Surgical Outcomes in Rigid versus Flexible Cervical Deformities

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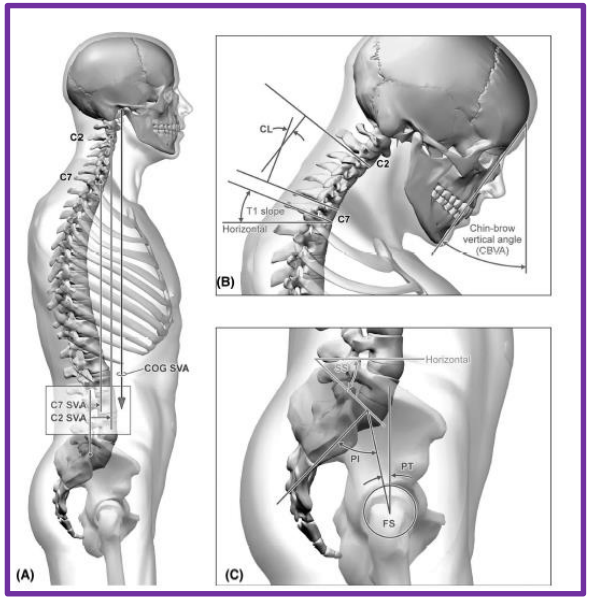
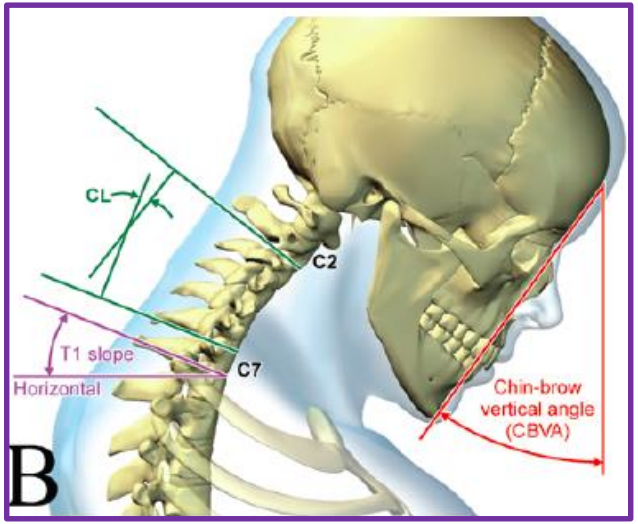
BACKGROUND

- Cervical deformity is debilitating and is challenging to treat
  - Patients with severe cervical deformity (CD) have poor health status, severe pain, and disability
  - Poor Health Related Quality of Life (HRQL) scores
- Little is known regarding how patients with fixed cervical deformity compare to patients with flexible deformity in disability and outcomes



STUDY OBJECTIVES

1. Analyze surgical variables in patients with rigid and flexible CD
2. Analyze complication rates following CD correction of rigid and flexible CD
3. Analyze HRQL scores in patients with rigid and flexible CD



MATERIALS & METHODS

- Operative adult CD patients were consecutively enrolled in a prospective database from 14 sites around the United States.
- Inclusion criteria were patients ≥ 18 years with CD
- CD was defined radiographically as any one of the following:
  - Cervical kyphosis - C2-C7 Sagittal Cobb Angle > 10°
  - Cervical scoliosis - C2-C7 Coronal Cobb Angle >10°
  - C2-C7 sagittal vertical axis (cSVA) > 4cm
  - Chin-brow vertical angle (CBVA) >25°
- Patients with active tumors or infections were excluded from the study

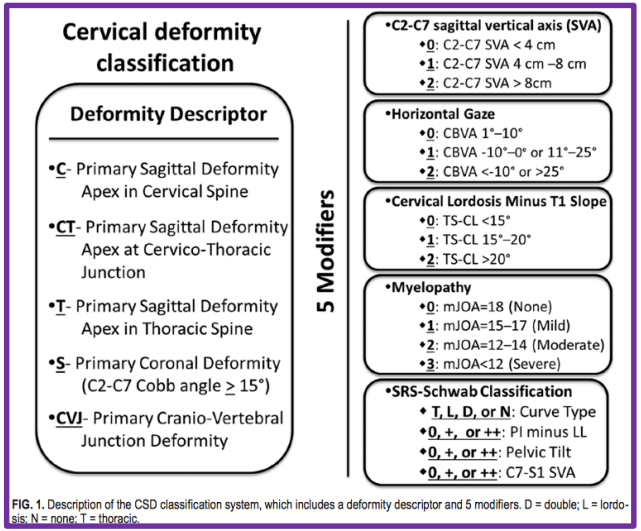


FIG. 1. Description of the CSD classification system, which includes a deformity descriptor and 5 modifiers. D = double; L = lordosis; N = none; T = thoracic.

MATERIALS & METHODS

- Patients were grouped based on the change in cervical lordosis (CL) from extension to flexion:
  - Rigid Deformity: Change in CL < 10°
  - Flexible Deformity: Change in CL > 10°
- Statistical Analysis:
  - Independent T-tests were used to compare continuous variables:
    - Demographic variables
    - Radiographic variables
    - Outcome measures at 1 year follow up
  - Chi-squared tests were used to compare categorical variables

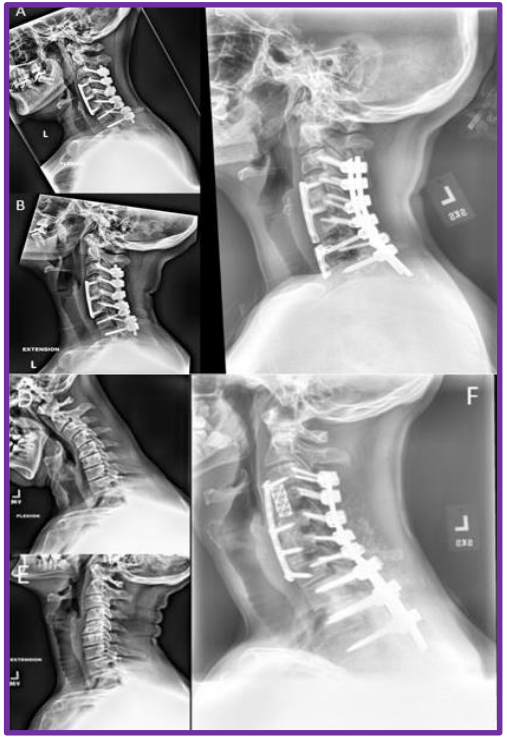


Figure 1 (A-C): Preoperative flexion/extension and postoperative x-rays in a patient with a rigid cervical deformity requiring a PSO at T1. (D-F): Preoperative flexion/extension and postoperative x-rays in a patient with a flexible cervical deformity requiring anterior/posterior fusion C3-T3.

RESULTS: Rigid vs Flexible CD – Demographics

- 127 patients met inclusion criteria
  - 32 rigid patients
  - 95 flexible patients
- No significant differences were found between rigid and flexible CD for baseline demographics

Demographic Information			
	Rigid (N = 32)	Flexible (N = 95)	p-Value
Age	63.05	60.1	0.156
BMI	29.04	26.78	0.304
Gender (%F)	66.70%	62.40%	0.67
Previous Surgery (%)	46.90%	47.40%	0.961
CCI	1.12	2.05	0.336
Smoker (%)	25.90%	35.30%	0.367

RESULTS: Rigid vs Flexible CD – Sagittal Alignment

- Rigid CD patients had significantly worse preoperative alignment compared to flexible CD
  - T1S
  - TS-CL
  - cSVA
  - C2S
- Rigid CD patients had worse cSVA at 1 year than flexible CD patients

	Rigid	Flexible	p-Value
Baseline Alignment			
T1S	38.0	28.1	***0.004***
TS-CL	43.9	34.4	***0.014***
CL	-5.5	-6.3	0.849
cSVA	56.4	43.1	***0.012***
C2S	45.4	34.1	***0.007***
1 Year Alignment			
T1S	40.5	34.2	0.126
TS-CL	31.3	24.9	0.070
CL	9.2	9.4	0.967
cSVA	47.4	37.5	***0.045***
C2S	30.4	23.5	0.069

RESULTS: Rigid vs Flexible CD – Surgical Parameters

- Rigid CD was associated with significantly more complex surgery:
  - Greater EBL
  - Greater levels fused
  - Greater mean osteotomy grade
  - Higher proportion of 3CO

Surgical Parameters			
	Rigid (N = 32)	Flexible (N = 95)	p-Value
Mean Op Time	483.41	484.89	0.98
Mean EBL	1036.72	698.54	***0.04***
Mean Ant Levels Fused	1	2.05	***0.01***
Mean Post Levels Fused	9.53	6.32	***<0.01***
Mean Number of Osteotomies	6.53	4.5041	***0.033***
Mean Osteotomy Grade	3.29	2.08	***<0.01***
Three Column Osteotomy (%)	40.6	12.6	***<0.01***

RESULTS: Rigid vs Flexible CD – Complication Rates

- There was no significant differences found in complication rates for rigid vs flexible CD

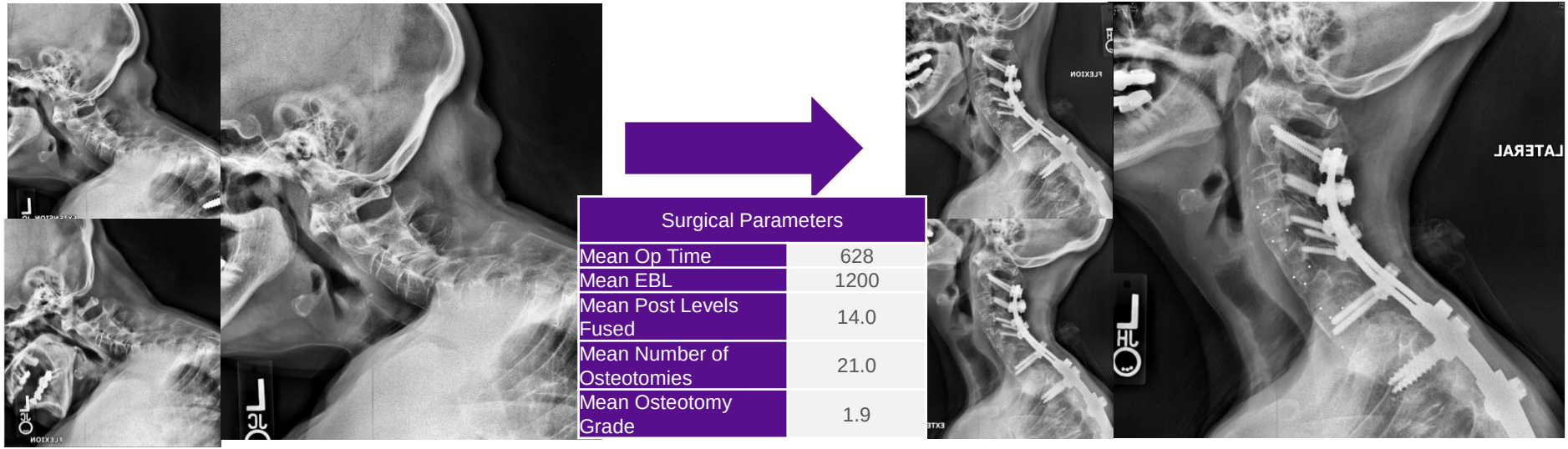
Complication Rates			
	Rigid (N = 32)	Flexible (N = 95)	p-Value
Re-Operation Required (%)	12.50%	11.60%	0.89
DJK Incidence (%)	14.30%	24.20%	0.41
Minor Intra-Op Complications (%)	12.50%	9.50%	0.625
Major Intra-Op Complications (%)	3.10%	5.30%	0.622
Minor Post-Op Complications (%)	34.40%	28.40%	0.52
Major Post-Op Complications (%)	21.90%	20.00%	0.82

RESULTS: Rigid vs Flexible CD – HRQL Scores

- There was no significant difference in baseline HRQL scores in rigid vs flexible CD patients
- Flexible patients improved more at 1 year based on EQ5D
  - Approaching significance

HRQL Scores			
	Rigid (N = 32)	Flexible (N = 95)	p-Value
Baseline			
NSR Neck	7.9	6.9	0.58
NDI	50.9	49.5	0.70
mJOA	12.9	13.8	0.13
EQ5D	0.73	0.73	0.64
Change (Baseline to 1 Year)			
NSR Neck Change	-2.4	-2.7	0.67
NDI Change	-8.4	-13.3	0.25
mJOA Change	0.11	0.62	0.44
EQ5D Change	0.01	0.05	***0.051***

RESULTS: Case Example – Rigid Cervical Deformity



Surgical Parameters	
Mean Op Time	628
Mean EBL	1200
Mean Post Levels Fused	14.0
Mean Number of Osteotomies	21.0
Mean Osteotomy Grade	1.9

Preop Alignment	
T1S	64.6
TS-CL	52.9
CL	11.7
cSVA	81.4
C2S	64.7

Preop and postop radiographs of a patient with rigid CD undergoing CD correction surgery. Rigid CD was associated with greater EBL, greater levels fused, greater utilization of osteotomies, greater utilization of 3CO, and greater cSVA postoperatively

Postop Alignment	
T1S	40.4
TS-CL	12.5
CL	27.9
cSVA	53.2
C2S	11.6

CONCLUSIONS

- Rigid CD patients had worse sagittal alignment:
  - Baseline – worse T1S, TS-CL, cSVA, C2S
  - 1 Year – worse cSVA
- Rigid CD was associated with more complex surgeries than flexible deformity
  - Greater EBL, greater utilization of osteotomies, more levels fused
- Rigid CD was not associated with an increased rate of complications compared to flexible deformity
- Rigid CD was associated with similar HRQL scores as flexible CD
  - Similar baseline disability
  - Similar improvement from baseline to 1 year

Disclosures

- Themistocles S. Protopsaltis
  - (a)Zimmer-Biomet, CSRS (b)Medicrea, NuVasive, Globus, Innovasis
- Frank J. Schwab
  - (b)Zimmer-Biomet (d)K2M, MSD (c,e)Nemaris Inc
- Justin S. Smith
  - (a) AOSpine, NREF (b)Zimmer-Biomet, NuVasive, Cerapedics, K2M
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