Neurological Comorbidities Predict Proximal Junctional Kyphosis: A Case-Matched Cohort Analysis Performed at a Single Center

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Introduction

Proximal Junctional Kyphosis (PJK) is a common and potentially devastating complication following surgery for adult spinal deformity (ASD). Although proposed prevention strategies include restoration of spinal balance, cement augmentation, and use of softer transitions such as hooks, the effectiveness of these measures has been limited. Recently, we reported that non-mechanical neurological comorbidities play an important role in postoperative sagittal imbalance and PJK. This study was performed to further define the contribution of non-mechanical factors to the occurrence of PJK after ASD.

Methods

We identified a consecutive series of ASD patients who required revision surgery for PJK between 2013 and 2015. A matched cohort of ASD patients that did not develop PJK was identified based upon age, gender, preoperative deformity type and number of fusion levels. We compared medical and surgical histories in the matched cohorts, with particular attention to the prevalence of preoperative neurologic comorbidities that might affect standing balance. Preoperative, immediate postoperative and follow-up radiographs were reviewed to document specific characteristics of mechanical failure that resulted in PJK and required revision surgery.

Table 1

Frequency and prevalence of comorbid conditions that can affect balance			
Comorbid condition	PJK (n=28)	NPJK (n=28)	*p* value †
Prior stroke	4	2	0.355
	14.2%	7.1%	
Metabolic encephalopathy	2	0	0.245
	7.1%	0%	
Parkinson's disease	1	0	0.500
	3.6%	0%	
Seizures	1	0	0.500
	3.6%	0%	
Polymyositis	1	0	0.500
	3.6%	0%	
Diabetic neuropathy	4	2	0.355
	14.2%	7.1%	
Neuropathy	4	5	0.500
	14.2%	17.9%	
Myelopathy	7	2	0.071
	25.0%	7.1%	
Neurological co-morbidities	21	9	**0.001**
	75.0%	32.1%	
Cataract	8	14	0.168
	28.6%	50.0%	
Glaucoma	1	2	0.500
	3.6%	7.1%	

PJK, proximal junctional kyphosis; NPJK, non proximal junctional kyphosis. * Bold type indicates statistical significance. †Comparison among two cohorts.

Results

Twenty-eight cases of PJK requiring revision surgery were identified. The prevalence of pre-operative neurological comorbidities in PJK patients were statistically significantly higher than in non-PJK patients (75% vs. 32%, $p < 0.001$). Neurological comorbidities included prior stroke (4), metabolic encephalopathy (2), Parkinson's disease (1), seizure disorder (1), cervical and thoracic myelopathy (7), diabetic neuropathy (4) and other neuropathy (4). (Table 1) The mean preoperative sagittal vertical axis in PJK patients was more positive compared to non-PJK patients (143mm vs. 65mm, p=0.009). There were no significant differences in immediate postoperative or follow-up radiographic parameters between cohorts (Table 2).

Conclusion

Risk factors identified for the development of PJK included non-mechanical neurological comorbidities, emphasizing the need to look beyond radiographic alignment in order to reduce the incidence of PJK.

Learning Objects

By the conclusion of this session, participants should be able to: 1) Be aware that patients with neurological comorbidities are an "at-risk" population for the development of PJK, 2) Discuss whether that risk can be modified. 3) Look beyond radiographic alignment in order to reduce the incidence of PJK.

Table 2

Radiographical Findings			
Radiographical parameters	PJK (n=7)	NPJK (n=16)	*p* value †
Preoperative parameters			
Preoperative thoracic kyphosis (°)	16.4 ± 12.2	22.8 ± 13.4	0.298
Preoperative lumbar lordosis (°)	15.2 ± 13.0	29.6 ± 19.3	0.053
Preoperative pelvic tilt (°)	28.7 ± 7.1	24.9 ± 10.3	0.385
Preoperative proximal junctional angle (°)	4.8 ± 3.4	8.1 ± 4.8	0.113
Preoperative sagittal vertical axis (mm)	143.6 ± 49.7	64.9 ± 63.4	**0.009**
Immediate postoperative parameters (°)			
Immediate postoperative thoracic kyphosis (°)	30.4 ± 16.0	34.3 ± 17.2	0.619
Immediate postoperative lumbar lordosis (°)	38.1 ± 7.6	42.3 ± 14.1	0.473
Immediate postoperative pelvic tilt (°)	30.4 ± 8.5	25.8 ± 8.9	0.257
Immediate postoperative proximal junctional angle (°)	13.8 ± 7.4	10.7 ± 5.1	0.253
Immediate postoperative sagittal vertical axis (mm)	73.6 ± 30.6	54.1 ± 41.1	0.276
Lumbar lordosis change (°)‡	22.9 ± 17.3	12.7 ± 10.6	0.095
Sagittal vertical axis change (mm)§	-70.0 ± 38.2	-10.8 ± 37.3	**0.002**
Final follow-up parameters (°)			
Final follow-up thoracic kyphosis (°)	34.9 ± 17.8	33.1 ± 14.8	0.789
Final follow-up lumbar lordosis (°)	39.0 ± 7.9	41.4 ± 14.3	0.841
Final follow-up pelvic tilt (°)	29.7 ± 7.1	25.7 ± 8.1	0.268
Final follow-up proximal junctional angle (°)	11.1 ± 5.1	10.9 ± 5.5	0.939
Final follow-up sagittal vertical axis (mm)	98.0 ± 49.8	61.3 ± 52.9	0.071
Pelvic incidence (°)	57.3 ± 10.1	54.4 ± 8.7	0.498

PJK, proximal junctional kyphosis; NPJK, non proximal junctional kyphosis. * Bold type indicates statistical significance. †Comparison among two cohorts. ‡Immediate postoperative lumber lordosis minus preoperative lumber lordosis. §Immediate postoperative sagittal vertical axis minus preoperative sagittal vertical axis.

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