


Pedicle Subtraction Osteotomy

John M. Small MD
Florida Orthopedic Institute
University South Florida
Department Orthopedic Surgery
Castellvi Spine May 11, 2017




Case JB

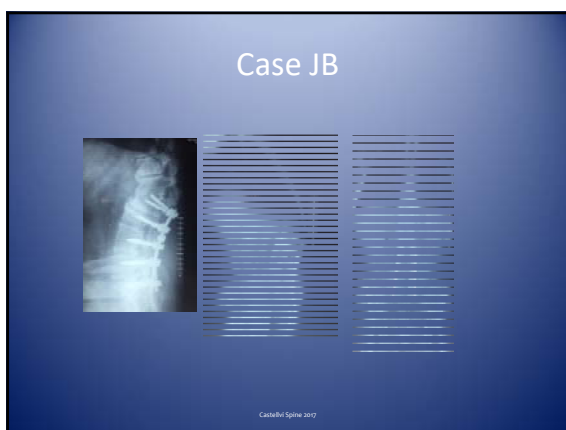
- 66 y/o male 74" 235 lbs
- Retired police officer
- C/O low back pain, bilateral leg pain with weakness, numbness and tingling.
- S/P fusion L2-S1 in 2004
 - History of smoking 3 ppd (stopped 10 years ago)

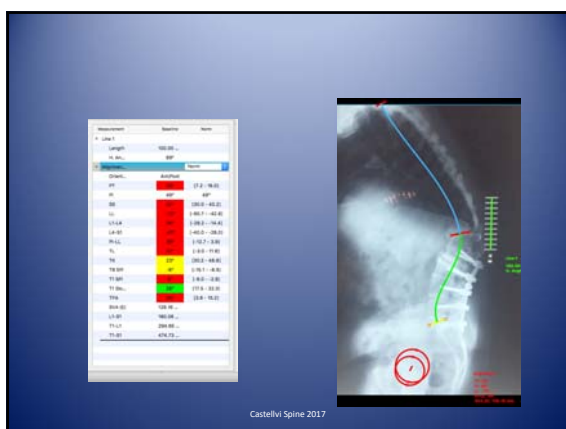
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Case: What we know

- Fixed deformity L2-S1 and PJK
- SVA- 13cm
- PT- 29
- LL-10
- PI- 49
- PI-LL= 39

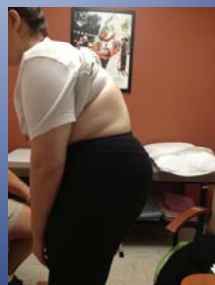


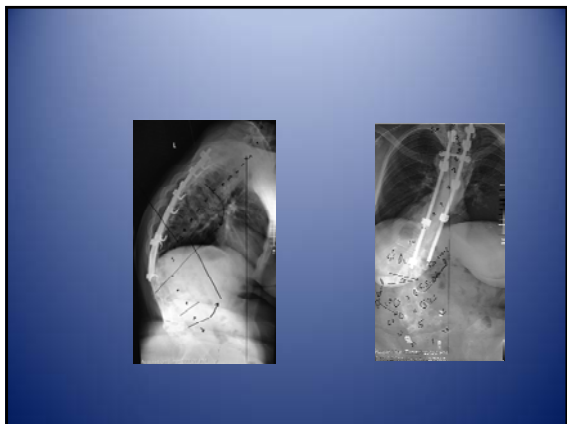
Spinal Alignment

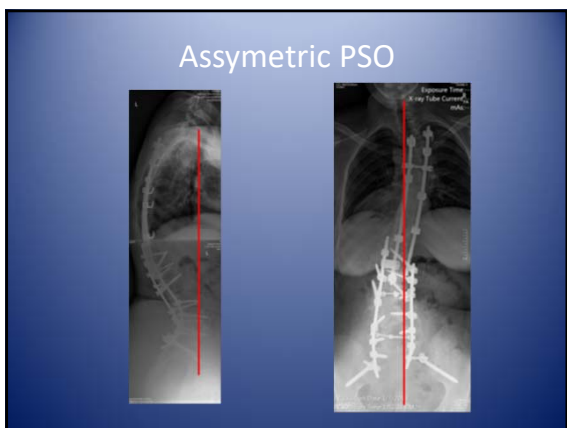
- Sagittal Profile
 - Ideal – all spinal parameters normal
 - Compensated Sagittal- Local or regional deformity. Sag balance maintained (CAM < 2cm)
 - Global Sagittal Imbalance – Can't stand without assistive device



N.Ambrose et al, Surg Radiol Anat (2009) 31: 781-792





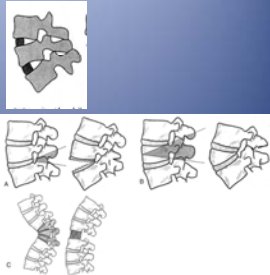


Challenges of Reconstructing Sagittal Imbalance

- Elderly Patient
- Co morbidities
 - PVD
 - Organ failure
 - DM
 - Inflammatory conditions
- Nutrition
- Extensive Pain Management
- Obesity
- Habits
- Beliefs
- Social situation
- Previous Surgery
- Surgical Procedure(s)
 - Surgeon Skill
 - Resources / Hospital
 - Approach
 - Single, 360, 540 etc
 - Technical Aspect
 - Equipment
 - Fusion levels
 - OSTEOTOMY?

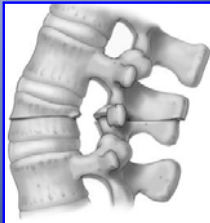
Spine Osteotomies

- Smith Petersen Osteotomy
- **Pedicle Subtraction Osteotomy**
- Vertebral Body Resection



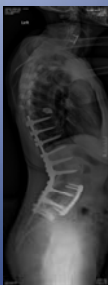
PSO

- Originally described for AS
- Correction
 - three column
 - posterior (one) approach
- maximizing the healing potential
- avoid stretching major vessels and viscera



PSO


- Average correction
 - 30-40° at a single segment
- **Indications**
 - Mostly lumbar level
 - ideal candidates for PSO
 - sagittal imbalance of >10 to 12 cm
 - a sharp, angular kyphosis
 - circumferential fusion, multiple segments



Bridwell KH
Spine (Phila Pa 1976). 2006 Sep 1; 31(19 Suppl):S171-8.

Technical Aspects of PSO

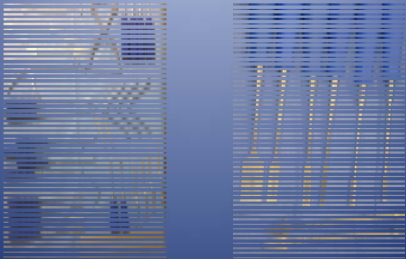
- Extensive Pre op planning
- 2 Skilled Surgeons
- Blood and Blood Products Available
- TXA
- Hinged OR Table (Axis Jackson Table)
- Osteotomy Set



Axis Jackson Table

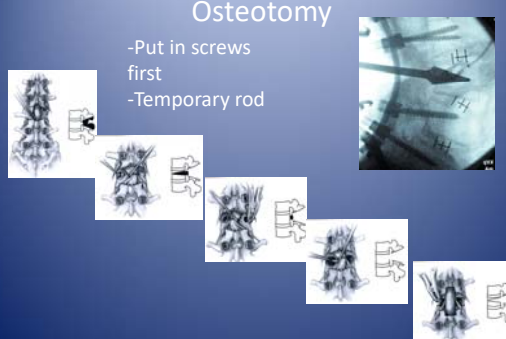


Osteotomy Set



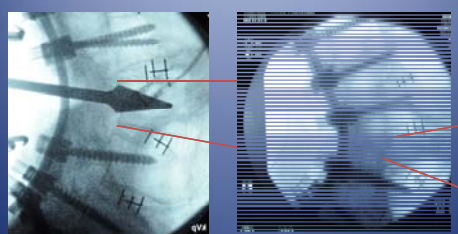
Controlled Steps In Pedicle Subtraction Osteotomy

-Put in screws first
-Temporary rod

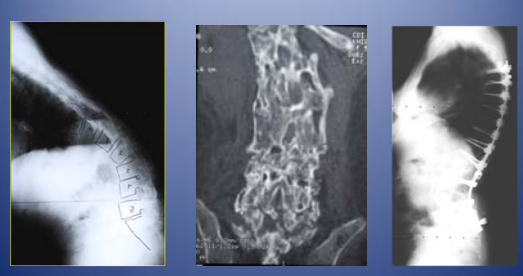


Brodwell et al, Pedicle Subtraction Osteotomy For Treatment of Fixed Sagittal Imbalance, JBJS, March 2004 v 86A

PSO




ALF L3-S1, PSO L2 and L4



PSO Complications

- Early
 - Death
 - Neurological Deficit
 - Excessive Blood Loss/Coagulopathy
 - Wound Infection
 - CSF Leak
 - DVT
 - Post op Respiratory Distress
 - Fluid Overload
 - Cardiac
 - MI
 - Failure
 - Arrhythmia
 - Stroke /Ischemia
 - Incomplete Correction of Sagittal Alignment / over correction?
 - Ileus
 - Brachial Plexus Injury
 - Visual Deficit
 - Great Vessel Injury
- Late
 - Vertebral Body Compression Fracture
 - Adjacent Level Breakdown / Kyphosis
 - Prominent/ painful Iliac Screws
 - Hardware Failure / Loosening
 - Non union
 - Breakdown L5/S1 – Fusion Stopped at L5




Spine (Phila Pa 1976), 2008 Sep 15;36(25):2179-84. doi: 10.1097/SPS.0b013e3181710428.

Proximal junctional kyphosis in adult spinal deformity after segmental posterior spinal instrumentation and fusion: minimum five-year follow-up.

Kim TJ, Bridwell KH, Leung JG, Ghaembari O, Finkelstein S, Chah G, Washington University Medical Center, St. Louis, Missouri, USA.


- The prevalence of PJK at 5+ years postop was **39%**.
- PJK progressed
 - significantly within **8 weeks** postop (59%)
 - between 2 years postop and ultimate follow-up (35%)
 - Older age at surgery (>55 years) and combined anterior and posterior spinal fusion
 - SRS Outcome Data adversely affected if PJK>20 degrees



OUTCOME AND COMPLICATIONS OF PEDICLE SUBTRACTION OSTEOTOMY IN CASES WITH SINGLE VERSUS TWO ATTENDING SURGEONS

Sassan, Keshavarzi; Deviren,Vedat; Ames, Christopher University of California San Francisco, Ca

- RESULTS: **75 PSO** (**37 single surgeon and 38 two surgeon**)
 - mean number of levels: posterior spinal fusion (8.82 vs 8.05)
 - spinal decompression (2.71 vs. 3.18)
 - EBL (mean)
 - single surgeon **4604 ml**
 - two surgeons **1970 ml** (P-value<0.0003)
 - Average surgical time:
 - single surgeon **432 min** (7.21 hrs)
 - two surgeons **291 min** (4.85 hrs) (P-value <0.0001).



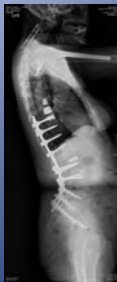
OUTCOME AND COMPLICATIONS OF PEDICLE SUBTRACTION OSTEOTOMY IN CASES WITH SINGLE VERSUS TWO ATTENDING SURGEONS *Sassan, Keshavarzi; Deviren,Vedat; Ames, Christopher University of California San Francisco, Ca*

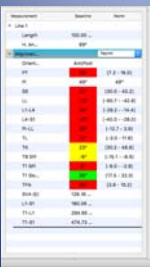
- Conclusion:
 - 2 experienced surgeons working simultaneously:
 - reduces operative time and blood loss.
 - decreased infection and other medical complication
- **Less stress**





PSO Retrospective Review

- 2 Experienced Surgeons
- 42 Patients over 7 years
 - Average Age: 60.3
 - 31 with Previous Spine Surgeries
- Avg. Surgery Time **6:57**
 - 417 min (including anesthesia)
- Avg. EBL: **1784ml**
- Avg. Blood Given: 2.8units
- Complications: 8 dural tears, 1 death, 1 PE, 1 deep infection





Case #	Age	Sex	Height	Weight	Time	EBL	Blood	Comp
101	60	M	178	75	417	1784	2.8	8
102	62	F	165	65	420	1800	3.0	9
103	58	M	180	80	415	1750	2.7	7
104	61	F	170	70	425	1850	3.1	10
105	59	M	175	72	410	1700	2.6	6
106	63	F	168	68	422	1820	3.0	9
107	60	M	172	70	418	1760	2.7	8
108	61	F	166	66	421	1810	2.9	9
109	59	M	174	71	416	1730	2.7	7
110	62	F	169	69	423	1830	3.1	10
111	60	M	176	73	419	1770	2.8	8
112	61	F	167	67	424	1840	3.1	10
113	59	M	173	72	417	1740	2.7	7
114	62	F	168	68	426	1860	3.2	11
115	60	M	171	70	414	1710	2.6	6
116	61	F	165	65	427	1870	3.2	11
117	59	M	174	71	415	1720	2.6	6
118	62	F	166	66	428	1880	3.3	12
119	60	M	172	70	416	1730	2.6	6
120	61	F	167	67	429	1890	3.3	12



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Correcting Sagittal Balance

- Restore C7 plumb line
 - Goal SVA < +5cm
- Restore spinopelvic alignment
 - Goal PT < 20 degrees
 - Goal LL = PI \pm 9 degree

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Single PSO

Level	SVA	PT	LL
C7	12.2	16.0	17.2
T1	10.5	15.5	16.5
T2	11.8	16.2	17.0
T3	13.1	17.0	17.8
T4	14.5	17.8	18.5
T5	15.9	18.5	19.2
T6	17.3	19.2	19.9
T7	18.7	20.0	20.6
T8	20.1	20.8	21.3
T9	21.5	21.5	22.0
T10	22.9	22.2	22.7
T11	24.3	23.0	23.4
T12	25.7	23.8	24.1
T13	27.1	24.5	24.8
T14	28.5	25.2	25.5
T15	29.9	26.0	26.2
T16	31.3	26.8	26.9
T17	32.7	27.5	27.6
T18	34.1	28.2	28.3
T19	35.5	29.0	29.0
T20	36.9	29.8	29.7
T21	38.3	30.5	30.4
T22	39.7	31.2	31.1
T23	41.1	32.0	31.8
T24	42.5	32.8	32.5
T25	43.9	33.5	33.2
T26	45.3	34.2	33.9
T27	46.7	35.0	34.6
T28	48.1	35.8	35.3
T29	49.5	36.5	36.0
T30	50.9	37.2	36.7
T31	52.3	38.0	37.4
T32	53.7	38.8	38.1
T33	55.1	39.5	38.8
T34	56.5	40.2	39.5
T35	57.9	41.0	40.2
T36	59.3	41.8	40.9
T37	60.7	42.5	41.6
T38	62.1	43.2	42.3
T39	63.5	44.0	43.0
T40	64.9	44.8	43.7
T41	66.3	45.5	44.4
T42	67.7	46.2	45.1
T43	69.1	47.0	45.8
T44	70.5	47.8	46.5
T45	71.9	48.5	47.2
T46	73.3	49.2	47.9
T47	74.7	50.0	48.6
T48	76.1	50.8	49.3
T49	77.5	51.5	50.0
T50	78.9	52.2	50.7
T51	80.3	53.0	51.4
T52	81.7	53.8	52.1
T53	83.1	54.5	52.8
T54	84.5	55.2	53.5
T55	85.9	56.0	54.2
T56	87.3	56.8	54.9
T57	88.7	57.5	55.6
T58	90.1	58.2	56.3
T59	91.5	59.0	57.0
T60	92.9	59.8	57.7
T61	94.3	60.5	58.4
T62	95.7	61.2	59.1
T63	97.1	62.0	59.8
T64	98.5	62.8	60.5
T65	99.9	63.5	61.2
T66	101.3	64.2	61.9
T67	102.7	65.0	62.6
T68	104.1	65.8	63.3
T69	105.5	66.5	64.0
T70	106.9	67.2	64.7
T71	108.3	68.0	65.4
T72	109.7	68.8	66.1
T73	111.1	69.5	66.8
T74	112.5	70.2	67.5
T75	113.9	71.0	68.2
T76	115.3	71.8	68.9
T77	116.7	72.5	69.6
T78	118.1	73.2	70.3
T79	119.5	74.0	71.0
T80	120.9	74.8	71.7
T81	122.3	75.5	72.4
T82	123.7	76.2	73.1
T83	125.1	77.0	73.8
T84	126.5	77.8	74.5
T85	127.9	78.5	75.2
T86	129.3	79.2	75.9
T87	130.7	80.0	76.6
T88	132.1	80.8	77.3
T89	133.5	81.5	78.0
T90	134.9	82.2	78.7
T91	136.3	83.0	79.4
T92	137.7	83.8	80.1
T93	139.1	84.5	80.8
T94	140.5	85.2	81.5
T95	141.9	86.0	82.2
T96	143.3	86.8	82.9
T97	144.7	87.5	83.6
T98	146.1	88.2	84.3
T99	147.5	89.0	85.0
T100	148.9	89.8	85.7



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2 PSOs

Level	SVA	PT	LL
C7	12.2	16.0	17.2
T1	10.5	15.5	16.5
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T17	32.7	27.5	27.6
T18	34.1	28.2	28.3
T19	35.5	29.0	29.0
T20	36.9	29.8	29.7
T21	38.3	30.5	30.4
T22	39.7	31.2	31.1
T23	41.1	32.0	31.8
T24	42.5	32.8	32.5
T25	43.9	33.5	33.2
T26	45.3	34.2	33.9
T27	46.7	35.0	34.6
T28	48.1	35.8	35.3
T29	49.5	36.5	36.0
T30	50.9	37.2	36.7
T31	52.3	38.0	37.4
T32	53.7	38.8	38.1
T33	55.1	39.5	38.8
T34	56.5	40.2	39.5
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T62	95.7	61.2	59.1
T63	97.1	62.0	59.8
T64	98.5	62.8	60.5
T65	99.9	63.5	61.2
T66	101.3	64.2	61.9
T67	102.7	65.0	62.6
T68	104.1	65.8	63.3
T69	105.5	66.5	64.0
T70	106.9	67.2	64.7
T71	108.3	68.0	65.4
T72	109.7	68.8	66.1
T73	111.1	69.5	66.8
T74	112.5	70.2	67.5
T75	113.9	71.0	68.2
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T77	116.7	72.5	69.6
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