

临床论著

两种前路术式治疗严重颈椎后纵韧带骨化症的疗效及神经功能恶化率对比

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【摘要】 目的: 比较颈椎椎体骨化物复合体可控性前移融合术 (anterior controllable antedisplacement and fusion, ACAF) 与颈前路椎体次全切除减压融合术 (anterior cervical corpectomy and fusion, ACCF) 治疗严重颈椎后纵韧带骨化症 (ossification of the posterior longitudinal ligament, OPLL) 的疗效及术后神经功能恶化率。**方法:** 回顾性分析 2018 年 3 月~2019 年 3 月在我院接受颈前路手术治疗的 72 例严重 OPLL 患者 (椎管侵占率 $\geq 50\%$) 的临床资料, 其中 35 例采用 ACAF 治疗 (ACAF 组), 37 例采用 ACCF 治疗 (ACCF 组), 术后随访 6~12 个月。收集两组患者手术时年龄、性别、随访时间, 术后 2 周内神经功能恶化发生情况、原因及预后, 术前、术后 2 周内及末次随访时采用 JOA 评分评估神经功能, 同时在术前和末次随访时的颈椎 CT 和 MRI 检查图片上观察骨化物类型, 测量椎管侵占率、椎管最狭窄处的减压宽度、椎管面积及脊髓前后径。**结果:** 两组患者手术时年龄、性别比、随访时间、骨化物类型、术前椎管侵占率、椎管面积、脊髓前后径、JOA 评分等均无统计学差异 ($P > 0.05$)。术后 2 周内, ACCF 组有 10 例出现神经功能恶化, 发生率为 27.0%, 其中 6 例系术中损伤脊髓, 2 例为硬膜外血肿压迫脊髓, 2 例为骨化物残留; ACAF 组 2 例出现神经功能恶化, 发生率为 5.7%, 均因骨化物残留所致。两组术后神经功能恶化率有统计学差异 ($P < 0.05$)。末次随访时, ACAF 组减压宽度大于 ACCF 组 ($18.5 \pm 2.5 \text{ mm}$ vs $16.9 \pm 1.9 \text{ mm}$), 差异有统计学意义 ($P < 0.05$); 椎管面积及脊髓前后径两组间比较差异无统计学意义 ($144.9 \pm 31.2 \text{ mm}^2$ vs $142.1 \pm 22.3 \text{ mm}^2$, $P > 0.05$; $5.5 \pm 0.5 \text{ mm}$ vs $5.2 \pm 1.4 \text{ mm}$, $P > 0.05$); 两组患者 JOA 评分较术前均明显改善, ACAF 组 JOA 评分改善率大于 ACCF 组 [$(79.5 \pm 8.7)\%$ vs $(68.9 \pm 20.3)\%$, $P < 0.05$]。**结论:** 相较于 ACCF, ACAF 治疗严重颈椎 OPLL 能够获得更加满意的临床疗效, 且降低了术后神经功能恶化率; 但在开展 ACAF 早期仍存在发生术后神经功能恶化的潜在风险。

【关键词】 后纵韧带骨化症; 椎体骨化物复合体可控前移融合术; 颈前路椎体次全切除术; 疗效; 神经功能恶化
doi: 10.3969/j.issn.1004-406X.2022.10.02

中图分类号: R681.5, R687.3 文献标识码: A 文章编号: 1004-406X(2022)-10-0872-09

Comparative study of the clinical outcomes and incidence rates of postoperative neurological deterioration between two anterior surgical procedures in the treatment of severe cervical ossification of the posterior longitudinal ligament/SHI Lei, SUN Jingchuan, YUAN Xiaoqiu, et al/Chinese Journal of Spine and Spinal Cord, 2022, 32(10): 872-879, 887

【Abstract】 Objectives: To compare the clinical outcomes and incidence rates (IR) of postoperative neurological deterioration between anterior controllable antedisplacement and fusion (ACAF) and anterior cervical corpectomy and fusion (ACCF) in the treatment of severe cervical ossification of the posterior longitudinal ligament (OPLL). **Methods:** We retrospectively analyzed 72 cases who underwent anterior surgery for severe cervical OPLL (occupying rate $\geq 50\%$) in our department from March 2018 to March 2019. Among them, 35 cases were treated with ACAF (ACAF group), and the other 37 cases were treated with ACCF (ACCF group). The patients were followed up for 6-12 months. Data of the two groups of patients were collected, including age at surgery, gender, follow-up time, and incidence of neurological deterioration within 2 weeks after operation and the cause and prognosis. JOA score was used to assess the neurologic function before operation, within 2 weeks after operation, and at the final follow-up, and meanwhile, the types of ossification were observed and

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the occupying rate, decompression width at the narrowest part of spinal canal, spinal canal area, and antero-posterior(AP) diameter of the spinal cord were measured on cervical CT and MRIs before operation and at final follow-up. **Results:** There was no significant difference in the age at surgery, gender ratio, follow-up time, ossification type, preoperative occupying rate, spinal canal area, AP diameter of the spinal cord, and JOA score between the two groups($P>0.05$). A total of 10 cases in ACCF group suffered neurological deterioration within 2 weeks after surgery (IR=27.0%), including 6 cases of intraoperative spinal cord injury, 2 cases of epidural hematoma compressing spinal cord, and 2 cases of residual ossification mass. In contrast, there were only 2 cases in ACAF group occurred neurological deterioration due to residual ossification mass (IR=5.7%). There was significant difference in the incidence rate of neurological deterioration between the two groups ($P<0.05$). At final follow-up, the decompression width was larger in ACAF group than that in ACCF group($18.5\pm 2.5\text{mm}$ vs $16.9\pm 1.9\text{mm}$), with significant difference($P<0.05$); There was no significant difference in the spinal canal area and AP diameter of the spinal cord between the two groups($144.9\pm 31.2\text{mm}^2$ vs $142.1\pm 22.3\text{mm}^2$, $P>0.05$; $5.5\pm 0.5\text{mm}$ vs $5.2\pm 1.4\text{mm}$, $P>0.05$). The JOA scores of both groups significantly improved after surgery, and ACAF group achieved higher improvement rate of JOA scores than did ACCF group [$(79.5\pm 8.7)\%$ vs $(68.9\pm 20.3)\%$, $P<0.05$]. **Conclusions:** Comparing with ACCF, ACAF can achieve better clinical outcomes and reduce the incidence rate of postoperative neurological deterioration in the treatment of severe cervical OPLL. However, there is still a potential risk of postoperative neurological deterioration in the early practice of ACAF.

[Key words] Ossification of the posterior longitudinal ligament; Anterior controllable antedisplacement and fusion; Anterior cervical corpectomy and fusion; Clinical outcomes; Neurological deterioration

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颈椎后纵韧带骨化(ossification of the posterior longitudinal ligament, OPLL)是发生在颈椎后纵韧带组织的异位骨化,可导致椎管狭窄、脊髓受压而引起四肢麻木无力、行走困难等临床表现。目前尚无有效药物阻止骨化进展,手术是唯一有效的治疗手段,手术方式可分为前路减压和后路减压^[1,2]。对于椎管侵占率 $\geq 50\%$ 的严重骨化患者,后路手术难以取得满意疗效,传统的颈前路椎体次全切除减压融合术(anterior cervical corpectomy and fusion, ACCF)通过前路直接切除骨化物,减压效果确切,但其手术难度大、风险高,尤其是术后神经功能恶化的发生率较高^[3-8]。我们在前期报道了一种颈椎椎体骨化物复合体可控性前移融合手术(anterior controllable antedisplacement and fusion, ACAF)^[9-11],将椎体连同骨化物整体前移,进而扩大椎管空间,达到减压效果,可获得满意疗效。对于严重骨化患者,ACAF与ACCF术后神经功能恶化的发生率及临床疗效是否存在差异,尚缺乏相关报道,本研究就该问题进行回顾性对比研究。

1 资料与方法

1.1 一般资料

收集 2018 年 3 月~2019 年 3 月在我院脊柱外科接受颈前路手术的颈椎 OPLL 患者的临床资料。病例纳入标准:(1)年龄 40~70 岁;(2)颈椎 OPLL 致脊髓受压,保守治疗至少 6 周无效;(3)影像学检查提示椎管侵占率 $\geq 50\%$;(4)围手术期和随访期的临床数据及影像学资料完整。排除标准:(1)颈椎外伤、颈椎间盘突出及其他脊柱退行性疾病引起的脊髓压迫症患者;(2)既往有颈椎手术史者;(3)围手术期和/或随访期的临床数据及影像学资料不完整。共纳入 72 例患者,其中 35 例患者采用 ACAF 治疗,37 例采用 ACCF 治疗。两组患者的年龄、性别、随访时间、术前椎管侵占率、骨化物类型见表 1,两组间比较均无统计学差异($P>0.05$)。

1.2 手术方法

在全麻下,患者仰卧位,颈部自然仰伸。经右侧横切口显露至颈椎前方,透视确定手术节段。

ACCF 组:去除骨化节段相邻椎间盘,咬骨钳咬除骨化节段椎体前半部分,保留椎体侧壁及后壁。高速磨钻沿后壁仔细打磨,并尽可能磨薄骨化物。将尖端带槽的后纵韧带钩于未骨化韧带处插入韧带与硬膜囊之间,适度分离、旋转并提起韧带,尖刀切断后纵韧带,微型枪钳、刮勺小心去除

韧带组织。能在骨化物与硬膜囊之间找到“安全间隙”者取出骨化组织;骨化物与硬膜囊紧密粘连或伴有硬膜囊骨化者,采取“漂浮法”处理^[12]。减压完成后,于上下椎体间置入填塞有松质碎骨的钛网,并在椎体前方置入钛板、螺钉固定,以重建手术节段的结构及稳定性。

ACAF 组:去除手术节段的椎间盘组织,注意最上椎间隙上位椎体后下缘与最下椎间隙下位椎体后上缘的潜行减压,避免提拉后存在卡压。根据骨化物厚度,去除前移节段椎体前方部分骨质。高速磨钻于椎体左侧钩突关节水平开槽,宽约 3mm,直至椎体后壁骨皮质断裂,探及后纵韧带。于椎间隙各置入填塞有松质碎骨的融合器 1 枚,钛板固定前移节段头尾两侧椎体,各前移椎体采用高速磨钻开口后拧入自攻螺钉。再于右侧钩突关节水平开槽至后壁骨皮质断裂,此时椎体完全游离,缓慢拧紧前移节段螺钉,提拉椎体骨化物复合体,从而扩大椎管空间、达到减压效果。

仔细止血,生理盐水反复冲洗,切口放置负压引流管。术后给予雾化吸入、激素、脱水药物及营养神经药物等治疗。术后第二天佩戴颈托下地活动,24h 引流<15ml 拔除引流管。颈托固定 6 周。

1.3 评价指标

术后随访 6~12 个月,术前、术后 2 周内及末次随访时采用 JOA 评分评估神经功能。JOA 评分改善率=(术后 JOA 评分-术前 JOA 评分)/(17-术前 JOA 评分)×100%。记录两组患者术后 2 周内神经功能恶化的发生情况及原因。神经功能恶化定义为术后出现手术节段支配平面以下肢体的运动功能和感觉功能障碍,包括手动肌肉测试

(manual muscle test, MMT)值下降≥1 级,或 JOA 评分下降>1 分者^[13]。

所有患者术前和术后均接受了颈椎 X 线片、CT 平扫+三维重建和 MRI 检查。通过颈椎 CT 平扫+三维重建评估骨化物形态、节段,并通过 CT 横断面图像计算椎管侵占率、椎管最狭窄处的减压宽度及椎管面积,其中椎管侵占率定义为横断面椎管最狭窄处骨化物的厚度÷骨性椎管的前后径×100%,减压宽度为椎体两侧开槽的宽度;通过 MRI 横断面图像测量椎管最狭窄处的脊髓前后径(图 1)。通过 CT 评估术后融合率(融合标准为植骨块周围骨桥形成,以及植骨接触面缝隙影不超过 50%),颈椎屈伸动力位 X 线片评估是否存在假关节。

1.4 统计学方法

使用 SPSS 18.0 统计软件(SPSS Inc, 美国)对数据进行统计分析。计量资料结果记录为均数±标准差形式,符合正态分布、方差齐性的计量资料比较用 *t* 检验;不符合正态分布或方差不齐的计量资料比较用 Wilcoxon 秩和检验;计数资料比较用卡方检验, $P<0.05$ 为差异有统计学意义。

2 结果

两组手术时间、术中出血量、减压宽度、术中和末次随访时的椎管面积、脊髓前后径、JOA 评分及术后 2 周内的神经功能恶化情况见表 2。ACAF 组手术时间长于 ACCF 组($P<0.05$),两组出血量无统计学差异($P>0.05$)。ACAF 组末次随访减压宽度大于 ACCF 组,差异有统计学意义($P<0.05$);两组末次随访椎管面积、脊髓前后径无统计学差异($P>0.05$)。末次随访时,两组患者 JOA 评分较术前均明显改善,ACAF 组 JOA 评分改善率为(79.5±8.7)%,ACCF 组为(68.9±20.3)%,两组比较差异有统计学意义($P<0.05$)。

ACCF 组共有 10 例术后出现神经功能恶化,发生率为 27.0%;ACAF 组 2 例术后出现神经功能恶化,发生率为 5.7%,两组间比较差异有统计学意义($P<0.05$)。12 例神经功能恶化患者的情况见表 3。其中,ACAF 组 2 例于术后 2 周内出现四肢感觉运动功能下降,CT 提示骨化物残留(图 2),予以颈后路翻修术后症状改善。ACCF 组有 6 例术后即刻出现四肢肌力下降、感觉减退,考虑术中脊髓损伤所致,予以激素冲击、脱水药物治疗后

表 1 两组患者一般资料对比

Table 1 Comparison of the demographic data between the two groups

	ACAF 组 ACAF group (n=35)	ACCF 组 ACCF group (n=37)
性别 Gender		
男性 Male	20	18
女性 Female	15	19
年龄(岁) Age(years)	55.9±10.6	59.1±8.4
随访时间(月) Follow-up time(months)	8.9±4.1	9.1±4.2
椎管侵占率(%) Occupying rate(%)	60.3±7.8	58.1±6.6
骨化物类型 Type of OPLL		
宽基底型 Wide-base	19	17
窄基底型 Narrow-base	16	20

症状缓解,后期给予营养神经药物、高压氧治疗及康复锻炼,其中 2 例于术后 3 个月随访、4 例于术后 6 个月随访时改善;2 例于术后 24h 内出现进行性四肢感觉运动功能下降,考虑硬膜外血肿压迫脊髓所致,行急诊血肿清除术后好转;2 例术后一直存在四肢麻木无力,并于术后 2 周时主诉症状再次加重,复查 CT 提示骨化物残留,MRI 提示椎管狭窄仍然存在(图 3),行颈后路椎管扩大成形术,术后症状改善。术后 2 周后两组均未再出现神经功能恶化病例。两组患者末次随访时均获满意融合,无假关节形成及内置物相关并发症。

3 讨论

颈椎 OPLL 合并神经功能损害症状缺乏有效的保守治疗手段,相关研究表明,对于椎管侵占率 $\geq 50\%$ 的严重骨化患者,ACCF 较之后路椎管扩大成形术可获得更好疗效^[3-5]。然而,有文献报道,ACCF 治疗 OPLL 术后神经功能恶化发生率为

1.4%~21.4%,平均为 8.4%^[6]。Kimura 等^[7]发现 ACCF 治疗 OPLL 术后上下肢神经功能恶化发生率分别为 13.3%和 2.0%。Odate 等^[8]报道,对于接受过后路椎管成形手术的 OPLL 患者,若采用 ACCF 进行翻修,其神经功能恶化发生率高达 26%。较高的神经功能恶化率,限制了该技术在 OPLL 治疗领域的应用。

Sun 等^[9]于 2018 年首次报道了应用 ACAF 治疗颈椎 OPLL,取得了满意疗效。本研究结果显示,术后 2 周内,ACCF 组有 10 例出现神经功能恶化,发生率 27.0%;而 ACAF 组仅有 2 例出现神经功能恶化,发生率 5.7%,两组间比较差异有统计学意义($P<0.05$)。其中,ACCF 组有 6 例在术后即刻出现四肢感觉运动功能下降,考虑术中脊髓损伤所致。究其原因,我们认为对于椎管侵占率 $\geq 50\%$ 的严重骨化患者,若采取 ACCF,因术中减压操作空间极小,而且此类患者骨化物与硬膜囊往往紧密粘连,甚至伴有硬膜囊骨化,需要反复多次

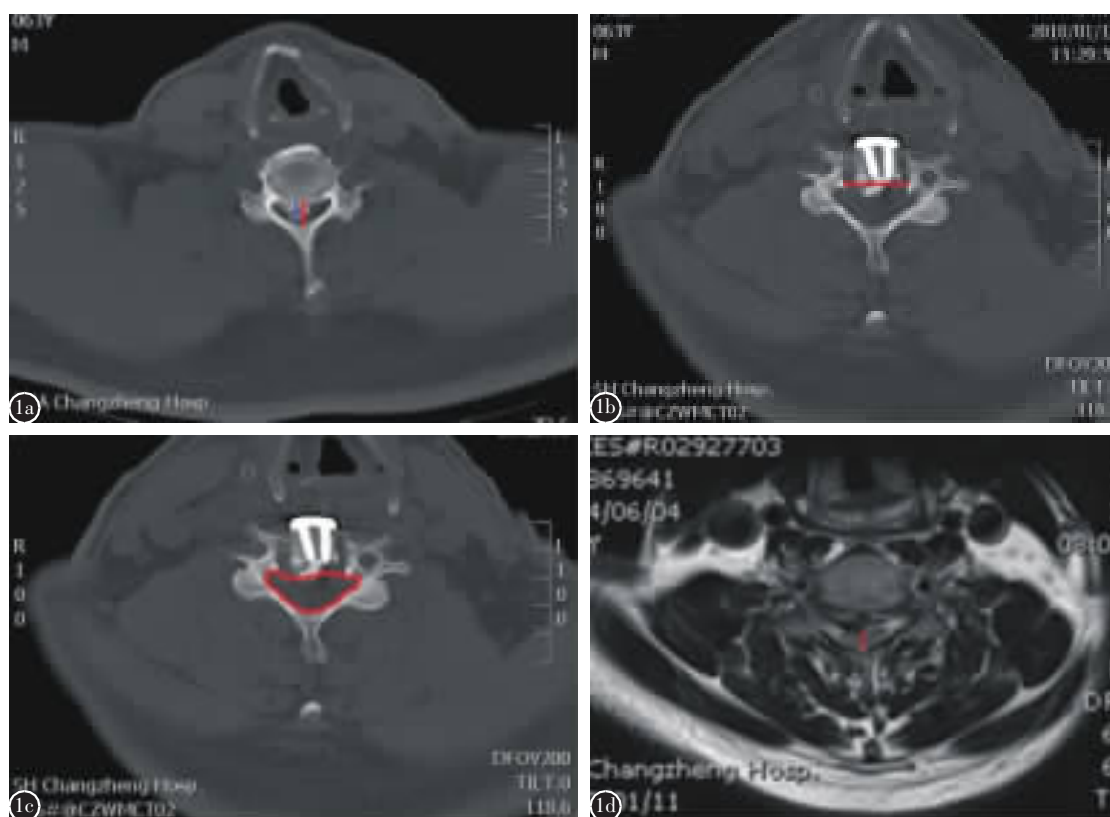


图 1 影像学测量方法 a 蓝线代表骨化物厚度,红线代表骨性椎管前后径,蓝线/红线的值即为椎管侵占率 b 减压宽度 c 椎管面积 d 脊髓前后径

Figure 1 Imaging measurement a The blue line representing the thickness of ossified mass, the red line representing the anteroposterior (AP) diameter of bony spinal canal. The lengths ratio of blue line/red line is the occupying rate b Decompression width c Spinal canal area d AP diameter of the spinal cord

探查,才有可能找到骨化物与硬膜囊之间的“安全间隙”,进而切除骨化物。此术式对操作水平有很高的要求,更主要的是,由于骨化物的压迫已经对脊髓方向形成了持续的压力,术中频繁地触碰、挤压硬膜囊,不可避免地增加了这种“向脊髓力”,使脊髓承受了额外的压力,故而容易出现损伤。而 ACAF 技术的减压效果是通过将椎体连同骨化物整体前移来实现的,而非直接切除骨化物,术中并不压迫硬膜囊,所有的减压操作方向均是远离脊髓,形成一种持续地去“向脊髓力”效果,实现了“脊髓原位减压”,理论上能够最大限度地避免损伤脊髓^[9,14]。本研究 ACAF 组无一例出现术中脊

髓损伤。

其次,ACCF 组有 2 例于术后 24h 内出现硬膜外血肿压迫脊髓,导致进行性神经功能下降。硬膜外血肿好发于术后 24h 内,其发生率虽不高,但若处理不及时,可导致脊髓持续受压,引起严重神经功能损害^[15,16]。颈前路术后硬膜外血肿的危险因素包括 OPLL、多节段手术、手术时间超过 4h、出血多、年龄超过 65 岁等^[17,18]。本组 2 例考虑术后硬膜外静脉丛及骨面持续渗血,血肿积聚在硬膜前方。由于硬膜囊完全“裸露”,当血肿压力超过硬膜囊张力,便可压迫脊髓导致神经功能损害。而 ACAF 组未发生硬膜外血肿致神经损伤。我们认为,严重 OPLL 往往与硬膜囊紧密粘连,或伴有硬

表 2 两组患者手术疗效及神经功能恶化率对比

Table 2 Comparison of the clinical outcomes and incidence rates of postoperative neurological deterioration between the two groups

	ACAF组 ACAF group (n=35)	ACCF组 ACCF group (n=35)
手术时间(mins) Operative time	158.5±47.4	127.3±34.5 ^①
出血量(ml) Blood loss	339±54.9	327±80.1
减压宽度(mm) Decompression width	18.5±2.5	16.9±1.9 ^①
椎管面积(mm ²) Spinal canal area		
术前 Preoperative	73.5±16.9	76.6±19.7
术后 Postoperative	144.9±31.2 ^②	142.1±22.3 ^②
脊髓前后径(mm) Anteroposterior diameter of the spinal cord		
术前 Preoperative	2.4±0.7	2.6±1.2
术后 Postoperative	5.5±0.5 ^②	5.2±1.4 ^②
JOA评分 JOA score		
术前 Preoperative	8.7±1.1	9.1±1.3
术后(末次随访) Postoperative(the last follow-up)	15.3±0.8 ^②	14.4±2.4 ^{①②}
改善率(%) Improvement rate	79.5±8.7	68.9±20.3 ^①
神经功能恶化原因 Causes of neurological deterioration		
术中脊髓损伤 Spinal cord injury	0	6
硬膜外血肿 Hematoma	0	2
骨化物残留 Remaining ossification mass	2	2
神经功能恶化率(%) The incidence rate of neurological deterioration	5.7	27.0 ^①

注:①与 ACAF 组比较 $P<0.05$; 与同组术前比较 $P<0.05$

Note: ①Compared with ACAF group, $P<0.05$; compared with the same group at preoperation, $P<0.05$

表 3 12 例神经功能恶化患者相关信息

Table 3 Data of 12 cases suffering neurological deterioration

	骨化物 类型 Type of OPLL	椎管侵 占率 (%) Occu- pying rate	术前 JOA 评分 Preop- erative JOA score	术后 2 周 内 JOA 评 分最低值 The lowest JOA score within 2 weeks after surgery	末次随 访 JOA 评分 score at the last follow-up
病例 1 Case 1	宽基底 Wide-base	59.3	8	5	10
病例 2 Case 2	窄基底 Narrow-base	61.2	8	5	11
病例 3 Case 3	宽基底 Wide-base	55.6	9	6	9
病例 4 Case 4	窄基底 Narrow-base	57.9	10	4	13
病例 5 Case 5	宽基底 Wide-base	60.5	10	3	10
病例 6 Case 6	宽基底 Wide-base	53.8	9	7	12
病例 7 Case 7	窄基底 Narrow-base	62.4	8	5	13
病例 8 Case 8	宽基底 Wide-base	60.8	9	6	12
病例 9 Case 9	宽基底 Wide-base	63.5	8	5	12
病例 10 Case 10	宽基底 Wide-base	60.7	10	6	14
病例 11 Case 11	宽基底 Wide-base	64.8	9	5	14
病例 12 Case 12	宽基底 Wide-base	62.1	8	6	13

注:病例 1~10 来自 ACCF 组,其中病例 1~6 系术中脊髓损伤,病例 7、8 系硬膜外血肿,病例 9、10 系骨化物残留;病例 11、12 来自 ACAF 组,均系骨化物残留

Note: Cases 1~10 were from ACCF group. Cases 1~6 suffered intraoperative spinal cord injury. Cases 7 and 8 suffered hematoma. Cases 9 and 10 suffered remaining ossification mass. Cases 11 and 12 from ACAF group, suffered remaining ossification mass

膜囊骨化^[19],因此在椎体骨化物复合体整体前移的同时,硬膜囊亦同时被提拉,使其张力变大、形成一种“帐篷”效应。即使有硬膜外血肿形成,这种“帐篷”效应亦可有效抵抗血肿的压力,对脊髓形成良好的保护,避免血肿压迫导致神经功能损害的发生^[20]。

ACCF 组和 ACAF 组各有 2 例出现术后骨化物残留。此类患者术后即刻神经症状有所改善,但

因术后脊髓膨胀、水肿,导致残留骨化物对脊髓造成二次压迫,最终加重神经损害,行后路手术翻修。我们发现,这 4 例患者的骨化类型均为宽基底型^[21],残留的骨化物均位于椎管外侧缘,术中减压不彻底,是导致骨化物残留的主要原因。其中,ACCF 组 1 例因硬脊膜损伤、脑脊液漏,1 例因椎管内静脉丛出血,无法继续扩大减压范围。ACCF 虽为直视下减压,但由于严重 OPLL 与硬膜囊紧

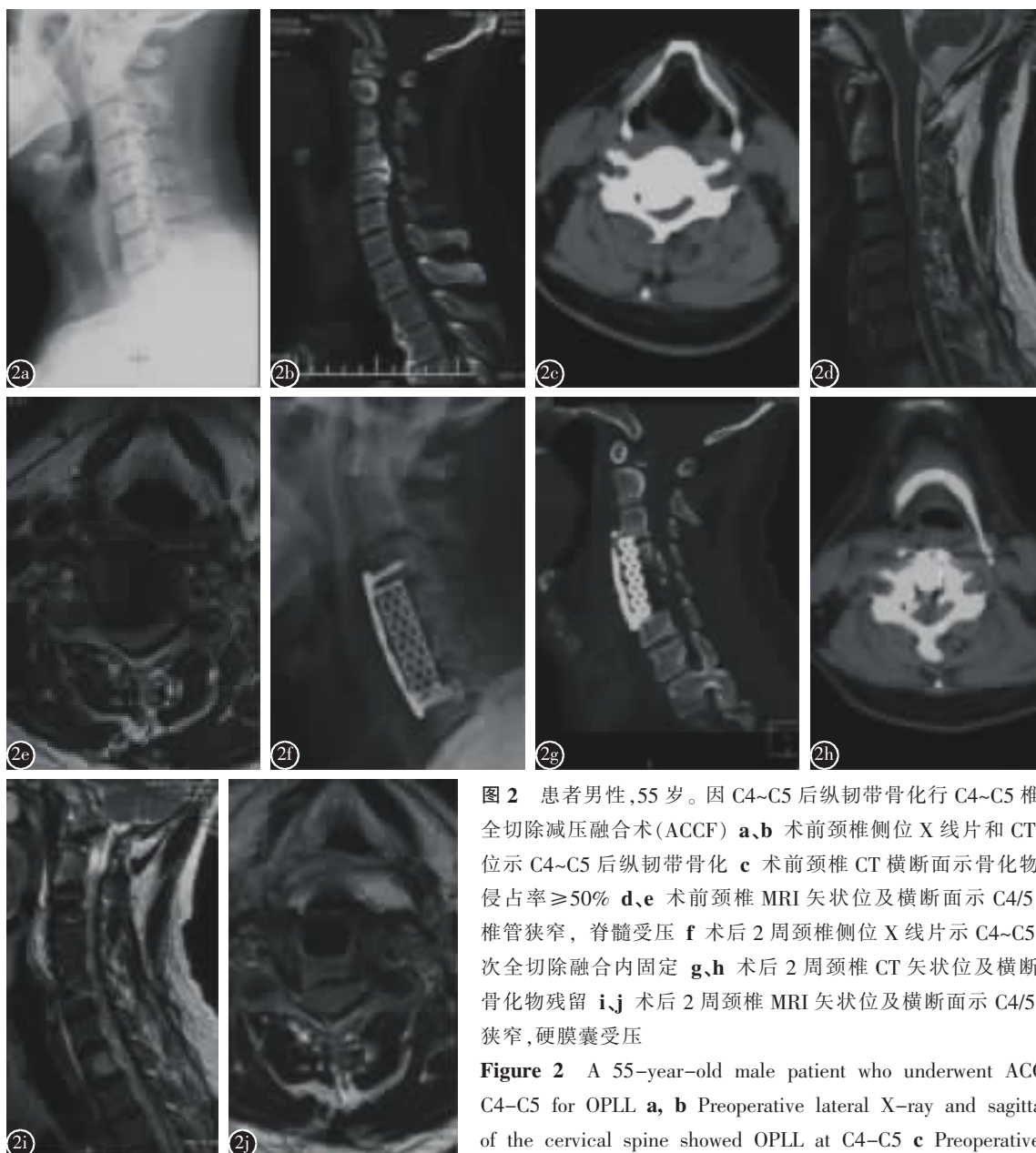


图 2 患者男性,55 岁。因 C4~C5 后纵韧带骨化行 C4~C5 椎体次全切除减压融合术(ACCF) **a、b** 术前颈椎侧位 X 线片和 CT 矢状位示 C4~C5 后纵韧带骨化 **c** 术前颈椎 CT 横断面示骨化物椎管侵占率 $\geq 50\%$ **d、e** 术前颈椎 MRI 矢状位及横断面示 C4/5 水平椎管狭窄,脊髓受压 **f** 术后 2 周颈椎侧位 X 线片示 C4~C5 椎体次全切除融合内固定 **g、h** 术后 2 周颈椎 CT 矢状位及横断面示骨化物残留 **i、j** 术后 2 周颈椎 MRI 矢状位及横断面示 C4/5 椎管狭窄,硬膜囊受压

Figure 2 A 55-year-old male patient who underwent ACCF at C4-C5 for OPLL **a, b** Preoperative lateral X-ray and sagittal CT of the cervical spine showed OPLL at C4-C5 **c** Preoperative axial CT showed occupying rate $\geq 50\%$ **d, e** Preoperative sagittal and axial MRIs showed anterior spinal cord compression and spinal canal stenosis at C4/5 **f** Lateral X-ray showed ACCF at C4-C5 at 2 weeks after surgery **g, h** Sagittal and axial CT showed residual ossification mass in spinal canal at 2 weeks after surgery **i, j** Sagittal and axial MRIs showed spinal canal stenosis and dura mater compression at C4/5 at 2 weeks postoperatively

and axial MRIs showed anterior spinal cord compression and spinal canal stenosis at C4/5 **f** Lateral X-ray showed ACCF at C4-C5 at 2 weeks after surgery **g, h** Sagittal and axial CT showed residual ossification mass in spinal canal at 2 weeks after surgery **i, j** Sagittal and axial MRIs showed spinal canal stenosis and dura mater compression at C4/5 at 2 weeks postoperatively

密粘连,以及椎管内静脉丛怒张,在切除骨化物的过程中容易造成脑脊液漏、大量出血等情况,影响操作视野,导致减压不充分,进而出现骨化物残留。ACAF 为非接触式减压,虽不需直接切除骨化物,但由于术中无法观察到骨化物的外侧缘,可导致开槽不充分,造成骨化物残留。本研究中 2 例均发生于 ACAF 技术开展的早期,我们在后续总结了一些方法,用于避免此类问题:(1)术中以双侧钩突基底部为开槽标志物,既能保证开槽宽度,又

不至于损伤椎弓根和椎动脉;(2)术前测量不同水平处骨化物的宽度,以及与双侧钩突的距离;(3)术中应注意保持垂直向下开槽,避免斜行开槽;(4)当开槽至椎体后壁骨皮质断裂,使用神经剥离钩探查开槽底部,检测骨化后纵韧带是否完全包含在椎体骨化物复合体中,如果在开槽的底部或外侧面仍有骨化物存在,则表明开槽的范围不够宽,在这种情况下,应向两侧扩展开槽范围,而不是继续切磨槽底骨化物,以避免骨化物残留^[22,23]。

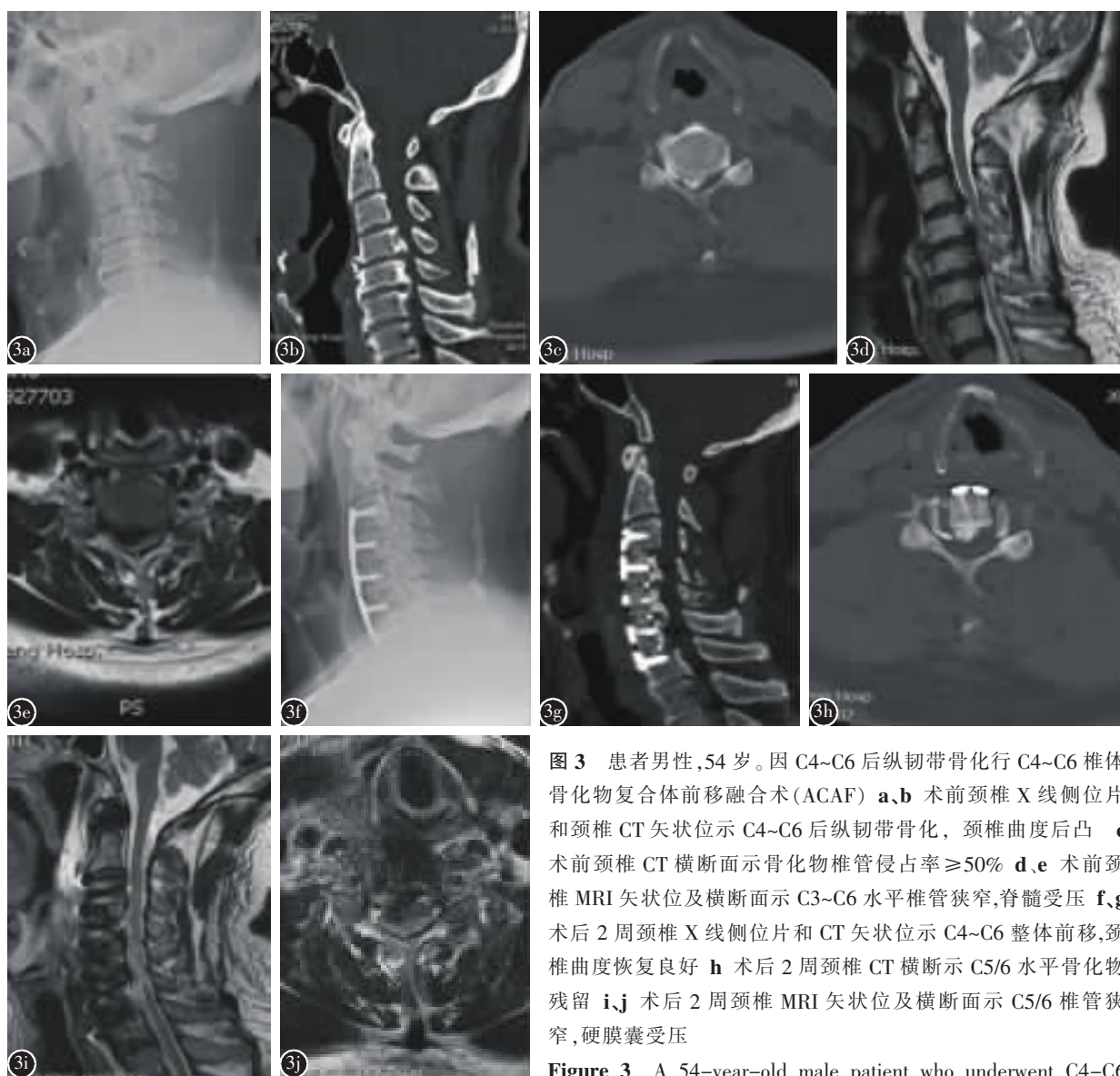


图 3 患者男性,54 岁。因 C4~C6 后纵韧带骨化行 C4~C6 椎体骨化物复合体前移融合术(ACAF) **a、b** 术前颈椎 X 线侧位片和颈椎 CT 矢状位示 C4~C6 后纵韧带骨化,颈椎曲度后凸 **c** 术前颈椎 CT 横断面示骨化物椎管侵占率 $\geq 50\%$ **d、e** 术前颈椎 MRI 矢状位及横断面示 C3~C6 水平椎管狭窄,脊髓受压 **f、g** 术后 2 周颈椎 X 线侧位片和 CT 矢状位示 C4~C6 整体前移,颈椎曲度恢复良好 **h** 术后 2 周颈椎 CT 横断示 C5/6 水平骨化物残留 **i、j** 术后 2 周颈椎 MRI 矢状位及横断面示 C5/6 椎管狭窄,硬膜囊受压

Figure 3 A 54-year-old male patient who underwent C4-C6

ACAF for OPLL **a, b** Preoperative lateral X-ray and sagittal CT of the cervical spine showed OPLL from C4 to C6 and cervical kyphosis **c** Preoperative axial CT showed occupying rate $\geq 50\%$ **d, e** Preoperative sagittal and axial MRI showed anterior spinal cord compression and spinal canal stenosis at C3-C6 **f, g** Lateral X-ray and sagittal CT showed C4-C6 ACAF with satisfied cervical lordosis at 2 weeks after surgery **h** Axial CT showed residual ossification mass at C5/6 at 2 weeks postoperatively **i, j** Sagittal and axial MRI showed spinal canal stenosis and dura mater compression at C5/6 at 2 weeks after surgery

在影像学方面,ACAF 组术后减压宽度超过 ACCF 组,差异有统计学意义($P<0.05$)。究其原因,ACAF 术中均以双侧钩突基底部为开槽标志物;而 ACCF 减压宽度取决于骨化物范围,本研究 ACCF 组中仅有 12 例需切除椎体至钩突基底部水平,故而其整体减压宽度不及 ACAF 组。另一方面,术后椎管面积、脊髓前后径两组间差异并无统计学意义($P>0.05$),两种术式均可有效解除骨化物对脊髓的压迫。在末次随访时,两组患者神经功能较术前均显著改善,ACAF 组取得了更高的 JOA 评分改善率($P<0.05$),可能与 ACAF 组术后神经功能恶化率较低有关。同时,我们发现在 ACCF 组神经功能恶化病例中,尤其是 6 例术中脊髓损伤患者,虽然末次随访时神经功能改善,但 JOA 评分较低,有 2 例仅恢复至术前水平,可能对本组 JOA 评分改善率造成负面影响。

综上所述,相较于 ACCF,ACAF 治疗严重颈椎 OPLL 能够获得更加满意的临床疗效,且降低了术后神经功能恶化率;但在开展 ACAF 早期仍存在发生术后神经功能恶化的潜在风险。另外,本研究尚存在一些局限性,比如随访时间较短,样本量较小,且为单中心回顾性研究,需要进一步开展多中心、大样本前瞻性研究以获得更高证据等级的结论。

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- (收稿日期:2022-05-15 末次修回日期:2022-09-15)
(英文编审 谭 啸)
(本文编辑 李伟霞)

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- (收稿日期:2022-02-09 末次修回日期:2022-07-08)
(英文编审 谭 啸)
(本文编辑 卢庆霞)