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成人脊柱畸形患者矫正术后力学性并发症发生率及其危险因素分析 *

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摘要 目的：研究成人脊柱畸形患者矫正手术后力学性并发症的发生率以及影响其发生的危险因素。**方法：**纳入 2016 年 6 月到 2020 年 6 月在我院接受脊柱畸形矫正术的患者 80 例，术后对所有患者进行为期 12 个月的随访。根据患者术后随访期间是否出现力学性并发症分为力学并发症组和无力学并发症组，调查两组患者年龄、BMI、术中失血量、手术时间、合并神经损伤、术中截骨、性别、主弯角度、矫正率、手术史、入路以及疾病类型等病历资料，并通过单因素和多因素 Logistic 回归分析成人脊柱畸形矫正术后发生力学性并发症的独立危险因素。**结果：**80 例脊柱畸形矫正术患者术后发生力学性并发症患者 18 例（22.50 %），分别为内固定失败 4 例、近端交界性失败 5 例、远端交界性失败 4 例以及术后冠状面失平衡 5 例。单因素分析结果表明，手术时间（*OR*=6.924，*P*=0.015）、年龄（*OR*=2.803，*P*=0.011）、矫正率（OR=3.215，*P*=0.032）、合并神经损伤（*OR*=1.629，*P*=0.021）、术中截骨术（*OR*=5.876，*P*=0.005）以及手术史（*OR*=1.692，*P*=0.043）与成人脊柱畸形矫正术后力学性并发症的发生有关。多因素 Logistic 回归分析结果表明，手术时间（*OR*=2.265，*P*=0.002）、年龄（*OR*=4.035，*P*<0.001）、合并神经损伤（*OR*=3.024，*P*=0.003）以及术中截骨术（*OR*=3.982，*P*<0.001）是成人脊柱畸形矫正术后发生力学性并发症的独立危险因素。**结论：**成年脊柱畸形患者矫正术后易发生力学性并发症，手术时间较长、年龄较大、合并神经损伤以及术中截骨术均会增加其发生风险。

关键词：脊柱畸形矫正术；力学性并发症；危险因素

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Analysis of the Incidence of Mechanical Complications and Risk Factors in Adult Patients with Spinal Deformity after Correction*

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ABSTRACT Objective: To study the incidence of mechanical complications in adult patients with spinal deformity after corrective surgery and the risk factors that affect their occurrence. **Methods:** Eighty patients who underwent spinal deformity correction surgery in our hospital from June 2016 to June 2020 were included. All patients were followed up for 12 months after the operation. According to whether the patients have mechanical complications during the postoperative follow-up, they are divided into mechanical complication group and non-mechanical complication group. We investigated the medical history data of the two groups of patients such as age, BMI, intraoperative blood loss, operation time, combined nerve injury, intraoperative osteotomy, gender, main curve angle, correction rate, surgical history, surgical approach, and disease type. And we used univariate and multivariate Logistic regression analysis to determine the independent risk factors for mechanical complications after adult spinal deformity correction. **Results:** Mechanical complications occurred in 18 patients (22.50 %) of the 80 patients after spinal deformity correction, including 4 internal fixation failures, 5 proximal junctional filure, 4 distal junctional filure and 5 postoperative coronal plane imbalance. Univariate analysis showed that operative time (*OR*=6.924, *P*=0.015), age (*OR*=2.803, *P*=0.011), correction rate (*OR*=3.215, *P*=0.032), combined nerve injury (*OR*=1.629, *P*=0.021), intraoperative osteotomy (*OR*=5.876, *P*=0.005) and surgical history (*OR*=1.692, *P*=0.043) were associated with mechanical complications after spinal deformity correction in adults. Multivariate Logistic regression analysis showed that operative time (*OR*=2.265, *P*=0.002), age (OR=4.035, *P*<0.001), combined nerve injury (OR=3.024, *P*=0.003), and intraoperative osteotomy (*OR*=3.982, *P*<0.001) was an independent risk factor for mechanical complications after spinal deformity correction in adults. **Conclusion:** Adult patients with spinal deformity are prone to mechanical complications after correction. Long operation time, eld, combined nerve injury, and intraoperative osteotomy all increase their risk.

Key words: Spine deformity correction surgery; Mechanical complications; Risk factors

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前言

脊柱畸形是指脊柱的冠状位、矢状位或者轴向位偏离了原本正常位置而发生形态上的异常。依据引起脊柱畸形的原因可将脊柱畸形分为特发性、先天性、神经肌肉型、间质性以及创伤性等[1-3]。脊柱畸形患者病情随年龄的增长而逐渐加重，且研究发现保守治疗无法有效改善成人脊柱畸形的外观和活动能力，必须进行手术治疗[4-6]。然而，成人畸形手术具有挑战性，会产生大量相关并发症。据报道[7-9]，成人脊柱畸形手术并发症发生率高达 80 %，翻修率高达 28 %，这不仅给患者及其家庭造成严重的经济负担，而且还会降低患者再次治疗的依从性，同时造成医患关系的紧张。成人脊柱畸形手术术后并发症根据性质可被分为力学性并发症和非力学性并发症。非力学性并发症主要包括术后感染伤口不愈合、神经损伤、呼吸衰竭、脑脊液泄漏以及术后认知功能障碍等[10,11]；力学性并发症主要包括内固定失败、近端交界性失败（Proximal junctional filure, PJF）、远端交界性失败（(Distal junctional filure, DJF）、假关节以及术后冠状面失平衡[12,13]。目前关于成人脊柱畸形矫形术后非力学性并发症的发生率以及其危险因素的研究较多[14-16]，而关于力学性并发症的发生率及其发生相关危险因素的研究较少。本研究通过对脊柱矫正术治疗的成人脊柱畸形患者进行术后随访，统计力学性并发症的发生率，并通过单因素和多因素 Logstic 回归分析研究影响成人脊柱畸形矫正术后力学性并发症发生的危险因素，现报道如下。

1 资料与方法

1.1 一般资料

本次研究共纳入进行脊柱畸形矫正术的患者 80 例，时间跨度 2016 年 6 月到 2020 年 6 月，根据术后 12 个月随访期间是否发生力学性并发症分为力学性并发症组和无力学性并发症组。所有患者女性 42 例，男性 38 例，平均年龄（25.68±3.56），特发性脊柱侧凸患者 43 例和先天性脊柱畸形患者 37 例。

纳入标准：（1）年龄 >18 周岁；（2）术后完成 12 个月随访；（3）年龄、BMI、术中失血量、手术时间、合并神经损伤、术中截骨、性别、主弯角度、矫正率、手术史、手术入路以及疾病类型等病历资料完整。

排除标准：（1）合并心、肺、肝以及肾等组织器官功能障碍；（2）合并慢性传染性疾病；（3）术后 12 个月内失联；（4）因其他非力学性并发症再手术或者死亡患者。

1.2 研究方法

所有患者均进行脊柱畸形矫正术，术后进行为期 12 月随访，根据是否发生力学性并发症分为力学性并发症组和非力学性并发症组。本次研究纳入的患者力学性并发症主要包括内固定失败、PJF、DJF 以及术后冠状面失平衡。调查两组患者病历资料：年龄、BMI、术中失血量、手术时间、合并神经损伤（是，否）、术中截骨（是，否）、性别（男，女）、主弯角度、矫正率、手术史（是，否）、手术入路（前路，后路，前路联合后路）以及疾病类型（特发性脊柱侧凸，先天性脊柱畸形）。先经单因素分析确定与脊柱畸形矫正术后力学性并发症相关因素，再通过多因素 Logstic 回归分析单因素分析确定的因素，确定独立危险因素。

1.3 统计学方法

本次研究通过 SPSS20.0 进行分析，以百分比计数资料，卡方检验比较两组计数资料间差异；（均值±标准差）计量资料，对符合正态分布的计量资料使用独立样本 t 检验比较两组间差异。Logstic 回归分析进行多因素分析。$P<0.05$ 表示差异显著具有统计学意义。

2 结果

2.1 力学性并发症发生率

80 例进行脊柱畸形矫正术患者，其中 18 例患者在术后发生力学性并发症，分别为内固定失败患者 4 例，PJK 患者 5 例，DJF 患者 4 例和冠状面失平衡患者 5 例，具体如表 1 所示。

表 1 力学性并发症发生率统计

Table 1 Statistics on the incidence of mechanical complications

Types	n	Ratio
Internal fixation failure	4	5.00 %
PJK	5	6.25 %
DJF	4	5.00 %
Surface imbalance	5	6.25 %
Summation	18	22.50 %

2.2 力学性并发症危险因素

本研究对年龄、BMI、术中失血量、手术时间、合并神经损伤、术中截骨、性别（男性）、主弯角度、矫正率、手术史、手术入路（前路、后路以及前路联合后路）以及疾病类型（特发性脊柱侧凸和先天性脊柱畸形）等成人脊柱畸形矫正术后力学并发症的危险因素进行统计。具体如表 2 所示。

2.3 力学性并发症危险因素的单因素分析

单因素分析结果表明，手术时间（OR=6.924，P=0.015）、年龄（OR=2.803，P=0.011）、矫正率（OR=3.215，P=0.032）、合并神经损伤（OR=1.629，P=0.021）、术中截骨术（OR=5.876，P=0.005）以及手术史（OR=1.692，P=0.043）与成人脊柱畸形矫正术后力学性并发症的发生有关。具体如表 3 所示。

2.4 力学性并发症危险因素的多因素分析

多因素 Logistic 回归分析结果表明，手术时间（OR=2.265，P=0.002）、年龄（OR=4.035，P<0.001）、合并神经损伤（OR=3.024，P=0.003）以及术中截骨术（OR=3.982，P<0.001）是成人脊柱畸形矫正术后发生力学性并发症的独立危险因素。具体如表 4 所示。

表 2 脊柱畸形矫正术后力学性并发症危险因素

Table 2 Risk factors of mechanical complications after spinal deformity correction

Indexs	Mechanical complications		Summation
	Yes	No	
n	18	62	80
Age (years)	32.98±3.28	28.63±3.81	29.61±3.56
BMI (kg/m^2)	19.86±3.66	20.15±2.54	20.08±3.02
Blood loss (mL)	935.23±98.85	932.58±86.72	933.18±93.56
Surgery time (h)	5.15±0.56	4.55±0.42	4.69±0.53
Main bending angle (°)	92.38±4.82	77.23±4.93	80.64±4.89
Correction rate (%)	57.69±3.25	62.65±4.89	61.53±3.98
Nerve injury (n/%)	7/38.89	7/11.29	14/17.50
Female (n/%)	10/55.56	33/53.23	43/53.75
Osteotomy (n/%)	10/55.56	13/20.97	23/28.75
Surgery history (n/%)	7/38.89	7/11.29	14/7.50
Surgical approach (n/%)			
Forward	2/11.11	7/11.29	9/11.25
Back	4/22.22	13/20.97	17/21.25
Forward + Back	12/66.67	42/67.74	54/67.5
Type of disease (n/%)			
Idiopathic scoliosis	10/55.56	33/53.22	43/53.75
Congenital spinal deformity	8/44.44	29/46.77	37/46.25

表 3 脊柱畸形矫正术后力学性并发症危险因素单因素分析

Table 3 Single factor analysis of risk factors for mechanical complications after spinal deformity correction

Indexs	*OR*	*95%CI*	*P*
Age	2.803	1.569-19.203	0.011
BMI	0.692	0.528-1.628	0.528
Blood loss	1.358	0.987-2.032	0.652
Surgery time	6.924	2.359-15.628	0.015
Main bending angle	0.539	0.214-3.539	0.635
Correction rate	3.215	2.013-20.156	0.032
Nerve injury	1.629	0.438-5.628	0.021
Female	1.628	1.035-2.324	0.629
Osteotomy	5.876	3.658-15.628	0.005
Surgery history	1.692	0.237-3.658	0.043
Surgical approach	1.236	1.008-2.256	0.723
Type of disease	3.524	2.389-4.628	0.889

3 讨论

成年人脊柱畸形不仅影响患者美观和活动功能，且会引起疼痛、甚至残疾，严重患者影响生活质量。成年人脊柱畸形可分为轻中度脊柱畸形和重度脊柱畸形，对于轻中度脊柱畸形，由于成人骨骼发育已停止，所以脊柱畸形进展十分缓慢，并且不会对患者心肺功能产生影响，不需要特殊治疗；而对于角度超过 50 度的重度脊柱畸形，即使成人发育停止其也会随年龄增长而逐渐加重，影响心肺功能，造成患者劳动能力丧失和寿命的缩短，因此必须及时进行治疗[17,18]。已有研究表明，保守治疗无法有效根治重度脊柱畸形，患者必须进行外科手术治疗，其中脊柱畸形矫正术是最常见的治疗脊柱畸形的外科手术之一。

表 4 脊柱畸形矫正术后力学性并发症危险因素多因素分析

Table 4 Multivariate analysis of risk factors for mechanical complications after spinal deformity correction

Indexs	*OR*	*95%CI*	*P*
Surgery time	2.265	1.567-8.937	0.002
Age	4.035	1.023-16.827	<0.001
Nerve injury	3.024	2.003-12.035	0.003
Osteotomy	3.982	1.567-13.568	<0.001

然而,由于脊柱畸形矫正术手术操作复杂,手术时间相对较长等原因造成术后并发症高发。研究显示:脊柱畸形矫正术后并发症发生率极高,而翻修率超过 20 %[19,20]。因此,正确认识脊柱畸形矫正术后并发症发生率以及其发生的危险因素对术后患者康复和降低翻修率意义重大。

脊柱畸形矫正术后并发症主要分为力学性并发症和非力学性并发症,其中力学性并发症是造成脊柱畸形矫正术后翻修的主要原因。本研究发现,80 例进行脊柱畸形矫正术的成人患者术后 1 年内共计 18 例患者发生力学性并发症, 发生率为 22.50 %,相较于 Kawabata A 等人[21]的研究力学性并发症的发生率较低。Kawabata A 等人对 202 例实施成人脊柱畸形矫正术的患者进行为期 2 年的随访发现, 共计 92 例患者发生力学性并发症, 发生率为 45.54 %, 显著低于本次研究发现的 22.50 %,这一差异主要由于本次研究术后随访时间为 1 年,而 Kawabata A 等人的术后随访时间为 2 年。此外,Ham D W 等人[22]的研究也同样发现,成人脊柱畸形矫正术后 2 年力学性并发症的发生率为 61 %(51/84)。结合本次研究结果均表明成人脊柱畸形矫正术后力学性并发症发生率较高,应引起重视。本研究单因素分析结果表明,手术时间、年龄、矫正率、合并神经损伤、术中截骨术以及手术史与成人脊柱畸形矫正术后力学性并发症的发生有关;多因素 Logstic 回归分析发现:手术时间、年龄、合并神经损伤以及术中截骨术是成人脊柱畸形矫正术后发生力学性并发症的独立危险因素。这一结果与 Garg M B[23]、钱邦平[24]以及 Shimizu T[25]的研究具有一致性。进一步分析可知: 由于本次研究所纳入的 80 例实施成人脊柱畸形矫正术的患者手术均为同一医生主刀,所以患者病情是影响手术时间的主要因素,脊柱畸形越严重,术前合并症越多,手术越复杂,手术时间就会越长[23]。年龄、肥胖和骨质疏松是影响成人脊柱畸形矫正术后是否发生近端交界性失败的重要危险因素,年龄越大患者骨密度越大, 脊柱畸形矫正术后近端交界性失败的风险越高[24,25]。术前合并神经损伤是重度成人脊柱畸形最常见的合并症之一, 此时的患者脊髓已经受脊柱畸形影响而被压迫,部分脊柱畸形达到顶点的患者此时出现神经黏连周围组织,不仅在脊柱畸形矫正术后会增加神经系统并发症的风险,还会增加内固定失败的风险[26-28]。此时患者的脊髓缺血 - 再灌注损伤抵抗能力降低,并容易导致神经损伤风险的增加。因重度脊柱畸形患者单纯矫正手术无法达到最优的畸形改善效果,必须配合截骨术,然而截骨手术治疗对患者创伤性较大,不仅会增加患者术中出血量, 还会造成术中截骨段移位和骨块残留等,极大的增加了患者术后力学性并发症的发生风险[29,30]。但需指出:由于成人脊柱畸形矫正术病例基数较低,研究术后力学性并发症需进行长期随访,造成本次研究纳入的样本量较小,因此本研究结论尚需大样本量临床数据验证。此外,本次研究随访时间为 1 年,相较于之前的研究较短,还需后期继续随访研究。

综上所述,成人脊柱畸形矫正术后力学性并发症发生率较高;手术时间越长、主弯角度越大、合并神经损伤以及进行术中截骨术的患者术后发生力学性并发症的风险越大。

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