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皮质骨轨迹螺钉与椎弓根螺钉行经椎间孔入路椎间融合术的疗效比较*

胥云 闫康 张小平 郭卫东 鲍小明 廖博[△]

(空军军医大学附属唐都医院 陕西 西安 710038)

摘要 目的:探讨皮质骨轨迹螺钉(cortical bone trajectory, CBT)与椎弓根螺钉(pedicle screw, PS)行经椎间孔入路椎间融合术(transforaminal lumbar interbody fusion, TLIF)治疗腰椎退行性疾病的临床疗效。**方法:**选取2016年5月至2018年5月采用TLIF治疗的腰椎退行性疾病患者资料50例作为研究对象,其中行CBT螺钉固定组25例,行PS螺钉内固定组25例。分别记录患者一般资料、围手术期参数及并发症发生情况。腰痛VAS评分、腿痛VAS评分及ODI功能指数评分评估临床效果。Bridwell分级标准评价两组融合情况。**结果:**平均随访时间 16.72 ± 3.6 个月。两组患者在性别、年龄、疾病诊断、手术节段方面组间差异无统计学意义($P > 0.05$)。皮质骨轨迹螺钉组平均手术时间及术中出血量为 171.88 ± 25.75 min、 225.20 ± 51.57 mL,椎弓根螺钉组为 221.24 ± 33.53 min、 297.60 ± 66.40 mL,两组比较差异有统计学意义($P < 0.05$)。两组患者术后1月及末次随访腰痛VAS评分、腿痛VAS评分及ODI功能指数评分均较术前有明显改善,两组间差异无统计学意义。末次随访两组患者均取得骨性融合。**结论:**对于腰椎退行性疾病患者,采用CBT螺钉和PS螺钉内固定方式行TLIF均能达到良好的临床疗效及融合率,采用皮质骨轨迹螺钉行TLIF患者手术时间短,术中出血量更少。

关键词:皮质骨轨迹螺钉;椎弓根螺钉;经椎间孔椎间融合术;腰椎退行性疾病

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Clinical and Radiological Comparison between Cortical Bone Trajectory Screw and Pedicle Screw in Transforaminal Lumbar Interbody Fusion*

XU Yun, YAN Kang, ZHANG Xiao-ping, GUO Wei-dong, BAO Xiao-ming, LIAO Bo[△]

(Department of Orthopedics surgery, Tangdu Hospital, The Air Force Military Medical University, Xi'an, Shaanxi, 710038, China)

ABSTRACT Objective: To compare the clinical and radiological outcomes of cortical bone trajectory (CBT) screw and pedicle screw (PS) for transforaminal lumbar interbody fusion (TLIF) in degenerative lumbar diseases. **Methods:** 50 patients from May 2016 to May 2018 were enrolled into this retrospective study. CBT screw was applied in 25 patients (CBT-TLIF Group) and PS was applied in 25 patients (PS-TLIF Group). General condition, perioperative parameters and complications were recorded and analyzed. VAS of back pain, VAS for leg pain and ODI were used to evaluate the clinical efficacy. Bridwell classification was used to evaluate the fusion. **Results:** Average follow-up duration was 16.72 ± 3.6 months. There is no difference between two groups in gender, age, diagnosis, and surgical segments. Operation duration and blood lost in the CBT-TLIF group was 171.88 ± 25.75 min, 225.20 ± 51.57 mL, and 221.24 ± 33.53 min, 297.60 ± 66.40 mL in PS-TLIF group. Significant difference was found in the above parameters between two group ($P < 0.05$). Both groups had significant improvements in the ODI (Oswestry disability index) and VAS (Visual Analogue Scale) scores at 1 month after operation and the last follow up, but no significant difference was found between the two groups. Comparable fusion rates of both groups were also observed by radiography. **Conclusions:** CBT-TLIF and PS-TLIF had comparable functional outcomes and fusion rate, while CBT-TLIF had superiority in and operation duration and blood control.

Key words: Cortical bone trajectory; Pedicle screw; Transforaminal lumbar interbody fusion; Degenerative lumbar diseases

Chinese Library Classification (CLC): R681.5; R687.3 **Document code:** A

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前言

经椎间孔椎间融合术(Transforaminal lumbar interbody fusion, TLIF)已广泛应用于治疗腰椎间盘突出症、腰椎退变性滑脱、腰椎管狭窄症等腰椎退行性疾病,其临床应用效果良好^[1,2]。

传统 TLIF 手术过程主要包括关节突关节切除、椎间融合器植入及后路椎弓根螺钉固定等^[3]。然而,椎弓根螺钉植入需要暴露至关节突关节,需要剥离更多的椎旁肌肉,因此可能带来更多的并发症,影响患者愈后^[4]。虽然微创经椎间孔椎间融合术提升了微创理念。但是仍然存在诸如射线暴露多、手术时间长等问

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作者简介:胥云(1989-),男,硕士研究生,主要研究方向:脊柱外科学, E-mail: xydean@fmmu.edu.cn

[△] 通讯作者:廖博(1978-),男,硕士生导师,教授,主要研究方向:脊柱外科学, E-mail: liao_b@hotmail.com

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题^[5]。2009年,国外学者 Santoni 等^[6]提出了皮质骨轨迹螺钉(cortical bone trajectory, CBT)的概念。与椎弓根螺钉(pedicle screw)置钉方式不同,该置钉轨迹在横断位由内向外,矢状位由尾端向头端走行。其基本理念在于更多的增加皮质骨接触界面,更远的避开神经血管重要组织,更少的软组织侵袭^[7]。目前国内尚无 CBT 结合 TLIF 治疗腰椎退行性疾病的研究报道。为进一步探讨两种置钉方式在经椎间孔椎间融合术中的应用,明确其临床效果,现结合我院收治病例,报道如下:

1 材料与方法

1.1 纳入标准及排除标准

纳入标准:(1)年龄 ≥ 18 岁;(2)有腰痛、双下肢疼痛和(或)间歇性跛行症状,影响工作及生活,经系统保守治疗3个月以上无效;(3)查体及影像学检查(X线、CT、MRI)与临床症

状相符,诊断明确,需要行手术治疗;

排除标准:(1)伴有脊柱感染、外伤、畸形、肿瘤患者;(2)失访或资料不全;(3)严重骨质疏松症;(4)伴有其他不适宜手术治疗的系统疾病。

1.2 一般资料

本组50例患者均行 TLIF 治疗,平均随访时间 16.72 ± 3.6 个月,依固定方式不同分为 CBT-TLIF 组、PS-TLIF 组。CBT-TLIF 组男性11例,女性14例,平均年龄 63.32 ± 7.22 岁,其中腰椎间盘突出症7例,腰椎滑脱患者9例,腰椎管狭窄症9例,融合范围为 L3-S1,其中单节段19例,双节段6例。PS-TLIF 组,男性13例,女性12例,平均年龄 64.28 ± 6.31 岁,其中腰椎间盘突出症8例,腰椎滑脱患者7例,腰椎管狭窄症10例,融合范围为 L3-S1,其中单节段20例,双节段5例。两组患者在性别、年龄、疾病类型、融合节段方面无明显差异,见表1。

表1 两组患者一般资料比较

Table 1 Comparison of general data between two groups

Groups	Number(n)	Male/female	Age	Diseases(n)			Fusion levels(n)	
				Disc herniation	Spondylolisthesis	Spinal stenosis	one	two
CBT-TLIF	25	11/14	63.32 ± 7.22	7	9	9	19	6
PS-TLIF	25	13/12	64.28 ± 6.31	8	7	10	20	5
χ^2/t		0.321	0.501		0.369		0.117	
P		0.778	0.619		0.831		1.000	

1.3 手术方法

1.3.1 CBT-TLIF 组 患者全麻满意后俯卧于手术台。定位手术节段,常规消毒铺单。行腰椎后正中约 5-6 cm 手术切口,于棘突两侧分离剥离椎旁肌,显露椎板外缘与关节突交界处。进针点选择同 Chin^[8],为上位椎体下关节突中央垂线与横突下缘交点处。磨钻开口,进针方向冠状位选择由内向外倾 $9-10^\circ$,矢状位头倾 $25-30^\circ$ 植入开路椎,建立置钉轨迹,然后植入导针。X线透视机确认导针位置良好,选择合适螺钉植入,螺钉直径 5.5 mm,长度为 30-35 mm。置钉结束后行减压、椎间融合。切除下关节突及部分上关节突,显露神经根及硬膜,保护性牵开神经根及硬膜行根管扩大及椎间处理;终板准备完毕后,植入合适融合器。X线机透视见融合器位置形态良好后,植入连接棒,拧紧尾帽。冲洗伤口,止血。放置负压引流装置,逐层缝合,术毕。典型病例见图1。

1.3.2 PS-TLIF 组 患者全麻满意后俯卧于手术台。手术节段定位准确,常规消毒铺单。行腰椎后正中约 5-6 cm 手术切口,于棘突两侧,骨膜下分离椎旁肌,显露上关节突外侧缘,以"人字嵴"顶点为进针点,冠状位由外向内倾 $5-15^\circ$ 植入开路椎,建立通道,然后植入导针,透视见导针位置良好。植入螺钉,直径 6.0-6.5 mm,长度 35-50 mm。减压融合过程同 CBT-TLIF 组。

1.4 术后处理

术后常规使用脱水消肿、营养神经等药物治疗 3-5 天;严密观察患者术后下肢感觉活动等情况,鼓励患者床上适度功能锻炼。术后 48 h,拔除引流管。复查术后 X 线片,视患者恢复情况,腰围或支具保护下下地活动。

1.5 评价指标

记录患者基本信息,手术时间、术中出血量、术后并发症等情况;术后1个月、末次随访采用功能障碍指数评分(Oswestry disability index, ODI)及疼痛视觉模拟评分(Visual Analogue Scale, VAS)评价并记录患者功能学改善情况。术后1个月及末次随访摄腰椎 X 线片,腰椎 CT,了解内固定有无松动、断裂及评价融合情况,融合评价标准采用 Bridwell 融合分级标准^[9]。

1.6 统计学分析

数据采用 SPSS13.0 软件分析处理。计量资料如手术时间、出血量、ODI 评分、VAS 评分等采用 $\bar{x} \pm s$ 表示。计量资料组间比较采用 t 检验;计数资料,组间比较采用 χ^2 检验。等级资料比较采用非参数检验。 $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 围手术期参数

CBT-TLIF 组手术时间为 171.88 ± 25.75 min, PS-TLIF 组手术时间为 221.24 ± 33.53 min,两组比较有统计学差异($t=5.838$, $P=0.000$)。CBT-TLIF 组术中出血量为 221.24 ± 33.53 mL, PS-TLIF 组出血量为 297.60 ± 66.40 mL,两组比较差异明显有统计学意义($t=4.306$, $P=0.000$)。见表2。

2.2 功能学参数

两组患者术前 ODI 及 VAS 评分差异无统计学意义。术后1个月、末次随访腰痛 VAS 评分、腿痛 VAS 评分及 ODI 评分结果均较术前明显改善,差异有统计学差异($P < 0.05$)。术后1个月及末次随访两组间比较,ODI 及 VAS 评分差异无统计学意义。

($P>0.05$)。见表 3。

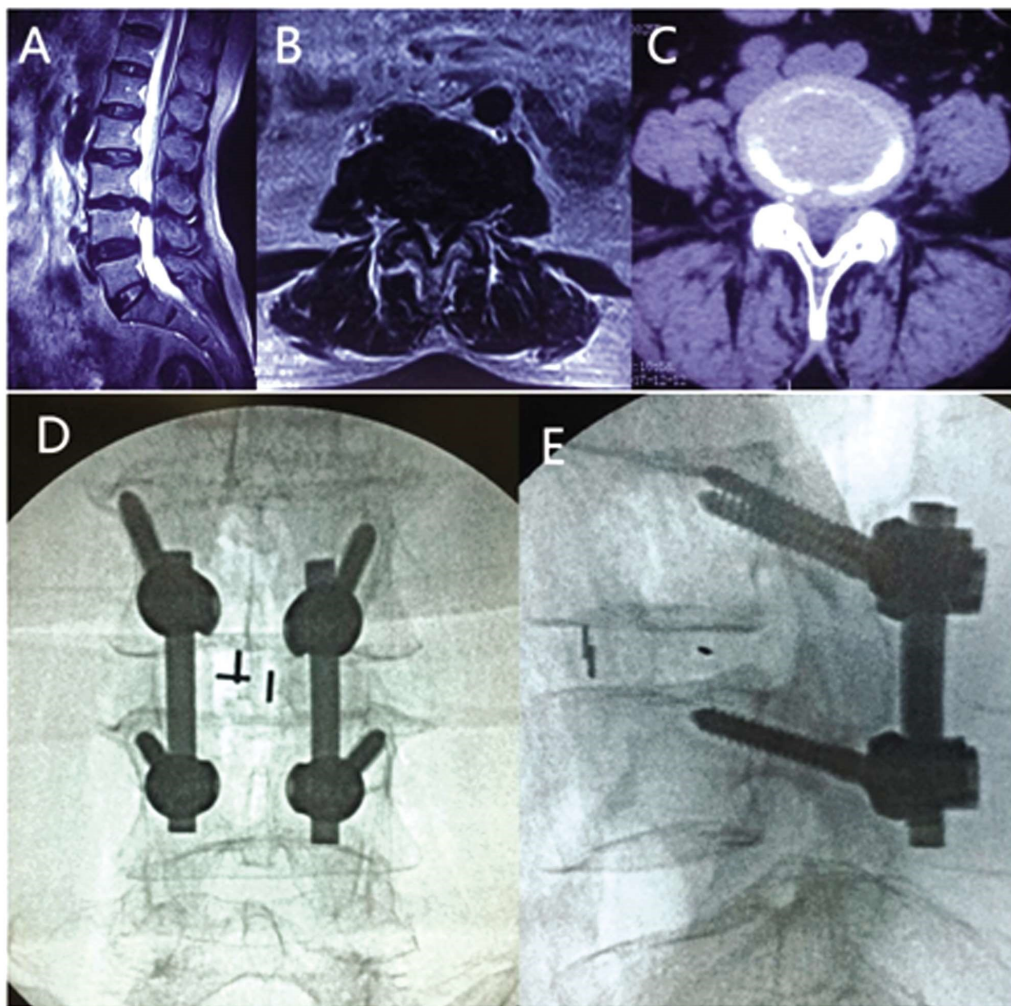


图 1 典型病例

Fig.1 A typical case of a 64 female, diagnosed as spinal stenosis

A-C: Preoperative MRI imaging and CT scans of lumbar spine demonstrated as spinal stenosis at L3/4. D-E: Intraoperative images of cortical bone trajectory screws and cage showing in good position.

表 2 两组患者围手术期结果比较

Table 2 Comparison of perioperative results between two groups

Groups	Number(n)	Duration of surgery (min)	Blood loss (mL)
CBT-TLIF	25	171.88± 25.75	225.20± 51.57
PS-TLIF	25	221.24± 33.53	297.60± 66.40
t		5.838	4.306
P		0.000	0.000

2.3 融合率

两组患者术后末次随访,根据 Bridwell 评分标准,均获得 1-2 级融合,两组间无明显统计学差异。随访中未发现内固定断裂松动、融合器移位、融合器沉降等情况。具体见表 4。

3 讨论

腰椎退行性疾病是脊柱外科常见病,老年患者人群多见。经严格保守治疗效果不佳者,多需要行手术治疗。经椎间孔椎间融合术,自 Harms^[1]1988 年提出以来,已经广泛应用于临床

治疗腰椎退行性疾病,效果良好^[10]。研究表明仅行椎间融合,易导致假关节形成,致使椎间融合失败的发生率高达 50%^[11]。因此,辅助的后路内固定系统是必须的,可以加强术后椎体间稳定性和提高椎体间融合率^[12]。传统的椎弓根螺钉(PS)固定技术解剖轴位轨迹铆钉松质骨,因其良好的生物力学稳定性一直是脊柱外科内固定方式的金标准。然而,随着国内外学者研究发现,传统的 PS 螺钉内固定技术也显现出诸多不足,表现在置钉过程椎旁肌肉侵犯多、神经血管损伤风险、螺钉断裂松动、置钉轨迹失准以及术后感染、融合失败等方面,在老年骨量减少或

者骨质疏松患者中尤为突出^[13]。因为老年患者松质骨骨小梁丢失,以椎弓根解剖轴位轨迹铆钉松质骨为特点的椎弓根螺钉失败率将大大增加。虽然经皮椎弓根螺钉(PPS)提升了微创理念,

但螺钉轨迹的生物力学不良因素依然存在。因此一种新的皮质骨轨迹(CBT)螺钉技术在 2009 年被提出。

表 3 功能学参数

Table 3 Parameters with functional statistics

	CBT-TLIF	PS-TLIF	P-value
Pre-op ODI(%)	52.12± 9.22	50.36± 8.40	0.484
Post-op ODI(%)			
1 months	35.32± 8.16	32.88± 6.25	0.241
Latest follow up	22.71± 3.57	23.40± 5.14	0.589
P-value(multiple comparisons)*	<0.05	<0.05	
Pre-op VAS back	5.88± 1.05	5.48± 1.35	0.250
Post-op VAS back			
1 months	3.68± 1.07	3.56± 1.04	0.690
Latest follow up	1.72± 0.68	1.92± 0.81	0.349
P-value(multiple comparisons)*	<0.05	<0.05	
Pre-op VAS leg	6.28± 0.89	6.36± 0.86	0.748
Post-op VAS leg			
1 months	2.04± 0.79	2.52± 0.96	0.060
Latest follow up	1.56± 0.65	1.68± 0.63	0.510
P-value(multiple comparisons)*	<0.05	<0.05	

Note: Values are presented as mean± standard deviation. * Multiple comparisons: 1month vs. pre-op, latest follow up vs. pre-op, P value <0.05.

表 4 两组患者融合率比较

Table 4 Comparison of fusion rates between two groups

Groups	Bridwell classification(n)	
	I	II
CBT-TLIF	20	5
PS-TLIF	19	6
P	0.735	

Note:* Based on Bridwell fusion grading: Grade I, fused with remodeling and trabeculae; Grade II, graft intact, not fully remodeled and incorporated though; Grade III, graft intact, but a definite lucency at the top or bottom of the graft; Grade IV, definitely not fused with resorption of bone graft and with collapse.

在本研究中,采用 CBT 螺钉或传统 PS 螺钉行 TLIF 术均取得满意的临床效果。然而,行皮质骨轨迹螺钉内固定组患者,术中出血量及手术时间显著低于行椎弓根螺钉内固定组,提示行皮质骨轨迹螺钉内固定治疗组术中创伤更小。这是因为 CBT 螺钉进针点位于椎弓根峡部,而传统椎弓根螺钉固定需要剥离至关节突关节,因此 CBT 螺钉内固定组椎旁肌肉剥离相对较少,也减少了对小关节的侵犯^[14]。Hung 等^[15]研究报道了行皮质骨螺钉固定和椎弓根螺钉固定手术前后上下邻近节段水平的脂肪浸润率变化,结果也表明皮质骨轨迹螺钉固定技术对多裂肌伤害较少,术后脂肪浸润率更低。同时,CBT 螺钉内固定置钉轨迹在冠状位由内向外,远离了神经血管组织,因此术中神经血管组织损伤风险较小,这可能也是行 CBT 螺钉内固定术中出血较少的原因。本研究两组患者在末次随访均取得良好的融合率,表明融合节段选择行传统 PS 螺钉或 CBT 螺钉均

稳定性良好。不同于传统椎弓根螺钉,CBT 螺钉长度更短,直径更小。Matsukawa 等^[16]认为 CBT 螺钉钉道穿过进针点部位的背侧皮质、椎弓根后方内侧壁、椎弓根前方外侧壁以及椎体侧壁的弧形区,这些区域都处在椎体和椎弓根强度较高的区域,这些解剖学特点是皮质骨螺钉稳定性的关键因素。本研究中 CBT 螺钉置钉过程中未发生硬膜撕裂、脊髓损伤等并发症、随访中未发现螺钉断裂、松动,表明 CBT 螺钉内固定安全可靠^[17,18]。然而,也有相关报道表明 CBT 螺钉存在如术中骨折、硬膜撕裂、螺钉松动、滑脱复位丢失、损伤下位神经根等并发症^[19-21],因此本研究临床结果仍需长期随访观察。

综上所述,对于腰椎退行性疾病患者,采用 CBT 螺钉及 PS 螺钉内固定行 TLIF 均可获得良好的临床效果及融合率,采用 CBT 螺钉行 TLIF 患者手术时间更短、术中出血量更少。

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