

临床论著

颈前路内固定融合治疗外伤性下颈椎损伤术后
邻近节段矢状面角度丢失的相关因素分析

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【摘要】目的:探讨外伤性下颈椎行颈前路融合内固定(anterior cervical fusion, ACF)术后邻近节段矢状面角度丢失的相关因素。方法:回顾性分析 396 例行 ACF 治疗的下颈椎外伤患者,记录患者年龄、性别、随访时间、手术方式、入院及末次随访 ASIA 评分(ASIA 分级 A~E 级分别记为 1~5 分),在颈椎侧位 X 线上测量上区域角、下区域角、局部后凸角、融合节段角度、邻近椎体及椎间隙角度等相关参数,回顾所有患者术前 MRI、CT,明确邻近节段损伤情况,所有患者局部后凸角术后角度丢失大于 5°归为 A 组(术后邻近节段角度丢失组,23 例),术后邻近节段角度无丢失为 B 组(373 例),并通过 T 检验、 χ^2 检验、Fisher 确切概率法对以上相关因素行两组间对比分析,采用 Logistic 回归分析 ACF 术后邻近节段角度丢失发生的危险因素。分析邻近节段椎间隙、椎体及融合节段角度在局部后凸角、上区域角、下区域角中所占比例,明确 ACF 术后邻近节段角度丢失的主要部位。结果:ACF 术后邻近节段角度丢失发生率为 5.81%(23/396),A、B 组年龄分别为 48.26±8.61 岁、31.04±6.17 岁,入院时 ASIA 评分两组分别为 3.5±0.8、3.7±1.0,差异均有显著性($P=0.021$, $P=0.045$)。手术方式、性别、随访时间、末次随访 ASIA 评分在 A 组和 B 组间差异无显著性($P>0.05$)。两组患者术前 CT、MRI 上显示非手术节段 MRI 椎间盘信号异常(A 组 3/23, B 组 13/373)、不伴椎间韧带复合体损伤的单侧非移位型关节突骨折(A 组 2/23, B 组 0/373)有显著性差异($P<0.001$, $P=0.003$)。多变量回归分析显示年龄、MRI 上非手术节段椎间盘信号异常、不伴椎间韧带复合体损伤的单侧非移位型关节突骨折是 ACF 术后邻近节段矢状面角度丢失的危险因素(P 分别为 0.031、0.006、0.002),入院时 ASIA 评分与 ACF 术后邻近节段后凸畸形发生无相关性($P=0.301$)。上邻近第 1 椎间隙角度丢失在局部后凸角、上区域角、下区域角角度丢失中分别为 78.07%、85.00%、90.19%,上邻近第 1 椎间隙角度丢失是邻近节段角度丢失的主要成分。结论:ACF 术后局部角度丢失有一定发生率,年龄、MRI 上非手术节段椎间盘信号异常及不伴椎间韧带复合体损伤的单侧非移位型关节突骨折是 ACF 术后后凸畸形发生的危险因素,以上邻近节段角度丢失为主。

【关键词】颈前路融合术;角度丢失;椎间盘;关节突骨折

doi:10.3969/j.issn.1004-406X.2016.02.06

中图分类号:R681.5, R619 文献标识码:A 文章编号:1004-406X(2016)-02-0131-08

Risk factors of the occurrence of adjacent segment angular loss after anterior cervical fusion in patients with cervical injury/CHEN Jiaoxiang, MA Xiangyang, XU Huazi, et al//Chinese Journal of Spine and Spinal Cord, 2016, 26(2): 131-138

【Abstract】 **Objectives:** To investigate risk factors of adjacent segment angular loss after anterior cervical fusion(ACF) in patients with cervical injury. **Methods:** A retrospective analysis was carried out, 396 patients undergoing ACF were included in the study. Factors such as age, gender, follow-up time, operation methods, ASIA scores (grade A-E recorded as 1-5 score respectively) in admission and at final follow-up were recorded. Radiographic parameters such as kyphosis, fusion segment angle, adjacent vertebral angle, adjacent intervertebral angle were measured, adjacent segment injury was identified by using MRI and CT. Patients were divided into two groups based on the angle loss at adjacent segment for 5°. 23 cases were in angular

基金项目:国家自然科学基金项目(编号:81371988);浙江省自然科学基金项目(编号:LR12H06001);浙江省医药卫生重大科技计划(编号:WKJ-ZJ-1527)

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loss group(group A) and 373 in non angular loss group(group B). The comparative results between the two groups were analyzed by T-test, Chi-square test or Fisher exact probability. Risk factors of adjacent segment angle loss after ACF were analyzed by using multivariate logistic regression. To identify the majority of the angle loss of adjacent segment after ACF, the proportion of the adjacent intervertebral angle, the vertebral angle and the fusion segment angle in the local kyphosis, the upper region angle and the lower region angle were analyzed. **Results:** The occurrence of adjacent segment angular loss after ACF was 5.81%(23/396). Age was 48.26 ± 8.61 and 31.04 ± 6.17 years ($P=0.021$) in group A and B, ASIA in admission for group A and B was 3.5 ± 0.8 and 3.7 ± 1.0 ($P=0.045$). Follow-up time, operation method, gender and ASIA at final follow-up showed no significant differences between group A and B ($P>0.05$). Significant difference was noted with respect to adjacent segment injury including abnormal disc signals in non-operation segment on MRI, unilateral, undisplaced cervical facet joint fracture without disc-ligament complex injury appeared in group A compared with group B ($P<0.001$ and $P=0.003$, respectively). Age, abnormal disc signals in non-operation segment on MRI, unilateral, undisplaced facet fracture without disc-ligament complex injury were independent risk factors of this complication by using multivariate logistic regression ($P=0.031$, 0.006 , 0.002 , respectively). By analyzing radiographic parameters, the angular loss of upper adjacent intervertebral space in the local kyphosis, the caudal angle and the distal angle was 78.07%, 85.00% and 90.19%, respectively. The angular lose in upper adjacent disc resulted in a progressive angular lose of adjacent segment. **Conclusions:** The incidence of adjacent segment angle loss after ACF is correlated to age, abnormal disc signals of non-operation segment on MRI, unilateral, undisplaced facet joint fracture without disc-ligament complex injury is considerable, mainly in the upper adjacent segment.

【Key words】 Anterior cervical fusion; Kyphosis; Disc; Facet fracture

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颈椎损伤仅占急诊外伤的 1%~3%,却是引起肢体瘫痪甚至死亡的主要原因^[1]。早期、准确评估颈椎骨折、脊髓压迫严重程度并制定合理的治疗方案至关重要^[2]。颈前路融合术(anterior cervical fusion,ACF)包括颈前路椎体次全切除内固定术(anterior cervical corpectomy decompression and fusion,ACCF)、颈前路椎间盘切除减压融合术(anterior cervical discectomy and fusion,ACDF),常用于治疗外伤引起的骨折、椎间盘及韧带损伤所致的颈椎不稳、颈髓损伤,该术式因创伤小、直接对椎管减压、融合率高、有效维持颈椎曲度并保证前路稳定性而广泛应用^[3-5]。然而,在临床工作中我们发现部分颈椎外伤患者 ACF 术后邻近节段出现不同程度角度丢失,针对这一现象,我们收集 2011 年 1 月~2014 年 12 月在我科行 ACF 患者 396 例,对 ACF 术后邻近节段角度丢失进行了回顾性分析,探讨 ACF 术后邻近节段角度丢失发生的相关因素。

1 资料与方法

1.1 一般资料

2011 年 1 月~2014 年 12 月因外伤致颈椎损伤在我院脊柱外科行 ACF 治疗的患者 473 例。排除标准:合并脊柱肿瘤、脊柱炎症、骨折疏松性等病理性骨折。排除患者 77 例,共纳入 396 例患者,男 220 例,女 176 例,年龄 18~53 岁,随访时间 49~180d,平均 121.08 ± 12.71 d。全部患者术前均行颈椎正侧位 X 线、CT 及 MRI 检查,伤后 3d 内手术治疗,术后佩戴颈托 3 个月。本研究纳入 ACDF 患者 326 例,均为单节段,其中 C3/4、C4/5、C5/6、C6/7 节段分别为 29 例、102 例、157 例、38 例;纳入 ACCF 患者 70 例,C4~C6 节段 28 例,C5~C7 节段 42 例。MRI 评估颈椎椎间盘、韧带损伤,CT 评估颈椎关节突等骨性结构损伤。本研究非手术节段椎间盘信号异常 18 例,黄韧带损伤 2 例,棘间韧带损伤 102 例,不伴有椎间盘韧带复合体损伤的关节突骨折 2 例,均位于上邻近第 1 节段。

1.2 治疗方法

外伤引起的椎间盘破裂伴/不伴椎管狭窄、无严重椎体骨折患者行 ACDF,术中切除椎间盘,充分减压后置入相应型号椎间融合器,合适的锁定钢板固定上下椎体。外伤引起的椎体前柱爆裂性

骨折患者行 ACCF, 术中将碎骨填入钛网并嵌入椎体间, 使其复位, 钢板固定上下椎体。融合器中植骨为术中自体骨, 未取髂骨及加入其他异体骨。

1.3 观察指标

统计两组患者的年龄、性别、手术方式、入院时及末次随访时 ASIA 评分 (ASIA 分级 A 级 1 分, B 级 2 分, C 级 3 分, D 级 4 分, E 级 5 分)。在颈椎侧位 X 线片上测量局部后凸角、上区域角、下区域角反映局部屈度 (图 1), 测量融合节段角、邻近椎体角及椎间隙角并分析其在局部后凸角、上区域角、下区域角中所占比例, 分析邻近节段矢状面角度丢失主要成分, 因 C4/5、C5/6 为颈椎损伤好发部位, 测量下邻近两个节段椎间隙困难 (部分颈胸段在 X 线侧位片上遭胸廓、肩遮挡使测量困难), 且颈椎较胸椎活动度大, 测量意义大, 故选择测量上两个邻近椎间隙、下一个邻近椎间隙。“+”表示颈椎前凸, “-”表示后凸, 角度丢失值是术后与末次随访测量角度的差值, 正值表示角度丢失 (相对后凸), 负值表示曲度在随访阶段有所矫正 (相对前凸)。考虑到测量受到体位、X 线片的拍片方式和画线的方式的影响, 为减少偏倚, 故以局部后凸角角度丢失 5° 为临界值^[9], 分为 A 组 (术

后邻近节段角度丢失组) 23 例, B 组 (术后邻近节段角度无丢失组) 373 例。测量两组患者术后、末次随访时的局部后凸角、上区域角、下区域角, 融合节段角、邻近椎体局部角度, 邻近椎间隙角度及各角度丢失值, 邻近节段椎间盘韧带复合体、骨性结构损伤情况。

1.4 统计学方法

通过 SPSS 17.0 进行相关数据分析处理, 计数资料采用频数表示, 采用 Fisher 确切概率法、卡方检验法分析; 计量资料采用均数 $\pm$ 标准差 ($\bar{x}\pm s$) 表示, 采用 T 检验; 对有统计学意义变量进一步采用多变量 Logistic 回归分析, $P<0.05$ 为差异有显著性。

2 结果

所有患者均完成术后随访, 术后再发邻近节段后凸畸形率为 5.81% (23/396)。A 组中 ACDF 17 例, ACCF 6 例, B 组中 ACDF 309 例, ACCF 64 例, 两组手术方式差异无显著性 ($P=0.266$)。A 组、B 组平均年龄分别为 48.26 ± 8.61 岁、 31.04 ± 6.17 岁, 差异有显著性 ($P=0.021$)。所有患者平均随访时间为 121.08 ± 12.71 d, 两组间性别、随访时

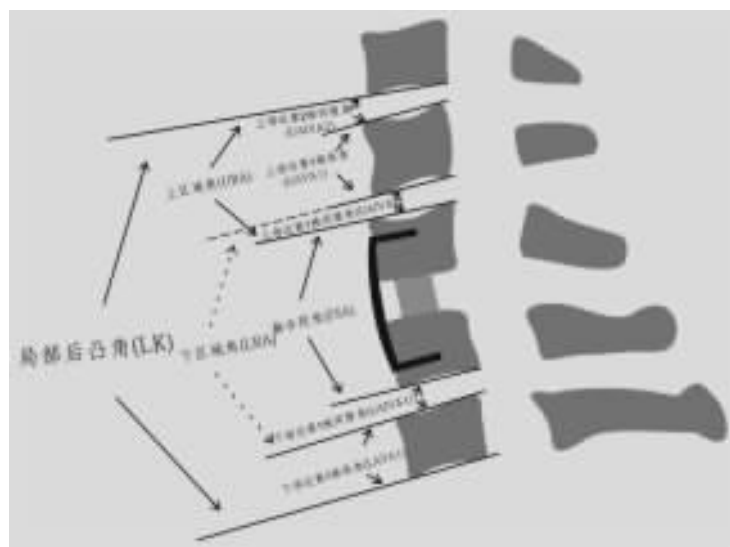


图 1 颈椎侧位片上各参数测量示意图 (局部后凸角、上区域角、下区域角反映颈椎局部曲度; 局部后凸角, 融合节段上邻近第 2 椎体下终板与下邻近第 1 椎体下终板之间夹角; 上区域角, 融合节段上终板与上邻近第 2 椎体下终板之间夹角; 下区域角, 融合节段上邻近第 1 椎体下终板与下邻近第 1 椎体上终板之间夹角)

Figure 1 Schematic diagram of parameters on lateral cervical X-ray (The local kyphosis, the upper region angle and the lower region angle reflected cervical local curvature. Local kyphosis was the angle between the inferior endplate of the second upper adjacent vertebra and the inferior end plate of the first lower adjacent vertebra. The upper region

angle was defined as angle between the superior end plate of fusion segment and the inferior end plate of the second upper adjacent vertebra. The lower region angle was defined as angle between the inferior end plate of the upper adjacent vertebra and the superior end plate of the lower adjacent vertebra)(UAIVA1: First upper adjacent intervertebral angle; UAIVA2: Second upper adjacent intervertebral angle; LAIVA1: First lower adjacent intervertebral angle; UAVA1: First upper adjacent vertebral angle; LAVA1: First lower adjacent vertebral angle; FSA: Fusion segment angle; URA: Upper region angle; LRA: Lower region angle; LK: Local kyphosis)

间差异无显著性(P 分别为 0.736、0.440,表 1)。A 组局部曲度随时间明显后凸加重,角度丢失 $8.71^{\circ} \pm 3.96^{\circ}$,B 组局部曲度变化不明显,两组角度丢失差异有显著性($P<0.001$,表 2)。回顾所有病例 CT、MRI,评估邻近节段椎间盘-韧带-骨性结构损伤情况,A 组邻近节段椎间盘-韧带-骨性结构损伤发生率 73.9%(16/23),明显较 B 组 (29.0%, 13/373)高,其中非手术节段椎间盘信号异常、不伴间盘韧带复合体损伤的单侧非移位型关节突骨折在两组间差异有显著性 ($P<0.001$, $P=0.003$,表 3)(图 2、3)。多变量回归分析提示年龄、MRI 非手术节段椎间盘信号异常、不伴间盘韧带复合体损伤的单侧非移位型关节突骨折与 ACF 术后邻近节段后凸畸形发生有显著相关性 (P 分别为 0.031,0.006,0.002),入院时 ASIA 与 ACF 术后邻近节段后凸畸形发生无相关性($P=0.301$,表 4)。

分别比较 A 组末次随访及术后局部后凸角、上区域角、下区域角,均有统计学差异(P 分别为 0.042、0.017、0.208),分析局部后凸角、上区域角、下区域角,发现上邻近第 1 椎间隙角度丢失占主要成分,分别为 78.07%、85.00%、90.19%,其余成分角度变化不明显(表 5、6)。

3 讨论

ACF 是目前治疗颈椎损伤的常用术式,通过前路解除颈髓前方压迫、植骨融合、椎体前方固定达到机械稳定,其治疗效果在临床上得到了大家的公认^[3-5]。曾有学者报道颈椎融合术后出现局部后凸畸形,认为其发生与术后加重邻近节段退变及钛网沉降有关,且后凸畸形程度轻^[7-9]。然而在临床工作中,我们发现部分患者术后邻近节段短期内角度丢失明显,针对该情况还未有报道。

颈椎非骨性结构以椎间盘韧带复合体为主,包括前纵韧带、后纵韧带、椎间盘、黄韧带、关节囊韧带、棘间韧带、项韧带等,其结构不完整可能导致颈椎不稳、生理曲度改变、颈髓压迫并产生各种神经症状^[10,11]。Richter 等^[12]通过生物力学实验逐步切除前纵韧带、椎间盘、后部韧带结构、关节囊韧带证明间盘韧带复合体损伤后可出现明显生物力学不稳,容易出现前屈不稳定导致后凸畸形。美国脊柱创伤小组首次将间盘韧带复合体纳入 SLIC 评分系统 (Subaxial Injury Classification Scoring System)用于指导手术治疗,充分肯定了非骨性结

表 1 A 组与 B 组一般资料对比
Table 1 Group A and group B comparison of general information

	A组 Group A	B组 Group B	P值 P value
例数 N	23	373	
性别(男/女) Gender(male/female)	14/9	206/167	0.736
年龄(岁) Age (year)	48.26±8.61	31.04±6.17	0.021
颈前路椎间盘切除减压融合术(ACDF)	17	309	
颈前路椎体次全切除内固定术(ACCF)	6	64	0.266
平均随访时间(天) Mean follow-up(day)	101.22±23.67	153±26.82	0.440
入院时 ASIA 评分(分) ASIA score in admission	3.5±0.8	3.7±1.0	0.045
末次随访 ASIA 评分(分) ASIA score in final follow-up	4.3±0.5	4.0±0.9	0.260

Note: ACDF, Anterior cervical discectomy and fusion; ACCF, Anterior cervical corpectomy and fusion; ASIA, America Spinal Injury Association

表 2 A 组与 B 组局部后凸角变化
Table 2 Local kyphosis(LK) changes of group A and group B

	A组 Group A	B组 Group B
术后局部后凸角($^{\circ}$) Post-operative LK	11.29±7.76	10.82±3.93
末次随访局部后凸角($^{\circ}$) Final follow-up LK	2.58±8.80	12.43±3.89
角度丢失($^{\circ}$) Angle loss	8.71±3.96	-1.61±1.38 ^①

注:①与 A 组比较, $P<0.001$
Note: ①Compared with group A, $P<0.001$

表 3 A 组与 B 组邻近节段韧带-骨性结构损伤情况
Table 3 Adjacent ligament-bony structure jinjury in group A and B

	A组 Group A	B组 Group B	P值 P value
椎间盘信号异常 (上邻近第 1 节段) Abnormal disc signal (FUAS)	5	13	$P<0.001$
黄韧带损伤(上邻近第 1 节段) LF ligament (FUAS)	1	1	$P=0.113$
棘间韧带损伤 (上邻近第 1 节段) ISL injury (FUAS)	8	94	$P=0.308$
不伴有椎间韧带复合体损伤的 关节突骨折(上邻近第 1 节段) Facet fracture without DLC injury (FUAS)	2	0	$P=0.003$

Note: FUAS, First upper adjacent segment; LF, Flavum ligament; ISL, Interspinous ligament; DLC, Disc-ligament complex

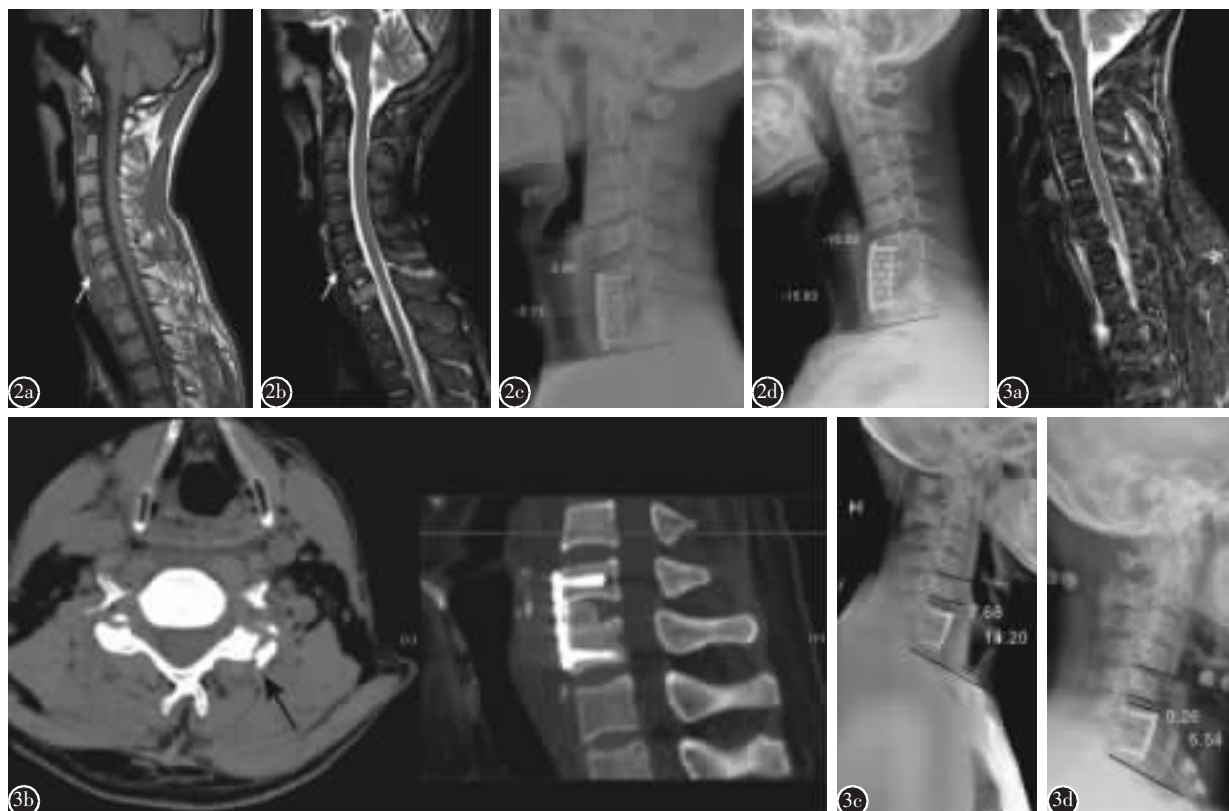


图 2 患者,男,39 岁 **a,b** 术前颈椎 MRI T1 像(**a**)、T2 像(**b**)示 C5/6 椎间盘信号改变 **c** ACCF 术后 X 线片示局部后凸角 -5.71° ,上邻近第 1 椎间隙 -2.06° **d** 58d 后复查,局部后凸角 -15.93° ,上邻近第 1 椎间隙角 -10.03° ,局部后凸角角度丢失 10.22° ,上邻近第 1 椎间隙角度丢失 7.97° **图 3** 患者,男,38 岁 **a** 术前 MRI 示 C5/6 节段未见椎间盘、韧带损伤信号 **b** ACDF 术后颈椎 CT 提示手术顺利,C5/6 节段关节突骨折 **c** 术后复查颈椎侧位 X 线片示局部后凸角 14.20° ,上邻近第 1 椎间隙 7.68° **d** 2 个月后复查颈椎侧位 X 线片示局部后凸角 5.54° ,上邻近第 1 椎间隙 0.26° ,局部后凸角角度丢失 6.52° ,上邻近第 1 椎间隙角度丢失 7.42°

Figure 2 A male, 39 years old **a, b** Pre-operative MRI showed abnormal disc signals on T1(**a**) and T2 STIR-weighted sequence(**b**) **c** X-ray showed local kyphosis(LK) and the first upper adjacent intervertebral angle(UAIVA1) after anterior cervical fusion were -5.71° and -2.06° respectively **d** After 58 days follow-up, X-ray showed LK was -15.93° , UAIVA1 was -10.03° , angle loss of LK and UAIVA1 were 10.22° and 7.97° **Figure 3** A male, 38 years old **a** Pre-operative MRI showed no disc and ligaments injury **b** Postoperative CT identified successful performance of anterior cervical discectomy and fusion(C6/7) and cervical facet fracture(C5/6) **c** Postoperative X-ray showed the local kyphosis (LK) and the first upper adjacent intervertebral angle (UAIVA1) were 14.20° and 7.68° respectively **d** After 2 months follow-up, X-ray showed LK was 5.54° , UAIVA1 was 0.26° , angle loss of LK and UAIVA1 were 6.52° and 7.42° respectively

构在维持颈椎稳定中的重要作用^[13]。有学者^[14]认为椎间盘损伤如果不加以必要手术治疗可能会引起颈部慢性疼痛及放射痛等并发症。因此,术前充分评估间盘韧带复合体损伤程度显得尤为重要。本研究还发现,A 组 23 例患者中有 5 例患者 MRI 上非手术节段椎间盘信号异常,其与术后后凸畸形有关($P<0.001$)。椎间盘能有效缓冲椎体间相互作用,维持颈椎曲度、活动度,以往认为外伤性椎间破裂导致颈椎不稳、颈髓损伤,建议手术治疗,而无颈椎不稳、椎管狭窄及颈髓损伤的椎间盘损

伤可保守治疗^[15,16]。本研究表明,MRI 上椎间盘信号异常是引起椎间隙塌陷导致邻近节段角度丢失的危险因素,考虑到 MRI 评估椎间盘损伤及严重程度有较高的准确性^[17],MRI 上椎间盘信号异常提示椎间盘结构性破坏,稳定性降低,其转归存在争议,对于 MRI 椎间盘信号异常手术治疗或为最佳选择。ACF(包括 ACDF、ACCF)术后可出现内置物沉降,引起融合段后凸,但程度轻^[9,18]。分析局部后凸角及下区域角,融合节段角度变化小(角度丢失分别为 1.38%、1.59%),因此,本研究中 ACF 术

表 4 各因素与颈前路融合术后邻近节段后凸畸形的 logistic 回归分析结果

Table 4 Result of logistic regression for adjacent segment kyphosis occurrence after anterior cervical fusion

	优势比 OR	95%可信区间 95% confidence interval	P值 P value
年龄(岁) Age (year)	1.336	1.078~4.382	0.031
入院时 ASIA ASIA in admission	1.021	0.948~1.342	0.301
MRI椎间盘异常信号 (上邻近第 1 节段) Suspected Disc injury(FUAS)	2.075	1.203~4.020	0.006
不伴间盘韧带复合体损伤的 关节突骨折(上邻近第 1 节段) Facet fracture without DLC injury (FUAS)	2.692	1.554~3.923	0.002

ASIA: America Spinal Injury Association; FUAS: First upper adjacent segment

表 5 A 组各个成分变化

Table 5 Changes in radiographic parameters of group A over time

	术后 Postoperation	末次随访 Final follow-up	角度丢失 Angle loss
下邻近第 1 椎间隙 Lower adjacent intervertebral angle	4.60±3.34	3.98±3.81	0.62±3.38
下邻近第 1 椎体 Lower adjacent vertebra angle	-1.18±2.18	-1.15±2.18	-0.03±0.18
融合阶段 Fusion segment angle	4.35±6.75	4.23±6.74	0.12±0.08
上邻近第 1 椎间隙 First upper adjacent intervertebral angle	2.88±2.77	-3.92±3.94	6.80±3.37
上邻近第 1 椎体 Upper adjacent vertebra angle	-1.74±2.31	-1.72±2.32	-0.02±0.65
上邻近第 2 椎间隙 Second upper adjacent intervertebral angle	2.38±3.85	1.16±2.97	1.22±3.29
上区域角 Upper region angle	3.52±0.70	-4.48±1.32	8.00±6.82
下区域角 Lower region angle	11.83±2.74	4.29±0.13	7.54±9.22
局部后凸角 Local kyphosis	11.29±3.76	2.58±0.80	8.71±3.96

后融合节段沉降不是术后局部后凸的主要原因。多变量回归分析提示年龄是 ACF 术后邻近节段角度丢失危险因素,椎间盘随年龄增大退变加重,生物力学性能减退^[9],退变的椎间盘受创伤打击后容易出现功能进一步减退,不排除加速椎间盘退变,颈椎 MRI 检查可明确,因本研究为回顾性

表 6 A 组的角度丢失分布分析(%)

Table 6 Analysis of angle loss contribution in radiographic parameters of group A

	局部后凸角 LK	上区域角 URA	下区域角 LRA
上邻近第 2 椎间隙 UAIVA2	14.01	15.25	0
上邻近第 1 椎体 UAVA1	-0.23	-0.25	0
上邻近第 1 椎间隙 UAIVA1	78.07	85.00	90.19
融合节段 FSA	1.38	0	1.59
下邻近第 1 椎间隙 LAIVA1	7.12	0	8.22
下邻近第 1 椎体 LAVA1	-0.34	0	0

UAIVA1: First upper adjacent intervertebral angle; UAIVA2: Second upper adjacent intervertebral angle; LAIVA1: First lower adjacent intervertebral angle; UAVA1: First upper adjacent vertebral angle; LAVA1:First lower adjacent vertebral angle; FSA: Fusion segment angle; URA: Upper region angle; LRA: Lower region angle; LK: Local kyphosis

研究,随访过程中患者未行 MRI 检查,故不能对椎间盘退变程度进行评估。

颈椎骨性结构包括椎体、关节突、椎板、棘突等。椎体塌陷造成前柱不稳、后凸角增大,可进一步移位引起脱位,对于严重椎体前柱骨折常行 ACCF^[13]。关节突在维持颈椎稳定中起到的作用同样不容忽视。Rasoulinejad 等^[10]通过生物力学实验验证了关节突在维持颈椎稳定中的重要作用,他们逐步切除后方韧带复合体、关节囊、同侧二分之一关节突及同侧全部关节突,关节突损伤时中性区变化有统计学意义。Oberkircher 等^[20]从生物力学角度肯定了这一结论。Lifeso 等^[21]回顾性分析 50 例颈椎骨折,发现单侧关节突骨折可引起颈髓、神经根损伤。本研究回顾分析发现 A、B 两组非手术节段关节突骨折差异有显著性($P=0.003$),表明关节突骨折后颈椎稳定性差,与相关研究得出结论相同^[21,22]。Aarabi 等^[23]通过分析 25 例单侧关节突骨折患者,认为无移位或不明显移位的关节突骨折手术治疗优于非手术治疗,但研究对象均伴不同程度间盘韧带复合体损伤。Lee 等^[24]认为单侧关节突骨折非手术治疗失败率极高,同样他们未评估非骨性结构损伤情况。本研究结果表明不伴椎间盘、韧带结构损伤的单侧非移位型关节突损伤是邻近节段角度丢失的危险因素,稳定性差,可考虑手术治疗。关节突损伤常伴有不同程度

椎间盘、韧带损伤^[25, 26], MRI 因能对非骨性结构直接显像在临床中广泛应用^[27, 28]。有学者提出术前 MRI 明确颈椎稳定性, 无椎间盘、韧带损伤且无不稳征象患者可选择保守治疗^[16, 24, 29], 本研究发发现不伴有椎间盘、韧带损伤的单侧非移位型关节突骨折术后邻近节段角度易丢失, 因此过分依赖 MRI 评估颈椎稳定性容易忽略不伴有间盘韧带复合体损伤的骨性结构损伤。对于 MRI 无损伤征象节段, 仍需警惕关节突骨折, 有必要扩大 CT 检查范围, 排除非手术节段引起颈椎不稳的骨性结构损伤。另外, 术中 C 型臂 X 线机下动态透视有助于发现非手术节段不稳, 及时调整手术方案^[30]。

由本研究结果可知, 邻近节段相关结构损伤后, 局部后凸角及上、下区域角角度丢失明显加重, 对其分析发现上邻近椎间隙角度丢失是邻近节段角度丢失的主要成分。回顾 CT、MRI, 我们发现此次研究患者邻近节段损伤集中于上邻近第 1 节段, 这与上邻近第 1 椎间隙角度变化最大相符。下颈椎头端与枕寰关节衔接, 尾端靠近胸廓且相对固定, 在暴力作用下靠近头端颈椎前屈程度大, 更容易产生相对位移, 因椎间盘及韧带起到缓冲载荷、限制椎体相对移位作用, 故上邻近节段韧带、骨性结构容易损伤。因此, 对于颈椎外伤患者应充分评估伤椎邻近节段包括骨性及非骨性结构损伤情况, 尤其是上邻近节段, 避免并发术后后凸畸形。

本研究所有患者术前均完成颈椎正侧位 X 线、CT、MRI, 通过 MRI 评估椎间盘、韧带损伤情况, CT 明确骨性结构损伤, 颈椎正侧位 X 线测量各个角度, 减少测量误差, 使测量结果更加准确。当然, 本研究中也存在如下不足: (1) 本次研究所有患者术后均佩戴颈托 3 个月, 在一定程度上有效维持了颈椎生理曲度, 导致 B 组假阴性率增高, 部分危险因素未能充分考虑, 且 A 组样本量小, 需要大样本的随机对照研究、前瞻性研究来进一步阐述各种因素与 ACF 术后邻近节段角度丢失发生的关系; (2) 本研究表明椎间盘破坏可能是导致术后邻近节段后凸的危险因素之一, 需进一步研究阐明不同程度椎间盘损伤的生物力学联系性; (3) 本研究随访时间相对较短, 随访阶段未能评估疼痛等临床症状, 需更长随访时间及相关前瞻性研究证实本研究结论。

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- (收稿日期:2015-11-12 修回日期:2016-01-17)
(英文编审 蒋欣/贾丹彤)
(本文编辑 彭向峰)

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2016 年本刊仍为月刊,大 16 开,正文 96 页,每月 25 日出版。全册铜版纸彩色印刷。每册定价 20 元,全年 240 元。全国各地邮局均可订阅,邮发代号 82-457。国外读者订阅请与中国国际图书贸易总公司中文报刊科联系(100044,北京市车公庄西路 35 号),代号:BM6688。

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