distributed continuous variables were expressed as M (Q_1, Q_3) and compared using the Mann–Whitney U test. Categorical variables were presented as case (%) and compared using χ^2 or Fisher's exact tests. Ordinal data were compared using rank-sum tests. A two-sided P value <0.05 was considered statistically significant.

Tab.1 Comparison of general information between two groups [n=50,$M(Q_1,Q_3)$]

Group	Age (years)	Height (cm)	Body weight (kg)	BMI (kg/m²)	ASA (I/II,case)
Group U	71.5(68.0,76.0)	167.5(161.5,170.0)	61.8±9.8	22.6(20.8, 24.3)	37/13
Group C	72.5(68.8,76.0)	165.0(159.8,170.0)	61.9±10.4	22.3(20.4, 5.0)	32/18
***Z*/*t*/χ^2value**	0.580	1.415	0.113	0.055	1.170
***P* value**	0.562	0.157	0.911	0.956	0.280

2. Results

2.1 Primary outcome

The study lasted 8 months with no dropouts. The number of attempts required for successful puncture was significantly lower in the group U than in the group C (Z=3.851, P<0.01). The first-attempt success rate was also significantly higher in the U group (94.0%) compared with the C group (62.0%) (χ^2=14.918, P<0.01) **(Table 2).**

2.2 Secondary outcomes

The group U showed shorter puncture completion time and fewer needle direction adjustments compared with the group C (P<0.05), whereas localization time and total puncture time were longer (P<0.05) (**Table 2**).

2.3 Patient satisfaction

There was no statistically significant difference in patient satisfaction between groups (P>0.05) (**Table 3**). Physician satisfaction was 100% in both groups.

2.4 Puncture-related complications

No complications occurred in the group U. In contrast, six patients (12.0%) in the group C experienced paresthesia during puncture or catheter placement. The incidence of complications in group C was higher than that in group U (χ^2=4.433, P=0.035).

Tab.2 Comparison of primary and secondary outcome indexes between two groups [n=50,$M(Q_1,Q_3)$]

Group	Number of attempts required for successful puncture (3/2/1, case)	Localization time (min),	Puncture completion time (min)	Total puncture time (min)	Number of puncture direction adjustments
Group U	0/3/47	3.2(3.2, 3.3)	9.5(9.4, 9.7)	12.8(12.6, 13.0)	2(1, 2)
Group C	1/18/31	0.8(0.7, 0.9)	10.4(10.2, 11.1)	11.2(11.0, 11.8)	2(2, 2)
***U* value**	3.851	8.737	8.358	8.438	2.993
***P* value**	0.001	＜0.001	＜0.001	＜0.001	＜0.001

Tab.3 Comparison of patient satisfaction between two groups [*n*=50, case(%)]

Group	Satisfied	Fair	Dissatisfied
Group U	49(98.0)	0	1(2.0)
Group C	46(92.0)	3(6.0)	1(2.0)
***U* value**		1.331	
***P* value**		0.183	

3. Discussion

For elderly patients, real-time 3D spinal ultrasound–guided puncture demonstrates remarkable advantages. This technique enables dynamic visualization of the needle trajectory throughout the procedure, thereby enhancing the success rate of neuraxial anesthesia and reducing the incidence of complications. In this study, compared with the traditional landmark-based method, the ultrasound-guided group required fewer puncture attempts, achieved a significantly higher first-attempt success rate, and required fewer needle redirections—consistent with the findings of previous studies [8,17].

Moreover, no complications occurred in the ultrasound-guided group, whereas six cases of paresthesia occurred in the control group. This suggests that real-time 3D spinal ultrasound provides superior safety by minimizing puncture-related complications in elderly patients. Although localization and total procedure time were longer in the ultrasound group, this difference may lack clinical relevance [13], since puncture completion was achieved more rapidly once localization was finalized. Given the improved success rate and reduced complications, a slight increase in procedure time is acceptable. Elderly patients often present technical challenges due to ligamentous hypertrophy, interspace narrowing, and vertebral overgrowth, which can obscure needle pathways during traditional ultrasound use. However, 3D spinal ultrasound, with its high-resolution imaging and real-time guidance, effectively overcomes these difficulties and ensures a smoother puncture process [17].

Limitations: (1) Although 100 elderly patients were included, the sample size remains relatively small and may not fully represent the overall efficacy of this technique. (2) The longer localization and operation times in the ultrasound group suggest that additional time may be required for preparation and execution. (3) Pre-procedural ultrasound-assisted localization, which may shorten puncture time, was not evaluated in this study. (4) Only short-term outcomes were assessed; long-term effects—such as postoperative recovery and quality of life—require further investigation.

In conclusion, 3D spinal ultrasound–guided CSEA improves first-attempt puncture success and reduces complication rates in elderly patients, providing solid evidence to support its clinical adoption and broader application.

Conflict of interest None

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·论　著·

三维脊柱超声引导腰硬联合麻醉穿刺术在老年患者手术中的应用

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摘要：目的　比较三维脊柱超声引导腰硬联合麻醉穿刺术与传统腰硬联合麻醉穿刺术在老年患者中的有效性与安全性。**方法**　选取2022年4月至2023年12月期间于洪湖市人民医院麻醉科行腰硬联合麻醉的老年患者100例，采用随机数字表法随机分为超声组（U组）和对照组（C组），每组50例。C组采用传统触摸法定位穿刺点，U组使用手持式超声Accuro进行定位。比较两组穿刺成功所需次数、1次穿刺成功率、定位时间、穿刺时间、穿刺方向调整次数、穿刺相关并发症及患者满意度等指标。**结果**　U组穿刺成功所需次数少于C组（Z=3.851，P < 0.01），1次穿刺成功率显著高于C组（94.0% *vs* 62.0%，χ^2=14.918，P < 0.01）。与C组比较，U组定位时间和总穿刺时间较长（P < 0.01），但完成穿刺时间较短[(9.5(9.4,9.7)min *vs* 10.4(10.2,11.1)min，Z=8.358，P<0.01]、穿刺方向调整次数较少[2(1,2) *vs* 2(2,2)，Z=2.993，P<0.01]。U组无任何并发症发生，C组有6例发生穿刺及置管异感，C组并发症率高于U组（0 *vs* 12.0%，χ^2=4.433，P < 0.05）。两组患者满意度差异无统计学意义（P>0.05）。**结论**　三维脊柱超声引导腰硬联合麻醉穿刺术可提高老年患者1次穿刺成功率，降低并发症发生率，为其临床应用提供了证据基础。

关键词：三维脊柱超声；腰硬联合麻醉；椎管内穿刺；定位；穿刺

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Application of three-dimensional spinal ultrasound-guided combined spinal-epidural anesthesia in elderly patients' surgery

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Abstract: Objective　To compare the effectiveness and safety between three-dimensional spinal ultrasound-guided combined spinal-epidural anesthesia (CSEA) and traditional CSEA in elderly patients. **Methods**　A total of 100 elderly patients undergoing CSEA in the Department of Anesthesiology at the People's Hospital of Honghu between April 2022 and December 2023 were selected and randomly divided into an ultrasound group (group U) and a control group (group C) according to the random number table method, with 50 patients in each group. The C group used the traditional palpation method to locate the puncture point, while the U group utilized the handheld ultrasound device Accuro for localization. Number of attempts required for successful punctures, first attempt success rate, locating time, puncture time, number of puncture direction adjustments, puncture-related complications, and patient satisfaction were compared between the two groups. **Results**　The number of successful punctures in group U was less than that in group C (Z = 3.851, P < 0.01), and the first attempt success rate was significantly higher than that in group C (92.0%*vs* 62.0%, χ^2= 14.918, P< 0.01). Compared with group C, the locating time and total puncture time in group U were longer (P < 0.01), but the puncture time was shorter [(9.5 (9.4, 9.7) min *vs* 10.4 (10.2, 11.1) min, Z = 8.358, P < 0.01], and

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the number of puncture direction adjustments was less [2(1, 2) *vs* 2(2, 2), Z=2.993, P<0.01]. No complications occurred in group U, and 6 cases in group C developed paraesthesia through puncture and catheter placement. The complication rate in group C was higher than that in group U (0 *vs* 12.0%, χ^2=4.433, P<0.05). There was no significant difference in patient satisfaction between the two groups (P>0.05). **Conclusion** Three-dimensional spinal ultrasound-guided CSEA can improve the first attempt success rate, reduce the incidence of complications in elderly patients, providing an evidence basis for the choice of clinical application.

Keywords: Three-dimensional spinal ultrasound; Combined spinal-epidural anesthesia; Intravertebral canal puncture; Location; Puncture

Fund program: General Program of National Natural Science Foundation of China (82272238); General Project of Key Laboratory of Anesthesia Resuscitation of Ministry of Education (2023MZFS004)

腰硬联合麻醉在临床上是下腹部和下肢手术的常用麻醉方法，其成功实施不仅关乎手术顺利进行，更直接影响到患者的术后恢复与生活质量[1]。通过触摸髂嵴和棘突等骨性标志，确定Tuffier线或Jacoby线来确定穿刺点后盲探穿刺是临床上最常用的穿刺方法[2-3]。基于体表标志的盲探穿刺法对于患者体位、患者的穿刺条件和操作者的熟练度要求高，在面对老年患者时，尤其是那些伴随有肥胖、脊柱畸形、钙化或体表标志模糊等问题的老年患者时，其局限性显得尤为突出[4]。老年患者的生理机能衰退，包括脊柱的退行性病变、骨质疏松以及肌肉组织的萎缩，使得传统触诊定位变得困难，可直接导致穿刺成功率下降和并发症风险增加，如血肿形成、神经损伤及感染等。这些并发症不仅延长患者的住院时间，增加医疗成本，还可能对其生活质量造成长期的不良影响[5]。鉴于此，探索更为精准、更安全、患者满意度更高的麻醉穿刺技术尤为重要[6]。近年来，三维脊柱超声技术的兴起为这一难题提供了新的解决思路[7]。该技术通过高精度成像，不仅能够清晰显示脊柱的骨性结构，包括棘突、椎间隙等关键标志，还能实时监测穿刺针的路径，确保其在正确的解剖层次内行进[8]，目前已在肥胖患者、孕产妇等穿刺困难患者的椎管内穿刺中得到广泛验证[9-11]。特别是手持式穿刺定位超声设备Accuro的应用，更是将这一技术的便捷性与高效性推向了新的高度。其自动测量硬膜外间隙深度并给出进针深度建议的功能，极大地降低了对操作者经验的依赖，使得经验尚浅的医师也能在较短时间内掌握并提高穿刺成功率[12-13]。尽管三维脊柱超声技术在理论上展现出了巨大的潜力，但其在临床实践中的广泛应用仍面临诸多挑战[14-15]。目前，该技术在老年患者腰硬联合麻醉中具体应用效果的临床研究仍较为有限，其技术规范、操作标准以及长期的临床收益尚需进一步的数据支持和验证[16]。因此，本研究旨在通过前瞻性设计的临床随机对照试验，全面评估手持式超声引导技术在老年患者腰硬联合麻醉穿刺中的有效性与安全性，以期为临床决策提供坚实的证据基础，推动该技术的规范化应用，最终惠及更多老年手术患者。

1 资料与方法

1.1 一般资料 选取2022年4月至2023年12月于洪湖市人民医院麻醉科在腰硬联合麻醉下行泌尿外科手术的患者100例，纳入标准：年龄>65岁；美国麻醉医师协会(American Society of Anesthesiologists, ASA)分级Ⅰ~Ⅱ级；择期手术。排除标准：存在椎管内麻醉禁忌证，如凝血功能障碍、穿刺部位感染、局麻药过敏等；既往脊柱手术史；精神疾病无法配合的患者。入组后剔除标准：同一操作者连续穿刺3次不成功者。本研究在开始前已获洪湖市人民医院医学伦理委员会批准(批件号HHRY202309)，所有患者入组前均签署知情同意书。对所有符合纳入标准的患者采用随机数字表法随机分为超声组(U组，n=50)和对照组(C组，n=50)。两组患者年龄、身高、体质量、身体质量指数(body mass index, BMI)及ASA分级比较差异均无统计学意义(P>0.05)。见表1。

1.2 穿刺方法 所有患者均在手术间完成腰硬联合麻醉穿刺置管术。患者进入手术间后予面罩吸氧，持续监测心电图、血压、血氧饱和度，建立静脉通道。确认患者生命体征平稳且在正常范围内后，同一麻醉主治医生进行腰硬联合麻醉行椎管内穿刺及置管术。行腰硬联合麻醉时两组患者均采用左侧卧位，膝关节屈曲。

对于C组患者，通过传统的体表定位法，即通过触摸髂嵴和棘突(两侧髂嵴最高点连线与脊柱交点为$L_{3\sim4}$椎间隙或L_4棘突)确定椎间隙$L_{2\sim3}$的穿刺点。根据阻力消失法盲探完成腰硬联合麻醉。

对于U组患者，同一医师使用手持式超声Accuro，

运用三维脊柱超声技术进行定位。超声显示屏出现蓝色图标时指示探头位于棘突水平；出现橙色图标时指示探头位于椎间隙水平；出现红色虚线时提示探头位于脊柱中线。调整探头，根据交替出现的图标确定$L_{2\sim3}$椎间隙和脊柱中线，当显示屏下方指示图标变为红色，且超声图像处看不到棘突成像，记录此时的橙色数字，即为预测穿刺深度，再轻压探头处的定位器，确定最佳穿刺点，并标记。垂直正中入路，在超声引导下完成腰硬联合麻醉。

1.3 结局指标 主要结局指标：穿刺成功所需的次数（穿刺针穿刺入皮肤后，针头在没有重定向的情况下一次穿刺成功的次数）。次要结局指标如下：（1）改变穿刺针方向的次数（穿刺针退至皮下后改变方向的次数）；（2）定位时间；（3）完成穿刺时间（从穿刺开始至引流出脑脊液的时间）；（4）总穿刺时间（从定位至引流出脑脊液的时间）；（5）患者及医生满意度；（6）穿刺相关并发症（穿刺过程中或在硬膜外置管时有异感、穿破硬脊膜、头痛、腰背痛、异常神经症状）的发生情况。

1.4 统计学方法 采用SPSS 25.0软件进行数据分析。使用Shapiro-Wilk检验确认数据分布的正态性，符合正态分布的连续变量以$\bar{x}\pm s$表述，采用两独立样本t检验比较，不符合正态分布的连续变量以$M(Q_1,Q_3)$表示，采用Mann-Whitney检验比较；分类变量以例（%）表示，采用χ^2检验或其校正法比较；等级资料比较采用秩和检验。双侧检验，$P<0.05$为差异有统计学意义。

2 结 果

2.1 两组主要结局指标比较 试验历时8个月，无剔除或脱落患者。U组穿刺成功所需次数显著低于C组（$Z=3.851$，$P<0.01$），1次穿刺成功率显著高于C组（94.0% *vs* 62.0%，$\chi^2=14.918$，$P<0.01$）。见表2。

2.2 两组次要结局指标比较 U组完成穿刺时间、穿刺方向调整次数均较C组更短（$P<0.05$），定位时间、总穿刺时间较C组更长（$P<0.05$）。见表2。

2.3 两组患者满意度比较 两组的患者满意度差异无统计学意义（$P>0.05$）。见表3。两组医生满意度均为100%满意。

2.4 两组穿刺相关并发症比较 U组无任何并发症发生，而C组有6例（12.0%）发生穿刺相关并发症，均为穿刺及置管异感，C组并发症发生率高于U组（$\chi^2=4.433$，$P=0.035$）。

表1 两组患者一般资料比较 ［n=50，$M(Q_1,Q_3)$］

Tab.1 Comparison of general information between two groups ［n=50，$M(Q_1,Q_3)$］

组别	年龄（岁）	身高（cm）	体质量（kg，$\bar{x}\pm s$）	BMI（kg/m^2，$\bar{x}\pm s$）	ASA Ⅰ/Ⅱ级（例）
U组	71.5（68.0，76.0）	167.5（161.5，170.0）	61.8±9.8	22.6（20.8，24.3）	37/13
C组	72.5（68.8，76.0）	165.0（159.8，170.0）	61.9±10.4	22.3（20.4，25.0）	32/18
$Z/t/\chi^2$值	0.580	1.415	0.049	0.055	1.170
P值	0.562	0.157	0.961	0.956	0.280

表2 两组主要、次要结局指标比较 ［n=50，$M(Q_1,Q_3)$］

Tab.2 Comparison of primary and secondary outcome indexes between two groups ［n=50，$M(Q_1,Q_3)$］

组别	穿刺成功所需次数（3次/2次/1次，例）	定位时间（min）	完成穿刺时间（min）	总穿刺时间（min）	穿刺方向调整次数
U组	0/3/47	3.2（3.2，3.3）	9.5（9.4，9.7）	12.8（12.6，13.0）	2（1，2）
C组	1/18/31	0.8（0.7，0.9）	10.4（10.2，11.1）	11.2（11.0，11.8）	2（2，2）
Z值	3.851	8.737	8.358	8.438	2.993
P值	0.001	<0.001	<0.001	<0.001	<0.001

表3 两组患者满意度比较 ［n=50，例（%）］

Tab.3 Comparison of patient satisfaction between two groups ［n=50，case（%）］

组别	满意	一般	不满意
U组	49（98.0）	0	1（2.0）
C组	46（92.0）	3（6.0）	1（2.0）
Z值		1.331	
P值		0.183	

3 讨 论

针对老年患者，三维脊柱超声实时引导下穿刺技术展现出了显著的优势。这一技术能够实时、动态地观察进针的方向和轨迹，使得椎管内麻醉穿刺过程实现了全程可视化，从而提高了穿刺的成功率，

并有效减少了并发症的发生。在本研究中,与采用传统方法的C组相比,使用三维脊柱超声实时引导技术的U组穿刺成功所需的次数明显减少,1次穿刺成功率明显提高,U组的穿刺方向调整次数也较C组更少,这与Kamimura、Zhang等[8,17]的研究结论相一致,说明三维脊柱超声实时引导技术能够显著提高椎管内穿刺的一次成功率。

另外,本研究中,U组未发生任何并发症,而C组则有6例患者出现穿刺及置管异感,提示使用三维脊柱超声实时引导技术相较于传统方法,在降低穿刺并发症上具有明显优势,且在老年患者腰硬联合麻醉中具有较高的安全性。通过减少穿刺次数和穿刺针方向调整次数,该技术有效降低了穿刺相关并发症的发生率。尽管U组定位和操作时间长于C组,但是这种差异也许并没有实际临床意义[13]。这是因为U组虽然定位时间更长,但实际穿刺时间却较C组明显更短。相较于一次穿刺成功率的提高和并发症的下降而言,操作时间的略微增加变得可接受。此外,对于老年患者进行实时穿刺确实比较困难,由于椎体和韧带增生、椎间隙变窄等原因,普通超声探头可能会阻塞穿刺针路径。然而,三维脊柱超声技术通过高精度成像和实时监测功能,能够克服这些挑战,确保穿刺过程的顺利进行[17]。

本研究有以下局限性:(1)虽然纳入了100例老年患者,但样本量仍相对有限,可能不足以全面反映三维脊柱超声引导穿刺术在老年患者腰硬联合麻醉中的普遍效果。(2)操作时间差异,研究显示U组的定位和操作时间长于C组,这也提示了在实际应用中,超声引导可能需要更多的时间来准备和实施。(3)术前超声辅助定位,在老年患者中,由于椎体和韧带增生、椎间隙变窄,普通超声探头更容易阻塞穿刺针路径。这提示术前进行超声辅助定位可能会缩短穿刺时间,但本研究并未对此进行探讨或实践。(4)长期效果未知,本研究主要关注了三维脊柱超声引导穿刺术在老年患者腰硬联合麻醉中的短期效果,如一次穿刺成功率、并发症发生率等。对于该技术的长期效果,如对患者术后恢复和生活质量的影响等,仍有待进一步的研究和验证。

综上所述,三维脊柱超声引导腰硬联合麻醉穿刺术可提高老年患者一次穿刺成功率,降低并发症发生率,为临床应用的选择提供了证据基础。

利益冲突 无

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