Preoperative Optimization of Modifiable Patient-Related Factors Reduces the Risk of Distal Junctional Kyphosis (DJK): A Virtual Analysis of a Novel Multicenter Complex Adult Cervical Deformity Database

Peter Gust Passias[1], Tobi Onafowokan, Peter Sergeyevich Tretiakov, Christopher Ames, Robert Shay Bess, Douglas C Burton[2], Alan Daniels[3], Bassel Diebo, Robert Kenneth Eastlack, Jeffrey Gum[4], Munish C Gupta[5], D. Kojo Hamilton[6], Robert A Hart[7], Richard A Hostin, Khaled M Kebaish[8], Michael Patrick Kelly, Han Jo Kim, Eric O Klineberg[9], Renaud Lafage[10], Virginie Lafage[10], Lawrence G Lenke[11], Stephen J Lewis[12], Breton G Line[13], Praveen Mummaneni, Gregory Michael Mundis, Pierce Dalton Nunley[14], David Okonkwo, Themistocles Stavros Protopsaltis[15], Frank J Schwab[10], Christopher I Shaffrey[1], Justin S Smith[16], Alexandra Soroceanu, Jay D. Turner[17], Juan Santiago Uribe[18], Michael Y Wang[19], Anthony Yung[1], Max Ray Fisher[1], Jamshaid Mir, International Spine Study Group

[1]Duke University, [2]Univ of Kansas Med Ctr, [3]Brown University, [4]Norton Leatherman Spine Center, [5]Dept. of Orthopedics, [6]University of Pittsburgh School of Medicine, [7]Swedish Neuroscience Institute, [8]Johns Hopkins University, [9]Uthealth Houston, [10]Lenox Hill Hospital, [11]Columbia University/Allen Hospital, [12]Tornoto Western Hospital, [13]Denver International Spine Center, [14]Spine Institute Of Louisiana, [15]NYU Hosptial For Joint Disorders, [16]University of Virginia, [17]Barrow Neurological Institute, [18]University Of South Florida, [19]University of Miami Miller School of Medicine

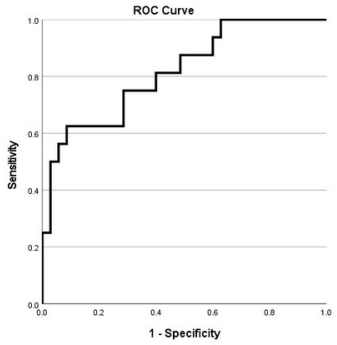
INTRODUCTION: Potentially modifiable patient-related factors may play a significant role in predicting post-operative complications. However, such effects have not been well studied in complex adult cervical deformity (ACD) surgery, especially in the context of distal junctional kyphosis (DJK).

METHODS: Complex ACD patients with baseline (BL) data were included, excluding those indicated for index DJK revision. Virtual risk of DJK was assessed based upon Passias et al. baseline-only factors: 1) prior diagnosis of diabetes, hypertension, or depression 2) presence of baseline neurological impairment 3) Baseline C2-T3 angle >31º). Pre-operative laboratory and comorbidity data correlating to a virtual risk was developed via backstep logistic regression. Conditional Inference Tree (CIT) determined thresholds for significant factors. A count score based on number of optimized variables was then created (Opt Count), with CIT determining threshold associated with DJK risk. Means comparison analysis assessed groups differences in BL patient-reported outcomes and frailty indices [Edmonton, Adult Cervical Frailty Index (ACFI)] in patients considered Optimized (Opt) vs not optimized (nOpt).

RESULTS: 52 ACD patients were included (mean age: 60.4±15.4, sex: 68.8% female, BMI: 27.5±5.8, CCI: 0.95± 1.4). Based upon Passias et al. criteria, 30.8% of patients were predicted to suffer DJK by 2Y post-operatively. Logistic regression revealed significant modifiable demographic, nutritional and metabolic factors predictive of DJK were: BMI <18.5 or >30, total spine DEXA T-score < 1.1, HgA1C > 7.0%, ESR > 15.7, INR > 0.9, Albumin > 4.2, Hematocrit > 41.7 (model p=.010). After calculation of Opt Count, CIT analysis revealed that optimization of a minimum of 3 variables was associated was protective against development of DJK [.727 (.591-.895), p=.003]. Of the total cohort, 73.1% were therefore considered Opt. Baseline analysis of demographic factors revealed that Opt patients were comparable in age, gender, prior history of spine surgery, nor indication for surgery (all p>.05). However, Opt patients with history of thoracolumbar surgery were more likely to have a significantly higher UIV (mean: T4) compare to nOpt patients (p=.036). In terms of HRQLs, though comparable in NDI, PROMIS, VR12, EAT-10, and NRS (all p>.05). Radiographically, Opt and nOpt patients did not differ in global deformity per C7-S1 SVA (p>.05), though nOpt patients did present with significantly greater C2-7 lordosis than Opt patients in standing static imaging (p=.031).

DISCUSSION AND CONCLUSION: Through virtual risk analysis, the present study demonstrates that empiric and potentially modifiable metabolic and nutritional factors, as well as pre-operative bone health, are significantly associated with predicted risk of distal junctional kyphosis by 2Y. As such, surgeons should consider reduction of >3 risk factors pre-operatively to expedite recovery, enhance peri-operative course, and reduce complications in complex adult cervical deformity patients.

Fig 1. ROC Curve of Virtual DJK Risk Prediction



Area Under the Curve

Test Result Variable(s): Predicted probability

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.816	.065	.000	.689	.943

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5