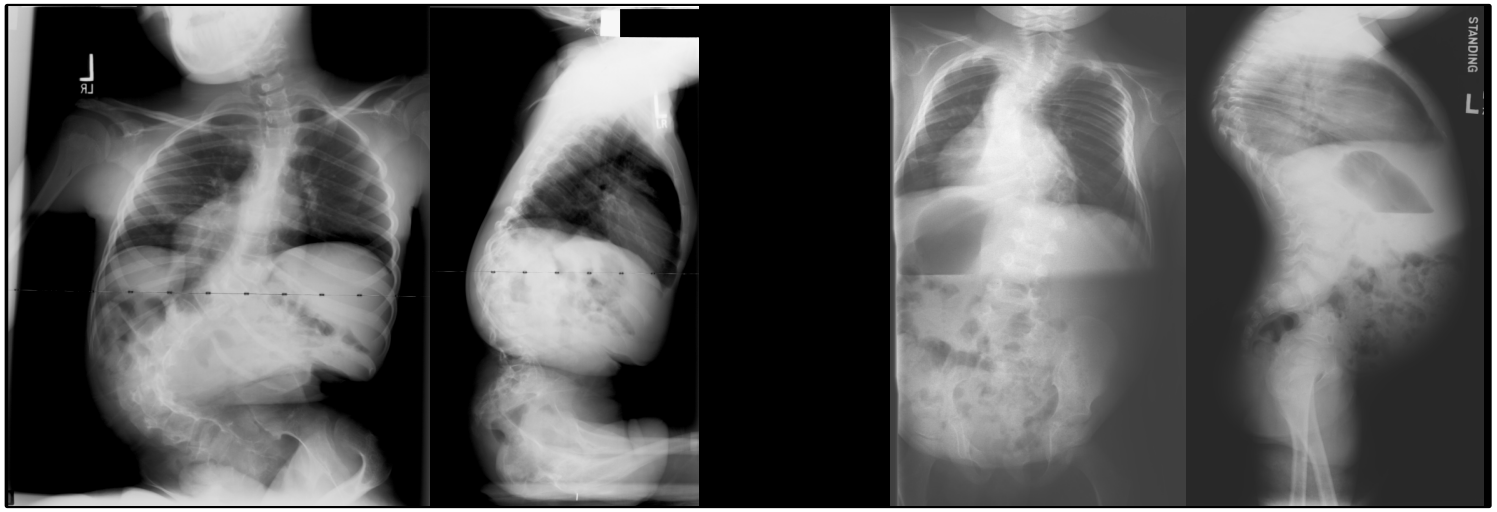
OUTCOMES OF SPINE SURGERY IN PATIENTS WITH CHONDRODYSPLASIA PUNCTATA



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CONDITIONS ASSOCIATED WITH PUNCTATE EPIPHYSES

Pathologic condition	Example	Inheritance
Intrinsic causes		
Cholesterol metabolism disorders	CDPX2	XD
	Smith-Lemli-Opitz syndrome	AR
	CHILD syndrome	XD
	Greenberg dysplasia	AR
Peroxisomal disorders	Rhizomelic CDP types 1-3	AR (Type 3 can be AR or XR)
	Zellweger syndrome	AR
Disorders in vitamin K metabolism	CDPX1	XR
	Mutation in the gene encoding gamma-glutamyl carboxylase	AR
	Vitamin K epoxide reductase deficiency	AR
Lysosomal storage disorders	I-Cell disease	AR
	Galactosialidosis	AR
	GM1 gangliosidosis	AR
Disorders of human matrix protein	Keutel syndrome	AR
Chromosome abnormalities	Trisomy 21	
	Trisomy 18	
	Deletion Xp22.3	
	Monosomy X	
Unknown	Tibia-metacarpal and Humero-metacarpal types	AD
Acquired		
Maternal vitamin K deficiency	Maternal celiac disease, malabsorption, short bowel syndrome	
Maternal exposure	Alcohol	
Maternal autoimmune disease	Systemic lupus erythematosus	
	Mixed connective tissue disease	
	Scleroderma	
Teratogen exposure	Warfarin	
	Phenytoin	
Intrauterine infections	Rubella	
	Cytomegalovirus	

PURPOSE

1. TO PRESENT A MULTICENTER SERIES OF CDP

2. TO DESCRIBE THE MID-TERM SURGICAL OUTCOMES OF SPINAL DEFORMITIES IN THIS PATIENT POPULATION

MATERIALS AND METHODS

RETROSPECTIVE REVIEW OF 13 CDP PATIENTS SEEN BEETWEEN 1975-2011 IN 2 CENTERS

DATA COLLECTED ON: AGE AT DIAGNOSIS
GENDER
CDP TYPE
AGE AT INITIAL SURGERY
LEVELS FUSED
CURVE CORRECTION
CURVE CORRECTION MAINTENANCE
BLOOD LOSS
LENGTH OF F/U

RETROSPECTIVE REVIEW OF 13 CDP PATIENTS SEEN BEETWEEN 1975-2011 IN 2 CENTERS

DIAGNOSIS: SUSPECTED ON CLINICAL EXAMINATION
CONFIRMED RADIOGRAPHICALLY
MRI OF THE SPINE WAS OBTAINED IN ALL PATIENTS REQUIRING SURGERY

CDP SUBTYPES

	Basic Defect	Common Clinical Findings	Radiographic Features	Spine Involvement
CDPX1	Defect in vitamin K-dependent enzyme arylsulfatase E	Nasomaxillary hypoplasia, short distal phalanges, mixed hearing loss, delayed cognitive development. No limb shortening or cataracts	Stippled epiphyses of ankles and distal phalanges, inverted triangular shape of distal phalanges with lateral stippling at the apex, trachea and main stem bronchi calcifications	Cervical stenosis, cervical instability, kyphoscoliosis
CDPX2	Defect in 3β-hydroxysteroid-Δ8-isomerase which catalyses the intermediate step in the conversion of lanosterol to cholesterol	Short stature, frontal bossing, flat nasal bridge, scaling ichthyosis, rhizomelic limb shortening, postaxial polydactyly, asymmetric cataracts, microphthalmia	Stippled epiphyses of long bones, vertebrae, trachea, and distal ends of the ribs	Kyphoscoliosis, tethered cord
Rhizomelic CDP Type 1	Peroxisomal; Mutation in PEX7, the PTS2 receptor	Severe symmetric rhizomelic limb shortening, joint contractures, bilateral cataracts, mental deficiency, growth retardation, early lethality	Stippled epiphyses at knee, hip, elbow, and shoulder, radiolucent coronal clefts of the vertebral bodies on lateral x-rays	Severe kyphoscoliosis in survivors
Rhizomelic CDP Type 2	Peroxisomal; Mutation in gene that encodes dihyroxyacetonephophate acyltransferase	Less severe than Type 1	Less severe than Type 1	Not described
Rhizomelic CDP Type 3	Peroxisomal; Mutation in gene that encodes alkyl-dihydroxyacetonephosphate synthase	Less severe than Type 1	Less severe than Type 1	Not described
Tibia-metacarpal and Humero-metacarpal types	Unknown	Short limbs due to shortening of metacarpals and tibiae or humeri	Short metacarpals and tibiae or humeri	Not described
Maternal Autoimmune Disease	Maternal autoantibodies mediated	Rhizomelic limb shortening, nasomaxillary hypoplasia, pectus carinatum, brachydactyly, camptodactyly,	Stippled epiphyses of the spine, proximal femora, and proximal humeri, sagittal clefts of vertebral bodies, hypoplastic distal phalanges,	Kyphoscoliosis, lordoscoliosis

RESULTS

SPINAL DEFORMITY: 13/17 (76.5%)

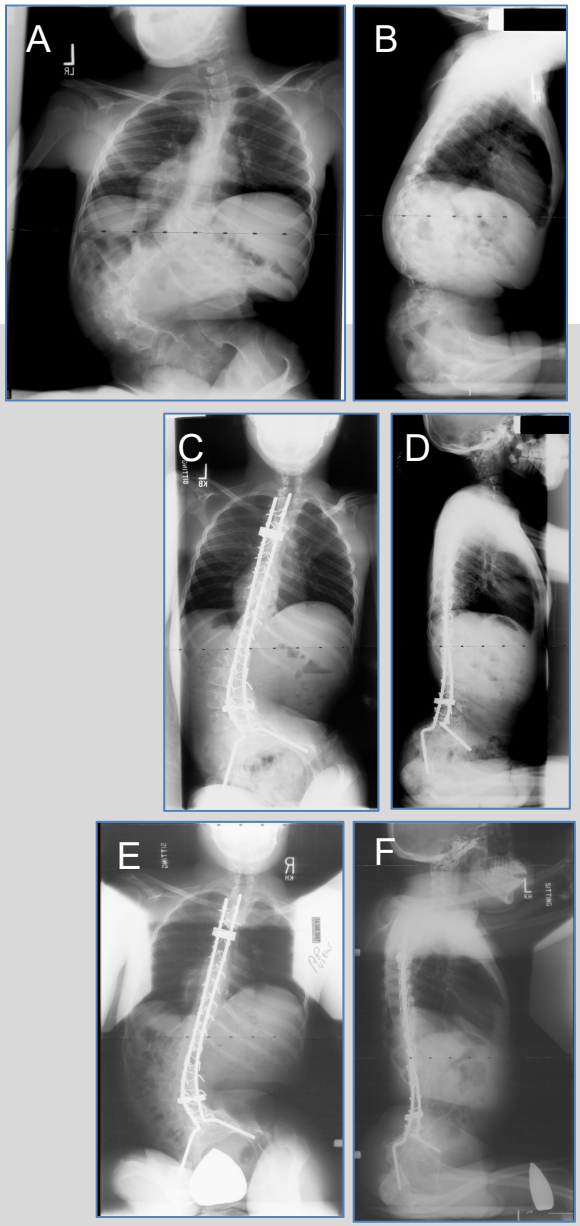
SCOLIOSIS: 13 (100%)

KYPHOSIS: 6 (46%)

AGE AT DIAGNOSIS: 14.6 M (RANGE; 1 W – 9 Y)

CURVE MAGNITUDE AT PRESENTATION: 27° (RANGE; 9°-50°)

FOLLOW-UP: 8.4 Y (RANGE; 2.8 - 195 Y)



PREOPERATIVE POSTEROANTERIOR (A) AND LATERAL (B) RADIOGRAPHS OF THE SPINE OF A 14-YEAR OLD MALE WITH SEVERE THORACOLUMBAR KYPHOSCOLIOSIS AND POSSIBLE DIAGNOSIS OF CDPX1 OR RCDP. POSTEROANTERIOR (C) AND LATERAL (D) FILMS IMMEDIATELY AFTER POSTERIOR SPINAL FUSION WITH LUQUE-GALVESTON INSTRUMENTATION SHOW SIGNIFICANT CORRECTION IN BOTH THE CORONAL AND SAGITTAL PLANE. AT THE LAST FOLLOW-UP, 4.4 YEARS AFTER SURGERY, POSTEROANTERIOR (E) AND LATERAL (F) VIEWS OF THE SPINE DEMONSTRATE EXCELLENT MAINTENANCE OF THE CORRECTION IN BOTH PLANES. HIS FUNCTIONAL OUTCOME IS CONSIDERED GOOD.

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RESULTS

SURGERY: 12/13 (92%)

♂ / ♀ : 7/ 5

AGE AT SURGERY: 77 M (17 – 168 M)

CURVE MAGNITUDE BEFORE SURGERY: 52° (RANGE; 20°-117°)

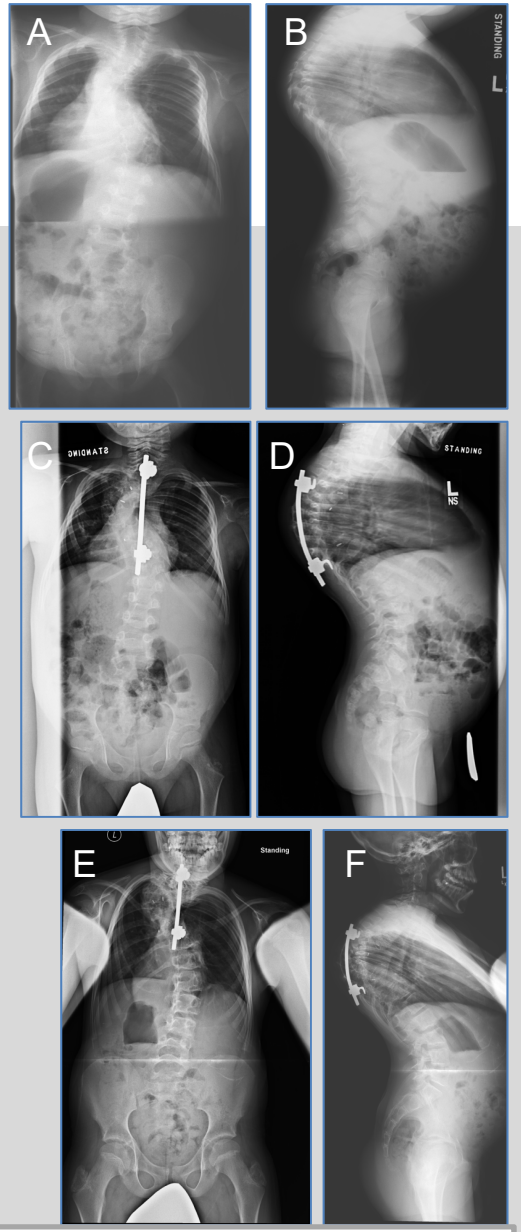
LEVELS FUSED: 9 PER PATIENT (RANGE; 4-16 PER PATIENT)

OPERATIVE TIME: 308 MIN (195 – 420 MIN)

BLOOD LOSS: 298 ML (75 - 900 ML)

 # OF SURGERIES: 2.6 PER PATIENT (1 – 14 PER PATIENT)

> 1 PROCEDURES: 5 PTS (42%)



PREOPERATIVE POSTEROANTERIOR (A) AND LATERAL (B) RADIOGRAPHS OF THE SPINE OF A 3.5-YEAR OLD MALE WITH KYPHOSCOLIOSIS AND POSSIBLE DIAGNOSIS OF CDPX1 OR RCDP. POSTEROANTERIOR (C) AND LATERAL (D) FILMS IMMEDIATELY AFTER COMBINED ANTEROPOSTERIOR FUSION AND INSTRUMENTATION WITH SINGLE ROD SHOW A GOOD CORRECTION IN BOTH THE CORONAL AND SAGITTAL PLANE. AT THE LAST FOLLOW-UP, 10 YEARS AFTER SURGERY, POSTEROANTERIOR (E) AND LATERAL (F) VIEWS OF THE SPINE DEMONSTRATE MILD SCOLIOSIS AND KYPHOSIS PROGRESSION. HIS FUNCTIONAL OUTCOME IS CONSIDERED EXCELLENT.

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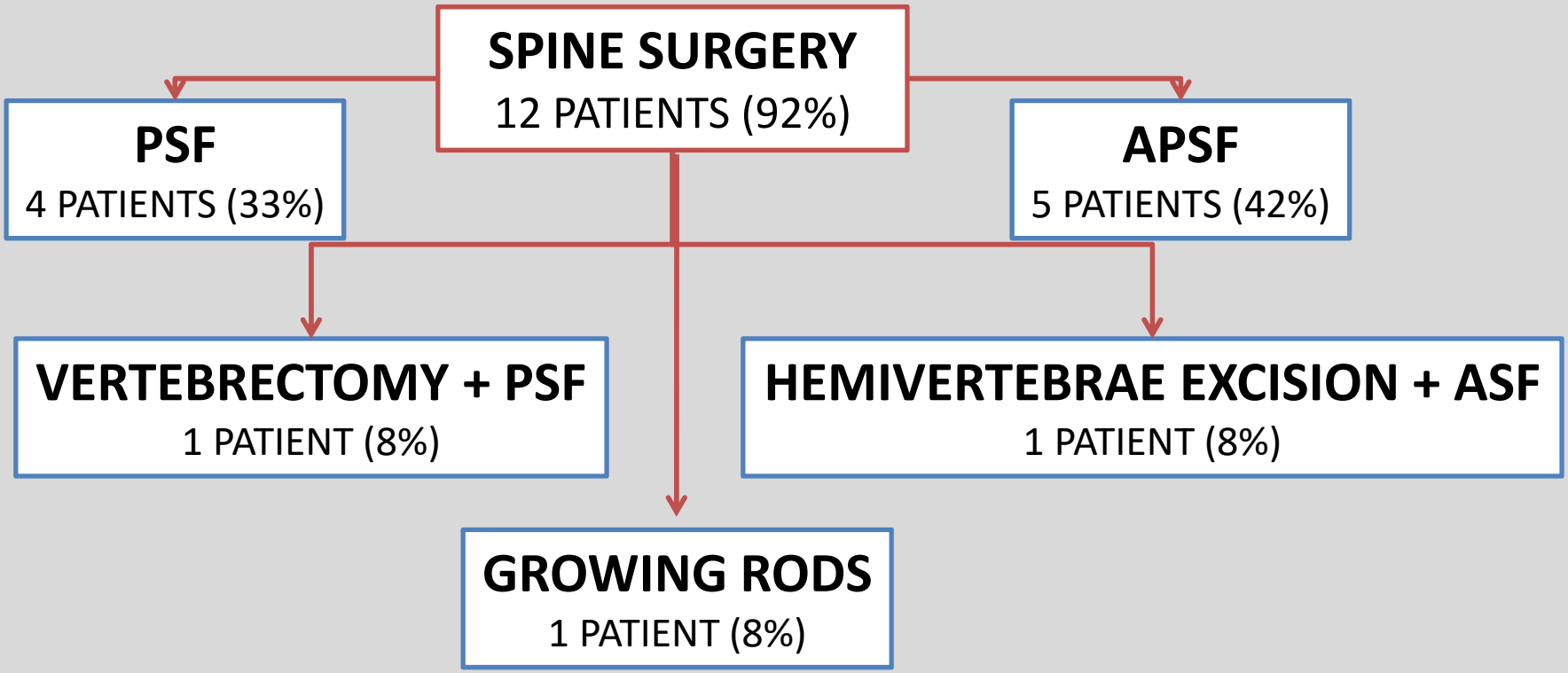
RESULTS


SPINE SURGERY
12 PATIENTS (92%)
PSF
4 PATIENTS (33%)
APSF
5 PATIENTS (42%)
VERTEBRECTOMY + PSF
1 PATIENT (8%)
HEMIVERTEBRAE EXCISION + ASF
1 PATIENT (8%)
GROWING RODS
1 PATIENT (8%)

RESULTS

POST-OP CURVE MAGNITUDE: 40° (14° – 71°) SCOLIOSIS
60° (5° – 130°) KYPHOSIS

POST-OP CURVE CORRECTION: 29% (3 – 62%)

CURVE MAGNITUDE AT LAST F/U: 52° (RANGE; 20°-117°) SCOLIOSIS
65° (9° – 108°) KYPHOSIS

COMPLICATIONS

SPASTIC QUADRIPARESIS IN 1PT. HE UNDERWENT DECOMPRESSION AT AGE 5 M WITH NO EFFECT. 2.5 Y LATER AN ANTERIOR VERTEBRECTOMY OF C3 AND C4 WAS PERFORMED WITH RIB STRUT GRAFT, WITH LIMITED IMPROVEMENT OF HIS NEUROLOGIC FUNCTION

SUMMARY OF PATIENT DATA

No	Gender	Probable Type	Spinal Deformity	Age at Diagnosis (months)	Age at Initial Surgery (months)	Initial Surgical Procedure	Levels Fused	Length of Surgery (minutes)	EBL (ml)	Pre-operative Curve (degrees)		Curve at last Follow-up (degrees)		Length of Follow-up (years)	Subsequent Surgeries
										Scoliosis	Kyphosis	Scoliosis	Kyphosis		
1	M	CDPX1 or RCDP	Yes	10	36	laminectomy (T11, T12, and L1), vertebrectomy (T11 and T1), and instrumented PSF (T10-L1)	T10-L1	310	150	39	63	-	46	3	None
2	F	CDPX2	Yes	At Birth	42	Hemivertebrae excision (T7 and T11) and instrumented ASF (T6-T12)	T6-T12	Unknown	Unknown	Unknown	Unknown	88	100	2.8	1. Repeat anterior fusion (T6-L1) and PSF (T6-L2) 2. Removal of posterior instrumentation
3	F	Tibia-metacarpal Type	No	At Birth	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	None
4	F	CDPX2	Yes	At Birth	108	Instrumented PSF	T6-L1	330	300	36	130	43	108	9	1. Anteroposterior fusion 2. Revision of anterior fusion
5	M	CDPX1	No	At Birth	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	M	CDPX1 or RCDP	No	At Birth	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	M	CDPX1 or RCDP	Yes	At Birth	72	Instrumented APSF	T5-T12	330	400	14	<50	14	<50	15	None
8	F	CDPX2	Yes	17	72	Instrumented PSF	T2-L2	210	75	22	<50	Unknown	90	19.5	None
9	F	CDPX2	No	At Birth	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	M	CDPX1 or RCDP	Yes	At Birth	17	Non-instrumented ASF with strut graft and in situ PSF	T3-T8	260	75	N/A	72	50	50	3.7	None
11	M	CDPX1 or RCDP	Yes	49	168	PSF with Luque-Galveston instrumentation	T3-pelvis	335	900	117	43	70	9	4.4	None
12	M	CDPX1 or RCDP	Yes	Unknown	104	Growing rods (claw constructs T3-T4 and pedicle screws L3-L4)	None	360	100	43	98	35	86	5.6	*(see below)
13	F	CDPX2	Yes	6	45	Halo traction for 5 months followed by anterior release (T6-T12) and instrumented PSF (T2-L1)	T2-L1	420	170	71	93	53	81	4.0	ASF with rib strut graft (T4-T12) and revision of PSF due to loss of proximal fixation and kyphotic progression 10 months after the initial procedure
14	M	CDPX1 or RCDP	Yes	108	N/A	N/A	N/A	N/A	N/A	N/A	N/A	53	N/A	17.0	N/A
15	F	CDPX2	Yes	12	72	PSF with sublaminar wires	T8-L3	195	455	40	49	47	26	10.8	Implant exchange with Harrington instrumentation (T6-L3) due to failure of the proximal and distal wires and subsequent rod sliding 4 months after the initial procedure
16	M	CDPX1 or RCDP	Yes	8	42	Halo traction for 10 weeks followed by ASF (T4-T10) and PSF (T3-T11) with single rod	T3-T11	250	150	72	79	78	88	10.0	None
17	M	CDPX1 or RCDP	Yes	24	147	ASF (T6-T12) with morselized rib and PSF (T6-L2) with TSRH instrumentation	T6-L2	390	500	53	43	40	29	3.8	None

CONCLUSIONS

1. THE PRESENT STUDY CONFIRMS THAT SPINAL DEFORMITY IN CPD-ASSOCIATED CONDITIONS MAY RANGE FROM SIGNIFICANT KYPHOSCOLIOSIS TO MINIMAL DEFORMITY THAT DOES NOT REQUIRE ANY TREATMENT

2. FOR THOSE PATIENTS IN WHOM SPINE SURGERY IS INDICATED, A HIGH INCIDENCE OF REVISION SURGERY AND CURVE PROGRESSION AFTER FUSION IS EXPECTED

3. ALTHOUGH SPINAL DEFORMITY AND NEED FOR SURGERY ARE CLOSE TO EQUALLY DISTRIBUTED BETWEEN MALES AND FEMALES, FEMALE PATIENTS WITH PROBABLE DIAGNOSIS OF CDPX2 ARE MORE LIKELY TO REQUIRE A SECOND SURGICAL PROCEDURE

4. THE MEAN NUMBER OF SPINE SURGERIES PER PATIENT WAS 2.6 WHICH IS IN ACCORDANCE WITH PREVIOUS STUDIES. HOWEVER, WHEN WE EXCLUDE THE PATIENT WHO WAS INITIALLY TREATED WITH GROWING RODS AND REQUIRED A TOTAL OF 14 PROCEDURES, THE MEAN NUMBER OF SPINE SURGERIES DECREASED TO 1.5 SURGERIES PER PATIENT WHICH IS SIGNIFICANTLY LESS THAN THE REPORTED IN THE LITERATURE

5. IN THE MAJORITY OF PATIENTS REQUIRING REPEATED PROCEDURES (75%) A SEVERE CURVE OF MORE THAN 90º WAS PRESENT PREOPERATIVELY

6. ISOLATED POSTERIOR FUSION SHOWED LESS FAVORABLE RESULTS COMPARED WITH COMBINED APSF IN TERMS OF REVISION SURGERY

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