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· 论 著 ·

加速康复外科理念在微创经椎间孔腰椎椎体间融合术患者麻醉管理中的应用

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[摘要] **目的** 通过回顾性队列研究, 探究围手术期加速康复外科 (ERAS) 理念指导下脊椎麻醉与全身麻醉对微创经椎间孔腰椎椎体间融合术 (MIS-TLIF) 患者围手术期指标的影响。**方法** 回顾性分析 2019 年 1 月至 2021 年 12 月成都大学附属医院行 MIS-TLIF 治疗的 40 例患者的围手术期资料, 其中行脊椎麻醉与全身麻醉的患者各 20 例。收集每位患者的手术时间、术中不良事件、术后不良事件、术后住院时间、麻醉后监测治疗室 (PACU) 中 3 h 内数值评定量表 (NRS) 疼痛评分、阿片类药物使用情况、术后初次下床活动时间等, 比较两组间的差异。**结果** 两组患者的一般资料差异均无统计学意义 (P 均 >0.05)。与全身麻醉组相比, 脊椎麻醉诱导后接受 MIS-TLIF 治疗患者的总手术室时间少 [(192.18 ± 18.09) min vs (223.22 ± 19.54) min, $P < 0.001$], 离开手术室时间少 [(5.44 ± 1.95) min vs (9.94 ± 1.28) min, $P < 0.001$], 术中平均心率低 [(67.39 ± 7.44) min^{-1} vs (72.94 ± 8.61) min^{-1} , $P = 0.035$], 术中平均动脉压低 [(78.38 ± 9.88) mmHg vs (84.47 ± 8.30) mmHg, $P = 0.041$] (1 mmHg = 0.133 kPa), PACU 中 3 h 内 NRS 疼痛评分低 [(3.81 ± 1.87) 分 vs (5.43 ± 2.24) 分, $P = 0.017$], PACU 中 3 h 内阿片类镇痛药物 (硫酸吗啡) 需求量少 [(5.36 ± 1.71) mg vs (7.22 ± 2.01) mg, $P = 0.003$], 术后第 1 次使用镇痛药时间晚 [(58.11 ± 20.19) min vs (45.58 ± 17.16) min, $P = 0.041$], 术后初次下床活动时间早 [(430.77 ± 122.38) min vs (843.86 ± 95.44) min, $P < 0.001$]。两组间总手术时间、术中出血量、术后住院时间的差异均无统计学意义 (P 均 >0.05)。**结论** 在 ERAS 理念指导下, MIS-TLIF 手术可选择脊椎麻醉, 其能有效减少手术室时间和术后疼痛, 并能早期术后活动。

[关键词] 脊椎麻醉; 全身麻醉; 微创手术; 经椎间孔腰椎椎体间融合术; 加速康复外科

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Application of enhanced recovery after surgery concept in anesthetic management of patients undergoing minimally invasive transforaminal lumbar interbody fusion

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[Abstract] **Objective** To explore the effects of spinal anesthesia (SA) and general anesthesia (GA) under the guidance of enhanced recovery after surgery (ERAS) concept on minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) through a retrospective cohort study. **Methods** Perioperative data of 40 patients who underwent MIS-TLIF in The Affiliated Hospital of Chengdu University from Jan. 2019 to Dec. 2021 were retrospectively analyzed, with 20 patients in the SA group and 20 in the GA group. The operative time, intraoperative adverse events, postoperative adverse events, postoperative hospital stay, numeric rating scale (NRS) pain score within 3 h in post-anesthesia care unit (PACU), opioid use, and the time from admission to the first mobilization of patients were collected, and the differences between the 2 groups were compared. **Results** There were no significant differences in the general data between the 2 groups (all $P > 0.05$). Compared with the GA group, patients receiving MIS-TLIF in the SA group had shorter total operating room time [(192.18 ± 18.09) min vs (223.22 ± 19.54) min, $P < 0.001$], shorter time to leave operating room [(5.44 ± 1.95) min vs (9.94 ± 1.28) min, $P < 0.001$], lower mean intraoperative heart rate [(67.39 ± 7.44) min^{-1} vs (72.94 ± 8.61) min^{-1} , $P = 0.035$], lower mean intraoperative arterial pressure [(78.38 ± 9.88) mmHg vs (84.47 ± 8.30) mmHg, $P = 0.041$] (1 mmHg = 0.133 kPa), lower NRS pain score within 3 h in PACU [(3.81 ± 1.87) points vs (5.43 ± 2.24) points, $P = 0.017$], lower dose of opioid analgesics (morphine sulfate) within 3 h in PACU [(5.36 ± 1.71) mg vs (7.22 ± 2.01) mg, $P = 0.003$], later time of the first use of analgesics after operation [(58.11 ± 20.19) min vs (45.58 ± 17.16) min, $P = 0.041$], and earlier time from admission to the first mobilization [(430.77 ± 122.38) min vs (843.86 ± 95.44) min, $P < 0.001$]. There were no significant differences in total operation time,

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intraoperative blood loss, or postoperative hospital stay between the 2 groups (all $P > 0.05$). **Conclusion** AS can be used for MIS-TLIF operation under the guidance of ERAS concept, and it can effectively reduce the operating room time and postoperative pain, also with an earlier return to normal activities.

[**Key words**] spinal anesthesia; general anesthesia; minimally invasive surgery; transforaminal lumbar interbody fusion; enhanced recovery after surgery

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经椎间孔腰椎椎体间融合术 (transforaminal lumbar interbody fusion, TLIF) 是一种常用于治疗脊柱疾病的手术技术。研究表明, 微创 (minimally invasive, MIS) -TLIF 较开放式 TLIF 有诸多优势^[1-5]。当前脊柱外科进展的趋势为逐渐微创化, 包括内窥镜的使用、机器人辅助和导航引导下的螺钉安置^[6-7]。为了进一步改善患者预后和加速康复, 脊椎麻醉在脊柱手术中的应用越来越受到关注。脊椎麻醉是临床常用的一种麻醉方法, 将局麻药注入到蛛网膜下腔, 作用于脊神经根而使相应部位产生麻醉作用, 又称蛛网膜下腔麻醉, 俗称腰麻。脊椎麻醉尤其适用于腰椎椎板减压术和椎间盘摘除术, 适用于脊柱围手术期加速康复外科 (enhanced recovery after surgery, ERAS) 治疗理念^[8-12]。

目前全身麻醉和脊椎麻醉均已运用于开放式腰椎疾病的手术治疗, 但全身麻醉的应用更为广泛。局部区域麻醉作为加速患者康复的重要组成部分^[13], 在骨科手术中脊椎麻醉被广泛用于治疗下肢创伤和关节置换术, 但该麻醉方式在 MIS-TLIF 中尚未被广泛运用。研究发现, 在开放式行腰椎椎板减压和椎间盘切除术中, 脊椎麻醉能减少药物消耗和止痛剂的使用、缩短麻醉和手术时间、减少失血及患者术后恶心和呕吐情况, 从而降低了围手术期的成本^[14-19]。

目前尚无相关研究探讨在 MIS-TLIF 中脊椎麻醉与全身麻醉的围手术期疗效和潜在益处。本研究通过回顾性队列研究分析 2019 年 1 月至 2021 年 12 月于成都大学附属医院行 MIS-TLIF 治疗患者的资料, 比较脊椎麻醉与全身麻醉下患者的围手术期疗效。由于长期疗效和疼痛缓解更多地依赖于患者腰椎间盘突出症神经压迫程度和手术减压融合的有效性, 而较少依赖于麻醉类型, 本研究将观察指标重点放在围术期和术中结果, 以确定这 2 种麻醉方式在 MIS-TLIF 中的潜在好处和风险, 为 MIS-TLIF

患者麻醉方式的选择提供参考。

1 对象和方法

1.1 研究对象

1.1.1 纳入标准 (1) 诊断为因腰椎退行性椎间盘疾病、椎管狭窄、腰椎 I° 或 II° 退行性滑脱, 存在下肢放射痛、麻木、间歇性跛行, 经保守治疗 3 个月无效而行 MIS-TLIF 治疗的患者; (2) 病历资料完整, 影像学及围手术期资料完整; (3) 无其他手术禁忌。

1.1.2 排除标准 (1) 合并其他脊柱疾病 (如结核、肿瘤、感染等); (2) 有癫痫或颅内高压病史; (3) 穿刺部位感染; (4) 有严重凝血功能障碍; (5) 脊髓造影显示蛛网膜炎; (6) 无法俯卧位者; (7) 无法耐受手术者。

依据纳入和排除标准, 选择 2019 年 1 月至 2021 年 12 月于成都大学附属医院行 MIS-TLIF 的 40 例患者作为研究对象。40 例患者中男 19 例、女 21 例, 年龄 36~78 岁, 平均年龄 (63.78±11.94) 岁。包括肥胖 (BMI>28 kg/m²) 者 16 例, 2 型糖尿病 7 例, 高血压病 25 例, 阻塞性睡眠呼吸暂停低通气综合征 (obstructive sleep apnea hypopnea syndrome, OSAHS) 6 例, 美国麻醉医师协会 (American Society of Anesthesiologists, ASA) 分级 II 级 19 例、III 级 21 例。

根据麻醉方式的不同将患者分为脊椎麻醉组和全身麻醉组, 每组 20 例。对两组患者的一般资料进行比较, 包括合并症 (肥胖、高血压、糖尿病和 OSAHS)、ASA 级别, 以验证其同质性。麻醉科、手术团队医师成员在本研究期间保持不变。术前麻醉医师随访患者并检查病历, 与患者及手术团队医师确认内科、外科和麻醉史, 以确定最合适的麻醉方案。具体麻醉药物的选择由麻醉医师自行决定, 所有患者均采用 ASA 标准监测。

1.2 麻醉方法

1.2.1 全身麻醉 患者术前一般给予咪达唑仑(1~2 mg)和/或芬太尼(25~150 μg)静脉注射。在100%氧气预充氧后,异丙酚(1.5~2.0 mg/kg)静脉联合利多卡因(20-100 mg)和芬太尼(50~250 μg)诱导全身麻醉。在静脉注射罗库溴铵(0.6~1.2 mg/kg)或琥珀胆碱(1 mg/kg)实现充分的肌肉松弛后,通过直接或可视喉镜进行气管插管。患者取俯卧位,头部置于泡沫枕头中。以异丙酚(75~200 mg/(kg·min)或七氟醚(含40%~70%氧气,1.0%~2.0%)维持全身麻醉。手术完成后,将患者从俯卧位置于仰卧位,停止麻醉。充分逆转非去极化肌肉松弛剂后,在患者清醒、自主呼吸并听从指令后拔管。椎间孔镜下融合手术完成切口关闭后,手术切口处予以0.375%罗哌卡因10 mL局部浸润麻醉。

1.2.2 脊椎麻醉 患者术前一般给予咪达唑仑(1~2 mg)和/或芬太尼(25~150 μg)静脉注射。在手术室患者取坐位,身体微前倾,用局部洗必泰溶液清洗背部。予以2%利多卡因(0.5~2 mL)皮下局部麻醉后,在无菌条件下(经术者确认高于或低于手术区域节段)椎间隙间引入脊髓穿刺针。确认针尖在蛛网膜下腔,有流动的脑脊液存在。等压布比卡因(0.5%, 2.5 mL)、2 μg 芬太尼和0.2 mg肾上腺素在蛛网膜下腔缓慢注射。然后患者俯卧在Wilson框架上,头部放置于有足够通风的泡沫枕头中,以防止二氧化碳循环再呼吸。给予轻度镇静,包括静脉注射右美托咪定[(0.2~0.7 $\mu\text{g}/(\text{kg}\cdot\text{h})$]和/或异丙酚[(10~50 $\mu\text{g}/(\text{kg}\cdot\text{min})$]。确定手术麻醉平面及麻醉深度后进行手术,术中通常不安置导尿管。手术完成后,将患者置于仰卧位,停止麻醉。所有患者均接受标准化围手术期多模式镇痛(术前等待区开始,每6 h口服对乙酰氨基酚1 000 mg)并予以恶心、呕吐预防(苏醒前静脉注射恩丹司琼4 mg)。术后每4 h给予氢可酮对乙酰氨基酚(10~325 mg)止痛;对于严重疼痛,部分患者给予氢吗啡酮(0.2 mg,静脉注射)。一旦脊髓阻滞消失,患者就被动员起来,并监测尿潴留。手术结束时,手术切口处予以0.375%罗哌卡因10 mL,提供长效局部麻醉^[20]。

1.3 围手术期统计指标 从电子医疗记录系统收集数据,包括:(1)总手术室时间,指患者从进

入手术室至离开手术室的时间。(2)总手术时间,指从手术切开皮肤时间至贴附手术切口敷料后的时间。(3)离开手术室时间,指从手术切口贴附敷料后至患者离开手术室的时间。(4)术中估计失血量采用称重法,检测吸引器储液罐中的血量并对沾血纱布进行称重,浸湿32 cm×20 cm大小的纱布计失血30 mL,浸湿36 cm×36 cm大小的纱布计失血50 mL;对无菌巾及地板上可见的血液进行估算。(5)术后住院时间,指手术后至出院时的时间;(6)麻醉后监测治疗室(post-anesthesia care unit, PACU)中3 h内接受的所有止痛药物的需求量。弱阿片类药物如曲马多、布桂嗪等;强阿片类药物吗啡、羟考酮、芬太尼等。为了分析术后麻醉需求,麻醉医师计算弱阿片类药物与强阿片类如吗啡等镇痛剂剂量的转换。该计算方式中等效镇痛的转换基于美国疼痛协会发布的指南^[21-22]。(7)在PACU中3 h内所有的数值评定量表(numeric rating scale, NRS)疼痛评分(0~10分)。0分为无疼痛;1~3分为轻度疼痛;4~6分为中度疼痛;7~10分为重度疼痛。(8)初次下床时间,即患者从离开手术室到第1次下床的时间。(9)患者术后第1次接受镇痛药物的时间。(10)在PACU观察期间患者恶心或实际呕吐发作情况。

1.4 围手术期镇痛及止吐方案 两组患者在到达手术室前均接受术前多模式镇痛药物,包括口服对乙酰氨基酚(1 000 mg)、塞来昔布(200 mg)和羟考酮(10 mg)。术中为预防恶心和呕吐予静脉注射地塞米松(10 mg)和恩丹司琼(4 mg)。术后中度疼痛的患者给予口服羟考酮(5~10 mg),重度疼痛的给予静脉注射氢吗啡酮(0.2~0.5 mg)。

1.5 术中血流动力学参数 包括患者首次进入手术室时记录平均心率和平均动脉血压,随后监测每分钟的平均心率和每5 min的平均动脉血压。

1.6 术后并发症 (1)全身麻醉苏醒延迟:手术麻醉结束后患者苏醒时间>90 min;(2)循环系统并发症:持续低血压、高血压、心律失常、心肌缺血。(3)呼吸系统并发症:呼吸道梗阻、通气不足、低氧血症、术后肺部感染等;(4)持续性低体温;(5)术后持续性寒战,出现不自主的肌肉收缩抽动;(6)术后持续性躁动及烦躁不安;(7)脑脊液漏及持续性术后头疼;(8)穿刺部位

持续性不可缓解疼痛; (9) 严重尿潴留: 膀胱平滑肌舒张过度造成的严重尿液潴留。(10) 穿刺部位不当引起神经根的损伤, 出现腰痛或下肢局部运动、感觉异常。

1.7 统计学处理 应用SPSS 24.0软件对数据进行统计分析。符合正态分布且方差齐的计量资料以 $\bar{x} \pm s$ 表示, 两组间比较采用独立样本 t 检验。计数资料以例数和百分数表示, 组间比较采用 χ^2 检验, 若 $1 \leq$ 理论频数 <5 则采用校正 χ^2 检验, 理论频数 <1 时采用Fisher确切概率法。检验水准(α)取双侧0.05。

2 结果

2.1 一般资料比较 脊椎麻醉组与全身麻醉组患者的年龄、性别、BMI、合并症(肥胖、高血压、糖尿病和OSAHS)、ASA分级、减压固定节段的差异均无统计学意义(P 均 >0.05), 见表1。手术均顺利完成, 无脊椎麻醉失败后转行全身麻醉的患者, 无术中不良事件发生, 无术中脑脊液漏及气道并发症发生。全身麻醉组有1例患者术后并发肺部感染, 遵呼吸科会诊意见予以头孢曲松抗感染, 雾化祛痰后症状缓解。

表1 两组行微创经椎间孔腰椎椎体间融合术患者的一般资料比较

Tab 1 General data of patients undergoing minimally invasive transforaminal lumbar interbody fusion in 2 groups

Index	SA group	GA group	Statistic	P value
Age/year, $\bar{x} \pm s$	66.55 \pm 8.81	61.01 \pm 14.09	$t=1.494$	0.144
Gender, n (%)			$\chi^2=0.902$	0.342
Male	11 (55.0)	8 (40.0)		
Female	9 (45.0)	12 (60.0)		
BMI/($\text{kg} \cdot \text{m}^{-2}$), $\bar{x} \pm s$	29.59 \pm 5.29	28.75 \pm 5.56	$t=0.493$	0.625
Obesity, n (%)			$\chi^2=0.417$	0.519
Yes	9 (45.0)	7 (35.0)		
No	11 (55.0)	13 (65.0)		
Hypertension, n (%)			$\chi^2=2.667$	0.102
Yes	10 (50.0)	5 (25.0)		
No	10 (50.0)	15 (75.0)		
Diabetes mellitus, n (%)			$\chi^2=0.173$	0.677
Yes	4 (20.0)	3 (15.0)		
No	16 (80.0)	17 (85.0)		
OSAHS, n (%)			$\chi^2=0.784$	0.376
Yes	4 (20.0)	2 (10.0)		
No	16 (80.0)	18 (90.0)		
Decompression fixation segment, n (%)			$\chi^2=0.229$	0.633
1	3 (15.0)	2 (10.0)		
2	17 (85.0)	18 (90.0)		
ASA classification, n (%)			$\chi^2=0.902$	0.342
II	11 (55.0)	8 (40.0)		
III	9 (45.0)	12 (60.0)		

SA: Spinal anesthesia; GA: General anesthesia; BMI: Body mass index; OSAHS: Obstructive sleep apnea-hypopnea syndrome; ASA: American Society of Anesthesiologists.

2.2 围手术期指标比较 脊椎麻醉组患者的总手术室时间较全身麻醉组减少约14.00% (约31 min), 两组间差异有统计学意义[(192.18 \pm 18.09) min vs (223.22 \pm 19.54) min, $P < 0.001$]。相较于全身麻醉组, 脊椎麻醉组离开手术室时间短[(5.44 \pm 1.95) min vs (9.94 \pm 1.28) min, $P < 0.001$], 术中平均心率低[(67.39 \pm 7.44) min^{-1} vs (72.94 \pm 8.61) min^{-1} , $P = 0.035$], 术中平均动脉压低

[(78.38 \pm 9.88) mmHg vs (84.47 \pm 8.30) mmHg, $P = 0.041$] (1 mmHg = 0.133 kPa), PACU 3 h内NRS疼痛评分低[(3.81 \pm 1.87)分 vs (5.43 \pm 2.24)分, $P = 0.017$], PACU 3 h内阿片类镇痛药物(硫酸吗啡)需求量少[(5.36 \pm 1.71) mg vs (7.22 \pm 2.01) mg, $P = 0.003$], 术后第1次使用止痛药时间晚[(58.11 \pm 20.19) min vs (45.58 \pm 17.16) min, $P = 0.041$], 术后初次下床时间早

[(430.77±122.38) min vs (843.86±95.44) min, $P<0.001$]。两组的总手术时间、术中出血量、术后住院时间的差异均无统计学意义 (P 均>0.05)。见表2。

2.3 典型病例影像学资料 脊椎麻醉组与全身麻醉组典型病例手术检查及治疗情况的影像资料见图1、图2。

表2 两组行微创经椎间孔腰椎椎体间融合术患者的围手术期相关指标比较

Tab 2 Perioperative indexes of patients undergoing minimally invasive transforaminal lumbar interbody fusion in 2 groups

Index	SA group	GA group	<i>t</i> value	<i>P</i> value
Total operating time/min	172.55±18.35	179.82±14.92	-1.376	0.177
Total operating room time/min	192.18±18.09	223.22±19.54	-5.214	<0.001
Time to leave operating room/min	5.44±1.95	9.94±1.28	-8.618	<0.001
Mean intraoperative arterial pressure/mmHg	78.38±9.88	84.47±8.30	-2.111	0.041
Mean intraoperative heart rate/min	67.39±7.44	72.94±8.61	-2.184	0.035
Intraoperative blood loss/mL	62.53±13.18	59.48±14.16	0.367	0.486
NRS pain score within 3 h in PACU	3.81±1.87	5.43±2.24	-2.443	0.017
Opioid analgesics (MS) within 3 h in PACU/mg	5.36±1.71	7.22±2.01	-3.153	0.003
Time of first use of analgesics after operation/min	58.11±20.19	45.58±17.16	2.115	0.041
Time from admission to the first mobilization/min	430.77±122.38	843.86±95.44	-11.904	<0.001
Postoperative hospital stay/h	72.76±26.33	79.93±24.57	-0.893	0.378

1 mmHg=0.133 kPa. SA: Spinal anesthesia; GA: General anesthesia; PACU: Post-anesthesia care unit; NRS: Numeric rating scale; MS: Morphine sulfate.

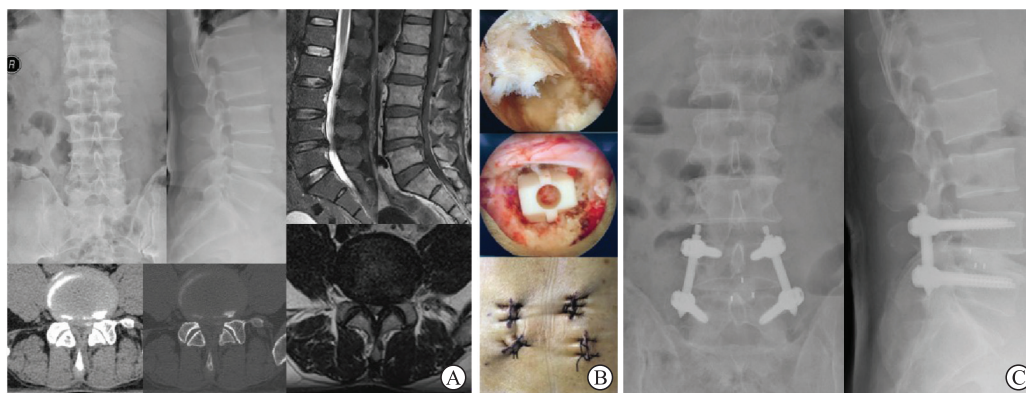


图1 脊椎麻醉下行微创经椎间孔腰椎椎体间融合术患者术前、术中及术后影像学资料

Fig 1 Preoperative, intraoperative, and postoperative imaging data of patients undergoing minimally invasive transforaminal lumbar interbody fusion under spinal anesthesia

The patient (69 years old, female) underwent endoscopic L₄₋₅ disc removal, spinal nerve root decompression and release, cage interbody fusion, and percutaneous pedicle screw fixation under spinal anesthesia. The operation was successful. A: X-ray, CT and MRI examinations showed lumbar degenerative changed; the posterior center of the L₄₋₅ disc was prolapsed to the left, the dural sac was clearly compressed, and the spinal canal was narrow. B: After spinal anesthesia, the disc was removed under endoscope, the endplate was treated, the fusion device was placed, and the incision was sutured. C: Postoperative X-ray review showed that the screw and fusion device were in good position. CT: Computed tomography; MRI: Magnetic resonance imaging.

3 讨论

脊椎麻醉作为全身麻醉在脊柱外科手术中的替代选择越来越受关注^[23]。本研究为回顾性病例对照研究,以同一围手术期团队(包括主刀医师、麻醉医师、护士)的治疗护理,比较脊椎麻醉和全

身麻醉在 MIS-TLIF 中的应用情况。既往研究中, Wang 等^[24]报道了局部麻醉下脊柱内镜 TLIF 减压融合经皮螺钉固定的有效性和安全性。本研究结果显示,脊椎麻醉组的总手术室时间和离开手术室时间均短于全身麻醉组,两组均无术中麻醉失败事件发生。由于术中接受脊椎麻醉时无需气管插管,

术后大大节省了拔管时间、麻醉复苏时间、呼吸功能恢复时间,从而缩短了总手术室时间及离开手术室时间^[8]。两组麻醉方式不同,血流动力学特征不同,脊椎麻醉组患者的术中平均心率较全身麻醉组患者的低。研究证实脊椎麻醉相较于全身麻醉血流动力学参数更优,当患者被允许自主呼吸时胸腔内压力降低,并结合交感神经阻滞,可有效控制心室率^[9]。多项研究表明,脊椎麻醉组患者的心率和血压较全身麻醉组患者的低^[25],脊椎麻醉较全身麻醉血流动力学稳定性的改善可能是由于术中抑制了应激激素的释放,导致平均动脉压、心率的升高和

波动较低^[26]。本研究结果显示,对于 MIS-TLIF, 2种麻醉方法之间平均心率及平均动脉压差异有统计学意义。本研究发现,在给予脊椎麻醉后接受 MIS-TLIF 治疗患者术后疼痛更少,与给予全身麻醉后接受 MIS-TLIF 治疗患者相比,在 PACU 中 3 h 内的平均 NRS 疼痛评分更低、阿片类镇痛药品需求量更少,术后第 1 次使用止痛药时间更晚,表明接受脊椎麻醉手术的患者术后疼痛控制相对更好。采用脊椎麻醉相较于全身麻醉进行 MIS-TLIF 的患者术后初次下床时间提前,脊椎麻醉组患者有可能更快恢复并减少并发症的发生。

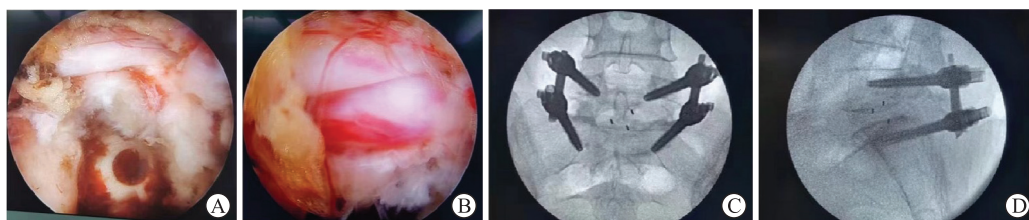


图2 全身麻醉下行微创经椎间孔腰椎椎体间融合术患者术中及术后影像学资料

Fig 2 Intraoperative and postoperative imaging data of patients undergoing minimally invasive transforaminal lumbar interbody fusion under general anesthesia

The patient (72 years old, female) with L₅-S₁ disc herniation, lumbar spondylolysis of L₅ pedicle with true spondylolisthesis, lumbago with right lower limb pain and numbness underwent minimally invasive transforaminal lumbar interbody fusion decompression and fusion fixation under general anesthesia. A: For disc removal under general anesthesia, a cage interbody fusion cage was placed in the L₅-S₁ intervertebral space for bone graft fusion; B: For intraoperative endoscopic disc removal, hyperemia and edema after decompression of the right nerve root of S₁; C, D: Anteroposterior and lateral positions of the C-arm lumbar spine under general anesthesia.

全身麻醉是目前脊柱手术的首选技术^[1]。研究表明,高危患者可能无法耐受全身麻醉的并发症或不良反应^[27]。如控制不良的糖尿病、心脏或冠状动脉疾病、无法控制的高血压、慢性阻塞性肺疾病、过敏和甲状腺肿,均被认为是高危患者。高危患者全身麻醉可能的并发症有头痛、背痛、恶心呕吐、牙齿损伤、喉咙痛和喉部损伤或痉挛、麻醉药继发的过敏反应、心血管意外、呼吸抑制、吸入性肺炎、体温过低、缺氧脑损伤、因体位引起的视神经损伤、栓塞(空气或血栓)和死亡等。脊椎麻醉更适合高危患者,用高压氧或等压局部麻醉药更容易达到适合腰椎手术所需的麻醉程度。在脊椎麻醉行 MIS-TLIF 时需十分明确手术所需的麻醉平面,术中需及时有效避免手术刺激引起的血流动力学变化^[28]。一般情况下, L₁~L₅ 手术需要至少 T₆~T₈ 皮肤感觉水平,坐位行脊椎麻醉后于俯卧位进行手术将更有利于成功麻醉。尽管所需的麻醉平面高于

手术部位的水平,但较高的水平的麻醉平面将尽可能提高脊椎麻醉的成功率,保证手术顺利进行,并根据局部麻醉药的选择,允许手术麻醉覆盖范围的缓慢消退^[24]。布比卡因被认为是首选的脊椎麻醉药剂,因为它可以提供足够的覆盖时间^[29]。此外,也有一些麻醉医师选择在局部麻醉药中添加其他药物,如阿片类药物、肾上腺素、去甲肾上腺素、新斯的明和可乐定等。在本研究中使用了等压布比卡因(0.5%, 2.5 mL)、2 μg 芬太尼和 0.2 mg 的肾上腺素用于脊椎麻醉。镇静剂用于脊椎麻醉可以减轻焦虑,提高患者的舒适度和配合力^[22]。虽然脊椎麻醉仅提供手术部位的麻醉便可完成手术,但若术中未辅助镇静药物,患者将仍然存在自主意识,由于患者术中不得不长时间保持在同一个位置及手术室的环境噪音,将会使患者感觉不适,所以脊椎麻醉术中辅助少量镇静药物是行之有效的^[30]。然而,镇静剂可能会导致气道阻塞,镇静过度后老年

患者可能表现出精神运动恢复延迟。但在本组患者的术中辅助小剂量镇静剂后未出现如延迟患者术后复苏、气道阻塞、缺氧、低血压等并发症。

本研究存在一定局限性:研究设计为回顾性病例对照研究,样本量相对较小且随访时间较短,未观察到长期的术后并发症情况。脊椎麻醉组与全身麻醉组患者一般资料比较结果提示,两组的同质性尚可,所有患有影响麻醉方法选择的疾病者尽可能排除在本研究之外。未来仍需要进行前瞻性、大样本随机对照试验进一步验证。

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