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Odontoid Fractures and Other Cervical Trauma: Geriatric Considerations

Vishal Khatri, MD
Division of Spine Surgery
Department of Orthopaedic Surgery
Cooper Bone and Joint Institute
Cooper University Health Care

Cooper Bone & Joint Institute

- no disclosures

Outline

- The Aging Spine
  - Osteoporosis Evaluation and Treatment
- Geriatric Odontoid Fractures
- Central Cord Syndrome

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The Aging Spine

- Population > 65 years old was 43.1 million in 2012 → increase to 83.7 million by 2050

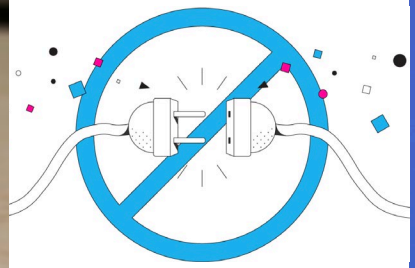
Fragility Fractures

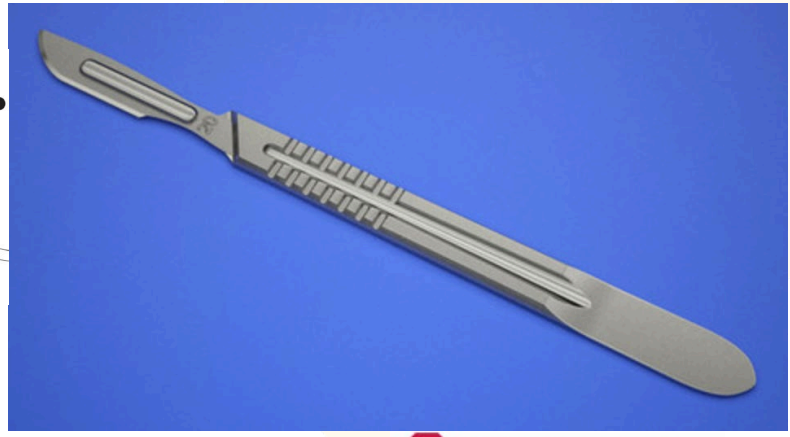
J Clin Densitom. 2014 Oct-Dec;17(4):479-83. doi: 10.1016/j.jocd.2014.01.009. Epub 2014 Mar 20.

Screening and treatment of osteoporosis after hip fracture: comparison of sex and race.

Antonelli M[1], Einstadter D[2], Magrey M[2].

- Only 19% of patients received treatment for osteoporosis after hip fracture surgery
- Women were nearly 3 times more likely to receive treatment than men (23.2% vs 8%, p=0.004)





Risk Factors for Osteoporosis

- Female gender
- Petite body frame
- White or Asian ancestry
- Sedentary lifestyle/immobilization
- Nulliparity
- Increasing age
- High caffeine intake
- Renal disease
- Lifelong low calcium intake
- Smoking
- Excessive alcohol use
- Long-term use of certain drugs
- Postmenopausal status
- Low body weight
- Impaired calcium absorption

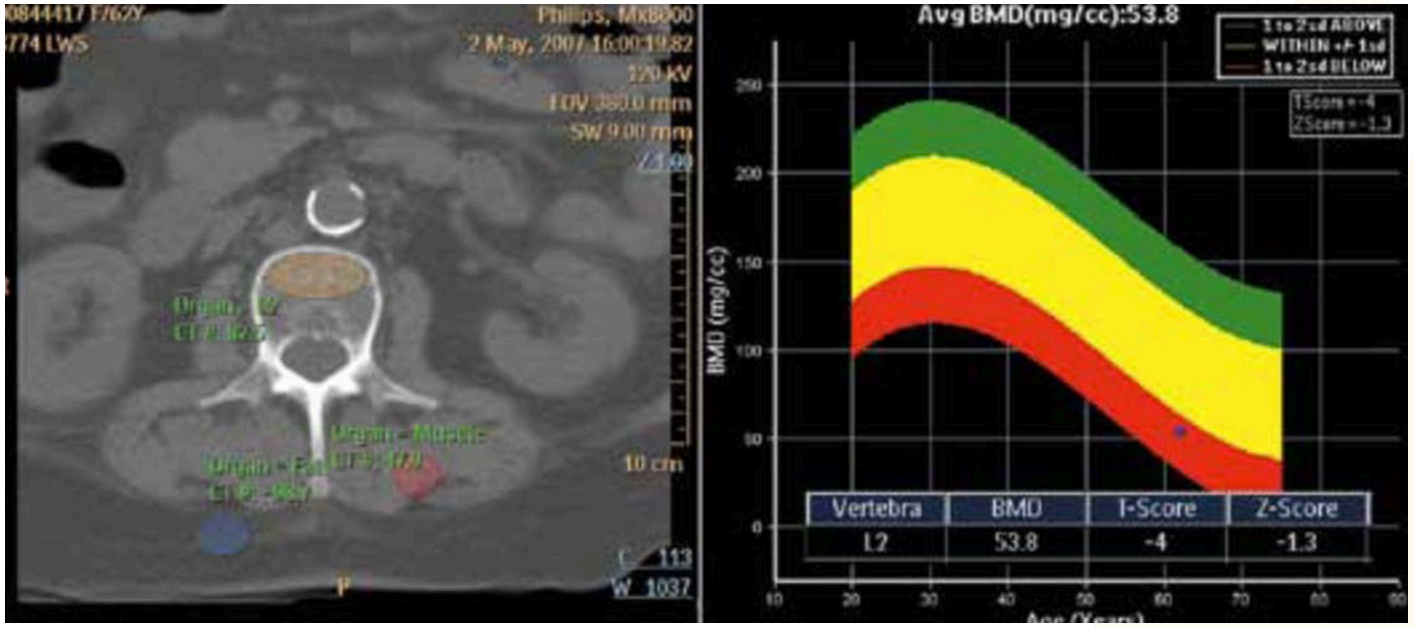
Osteoporosis Evaluation

- The U.S. Preventive Services Task Force recommends using DEXA screening on:
  - ALL women > 65
    - Rescreening every 4 years if normal bone mineral density
  - younger women who have an increased fracture risk as determined by the World Health Organization's FRAX Fracture Risk Assessment Tool.
  - insufficient evidence to recommend screening for osteoporosis in men; other organizations recommend screening all men 70 years and older.

FRAX® Fracture Risk Assessment Tool

Population	Recommendation	Grade (What's This?)
Women age 65 years and older	The USPSTF recommends screening for osteoporosis with bone measurement testing to prevent osteoporotic fractures in women age 65 years and older.	B
Postmenopausal women younger than age 65 years at increased risk of osteoporosis	The USPSTF recommends screening for osteoporosis with bone measurement testing in postmenopausal women younger than age 65 years who are at increased risk of osteoporosis, as determined by a formal clinical risk assessment tool.	B
Men	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening for osteoporosis to prevent osteoporotic fractures in men.	I

Quantitative CT to assess bone mineral density as a diagnostic tool for osteoporosis and related fractures



Normal BMD > 120 mg/cc

Osteopenia < 120 mg/cc

Osteoporosis < 80 mg/cc

Very high fracture risk < 50 mg/cc.

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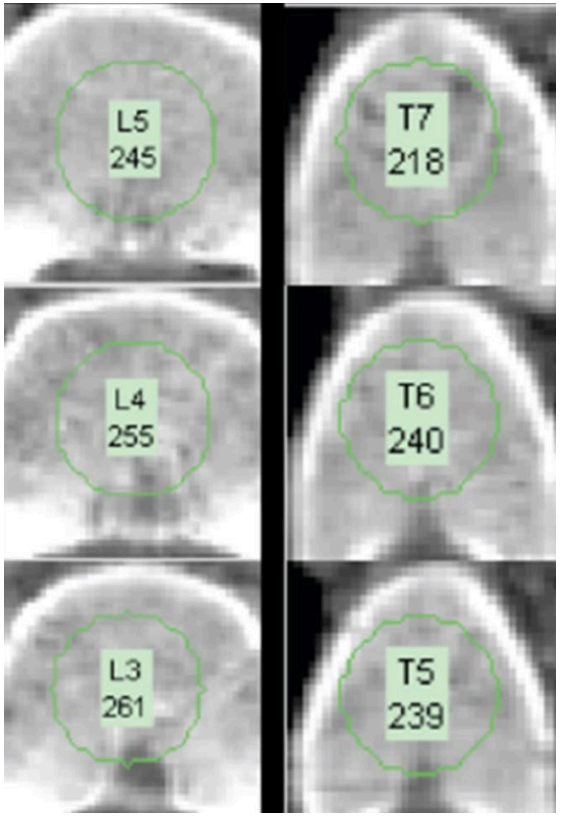
Normative Vertebral Hounsfield Unit Values and Correlation with Bone Mineral Density

Shaun P. Patel[1*], John J. Lee[2], Garin G. Hecht[3], Sven A. Holcombe[4], Stewart C. Wang[4] and James A. Goulet[5]



		Hounsfield Units			
		DXA Automated Reports		DXA Radiology Reports	
Classification	T-Score	Mean ± SD	95% CI	Mean ± SD	95% CI
Normal	Greater than -1.0	195.7 ± 55.5	171.4 – 220.0	189.3 ± 58.9	159.5 – 219.1
Osteopenia	Between -1.0 and -2.5	118.9 ± 29.1	98.7 – 139.0	139.4 ± 48.8	109.2 – 169.7
Osteoporosis	Less than -2.5	97.9 ± 58.8	54.4 – 141.5	107.2 ± 60.4	65.3 – 149.0

Notes: Values of $P < 0.001$ between automated groups and $P < 0.01$ between radiology groups. DXA, dual x-ray absorptiometry.

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Nutrition

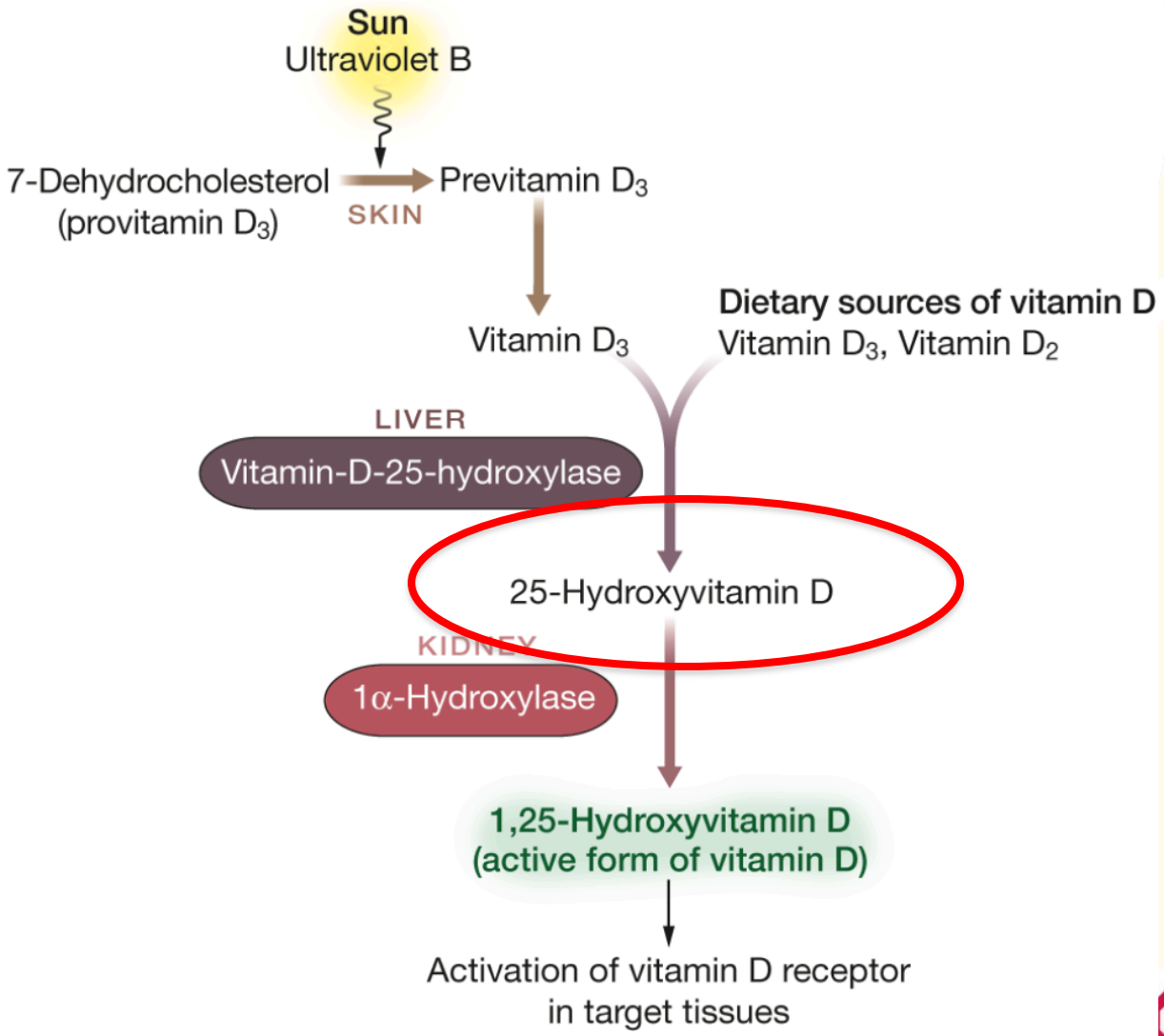
- Routinely recommending vitamin D supplementation for all spine fusion patients (especially those aged > 65 years) may be the most efficient way to ensure that a patient will have a sufficient level at the time of surgery

Recommended Daily Allowances for Vitamin D and Calcium From the Institute of Medicine, 2011[13]

Age Group (yr)	Vitamin D	Calcium
Men and women aged 19–70	600 IU	1,000 mg for men 1,200 mg for women
Men and women aged >70	800 IU	1,200 mg

Vitamin D Status	Blood Level
Deficient	0-30 ng/ml
Insufficient	31–39 ng/ml
Sufficient	40-80 ng/ml
Toxic	>150 ng/ml

Vitamin D Metabolism



Laboratory Evaluation

- Complete Metabolic Panel (Cr, Ca)
- TSH and free T4
- PTH
- 25-OH-Vit D

Vitamin D Status	Blood Level
Deficient	0-30 ng/ml
Insufficient	31–39 ng/ml
Sufficient	40-80 ng/ml
Toxic	>150 ng/ml

Evaluation of Secondary Osteoporosis

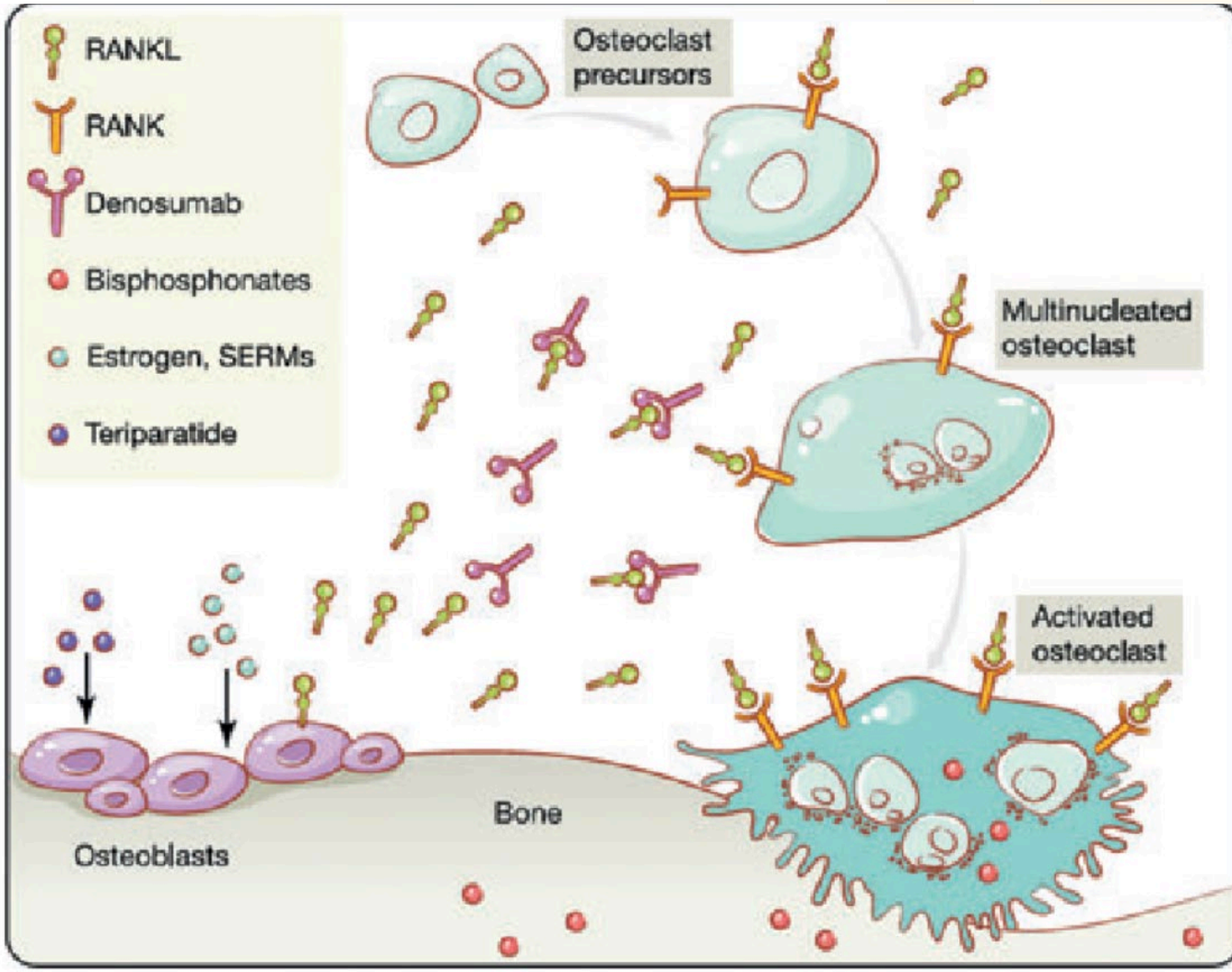
ABNORMAL STUDY RESULT	*SUGGESTED PATHOLOGY*
Increased creatinine level	Renal disease
Increased hepatic transaminase levels	Hepatic disease
Increased calcium level	Primary hyperparathyroidism or malignancy
Decreased calcium level	Malabsorption, vitamin D deficiency
Decreased phosphorus level	Osteomalacia
Increased alkaline phosphatase level	Liver disease, Paget's disease, fracture, other bone pathology
Decreased albumin level	Malnutrition
Decreased TSH level	Hyperthyroidism
Increased ESR	Myeloma
Anemia	Myeloma
Decreased 24-hour calcium excretion level	Malabsorption, vitamin D deficiency

Treatment – Non-Pharmacological

- Behavior Modification
  - Smoking Cessation
  - Reduce Caffeine intake
  - Reduce/Eliminate Alcohol Consumption
- Exercise
- Sunlight

Treatment - Pharmacological

- Ca/Vitamin D
- Calcitonin
- Bisphosphonates
- Raloxifene (Evista)
- Teriparitide (Forteo)
- Denosumab (Prolia)



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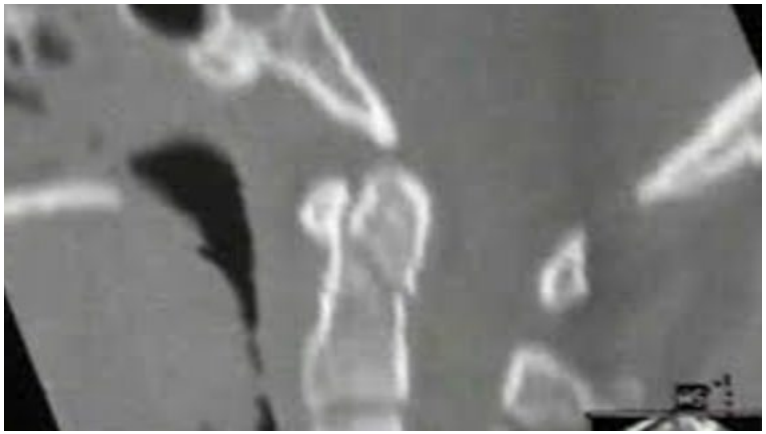
- **Geriatric Odontoid Fractures**
- Central Cord Syndrome

Geriatric Odontoid Fractures



67 year old healthy male

- Very active
- Avid tennis player, mountain biker
- Neck pain
- No deficits
- Isolated injury

85 year old female

- Sedentary
- Nursing home resident
- Mild dementia
- Household ambulator
- Minimal neck pain

Geriatric Odontoid Fractures

- Odontoid fractures are the most common cervical spine fracture in adults aged > 70 years
- Usually result of low-energy, ground-level fall
  - Head trauma → extension injury
  - Blunt trauma patients > 65 are 2X more likely to have C-spine injuries than younger patients
- Increasingly prevalent with an aging population

Geriatric Odontoid Fractures

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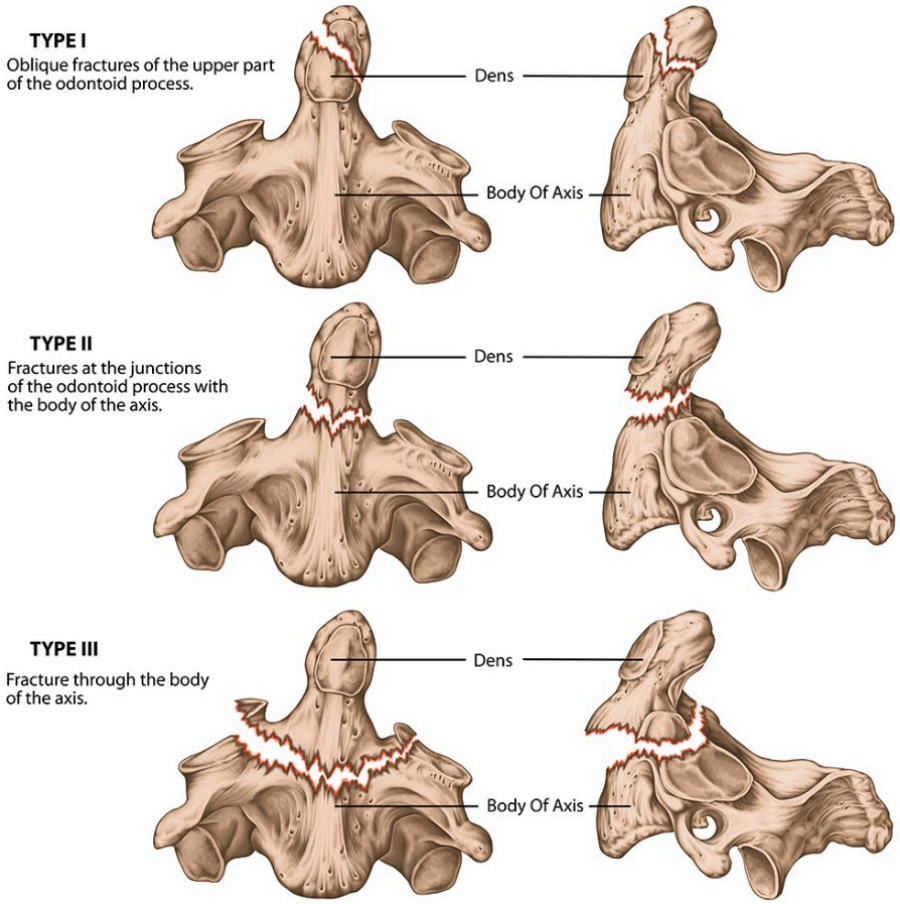
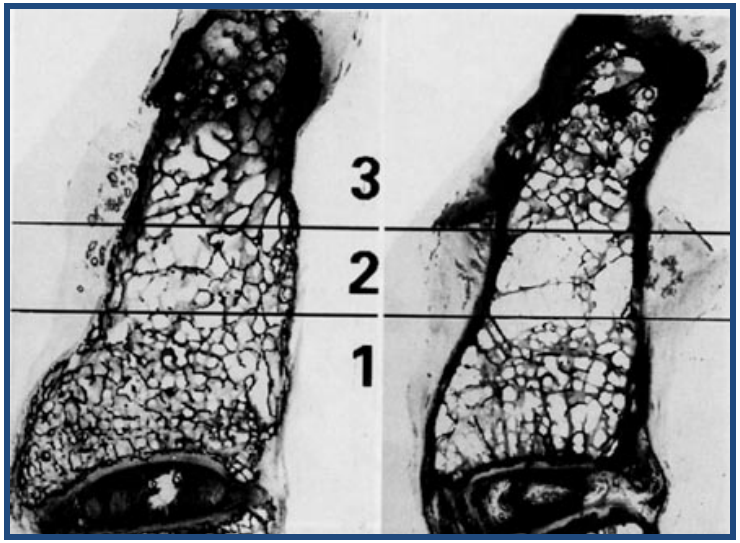
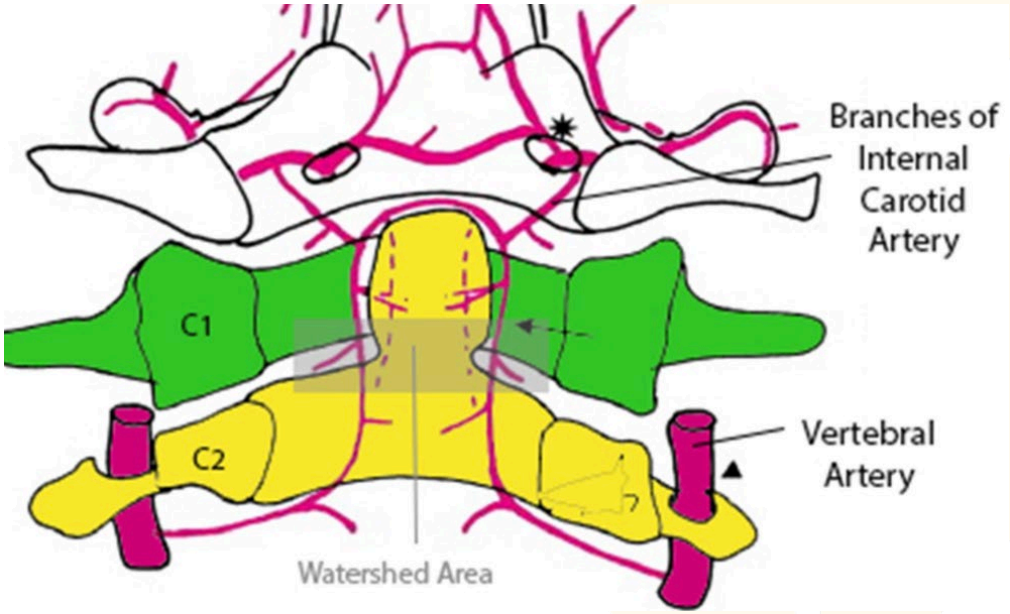


Geriatric Odontoid Fractures

- The management of type II odontoid fractures is CONTROVERSIAL with no consensus

- Watershed area with relatively poor blood supply for type II dens fractures





Non-operative Treatment

- An option in elderly with comorbidities
- 2 options:
  - Hard Cervical Collar
  - Halo-vest Orthosis

Non-operative Treatment - Halo

Halo-Vest Immobilization Increases Early Morbidity and Mortality in Elderly Odontoid Fractures

Robert Z. Tashjian, MD, Sarah Majercik, MD, Walter L. Biffl, MD, Mark A. Palumbo, MD, and William G. Cioffi, MD

66% Complication rate & 40% Mortality rate

Halo Vest Immobilization in the Elderly: A Death Sentence?

Sarah Majercik, MD, Robert Z. Tashjian, MD, Walter L. Biffl, MD, David T. Harrington, MD, and William G. Cioffi, MD

- Pin-site infections
- Pin loosening-ring slippage
- Pressure sores
- Nerve injury
- Headache
- Aspiration

- Re-dislocations/instability
- Pneumonia
- Dysphagia
- PE
- Dural perforation-CSF leak
- Intracranial abscess
- Seizure
- Respiratory decline

Non-operative Treatment - Hard Collar

SPINE Volume 25, Number 10, pp 1234–1237

Management of Type II Dens Fractures

A Case-Control Study

Peter J. Lennarson, MD,* Homan Mostafavi, BS,* Vincent C. Traynelis, MD,* and Beverly C. Walters. MD†

Table 2. Nonsignificant Variables

	P Value*
Sex	0.27
Displacement < 5 mm, ≥ 5 mm	0.14
Direction a = 1, n = 0, p = −1	0.81

* Fisher's Exact test, two-tailed.

Table 4. Contingency Table for Age of Cases and Controls

Age	Cases	Controls	Total
$<$ 50 years	1	15	17
$\geq$ 50 years*	10	7	16
Total	11	22	33

$P = 0.002$ (Fisher's Exact test, two-tailed).
Odds ratio = 21.4**. 21 times more likely to fail halo immobilization if age $\geq$ 50.
* The risk factor in this analysis is age $\geq$ 50.

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Non-operative Treatment – Hard Collar

- High non-union rates (17-63%)
  - 21X risk of non-union in older patient
- Risk Factors for Non-union
  - Displacement > 5mm
  - Angulation > 10 deg
  - Age > 50
  - Fracture comminution
  - Delayed Surgery (> 2mo)
  - Smoking

Factors associated with nonunion in conservatively-treated type-II fractures of the odontoid process

J Bone Joint Surg [Br] 2004;86-B:1146-51.

Non-operative Treatment – Hard Collar

Rigid cervical collar treatment for geriatric type II odontoid fractures

Robert W. Molinari · Oner A. Khera · William L. Gruhn · Ryan W. McAssey

Eur Spine J (2012) 21:855–862

- Retrospective review of 34 patients with < 50% displacement treated with hard collar for 12 wks
  - Avg age 84.9 yrs
- Results at 15 months:
  - 6% (2) had evidence of fracture healing
  - 12% (4) mortality rate
  - 70% (21) had mobile non-union (avg 2.5mm on flex-ex)
  - No difference in NDI between healed fx, mobile non-union or age-matched cohort groups
- Fracture healing and stability did not correlate with improved outcomes with respect to levels of pain, function, and satisfaction.

Non-operative Treatment

- Many small retrospective studies with support for non-operative treatment

…HOWEVER…

- Recent data shows increase survivorship
- View odontoid fracture as “sentinel event”

Type II Odontoid Fractures of the Cervical Spine

Do Treatment Type and Medical Comorbidities Affect Mortality in Elderly Patients?

Andrew J. Schoenfeld, MD,* Christopher M. Bono, MD,† William M. Reichmann, MA,‡ Natalie Warholic, MA,§ Kirkham B. Wood, MD,¶ Elena Losina, PhD,|| Jeffrey N. Katz, MD, MSc,** and Mitchel B. Harris, MD, FACS††

- 152 patients age 65+ with type II odontoid fractures
  - 44 treated surgically (28%)
  - 112 treated non-surgically (72%)
- Overall 3-year mortality was 39%
- Lower mortality in operatively treated group
  - 11% vs 25% @ 3 months
  - 21% vs 36% @ 1 year

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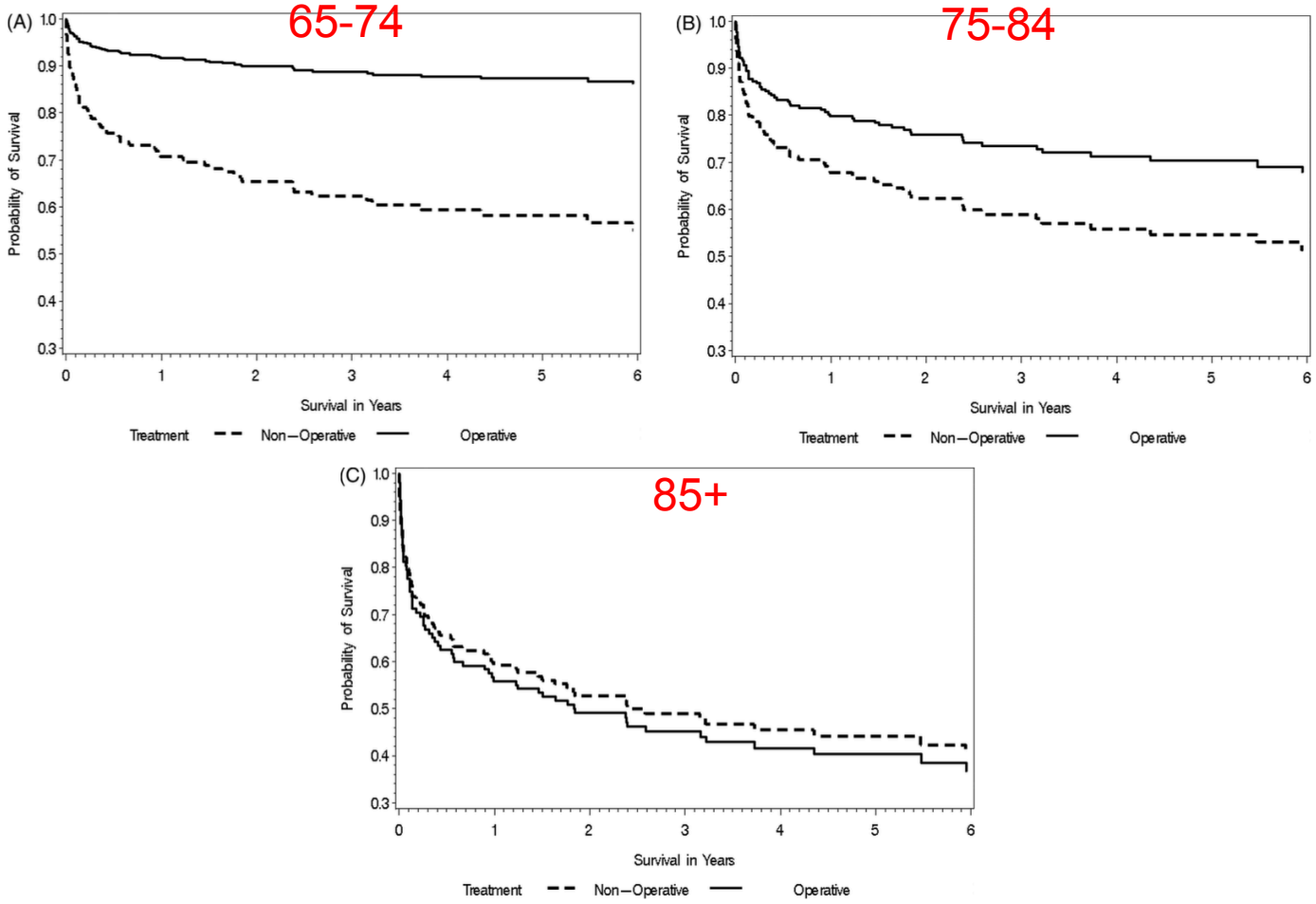

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The AOSpine North America Geriatric Odontoid Fracture Mortality Study

SPINE Volume 38, Number 13, pp 1098–1104

A Retrospective Review of Mortality Outcomes for Operative Versus Nonoperative Treatment of 322 Patients With Long-Term Follow-up

Jens Chapman, MD,* Justin S. Smith, MD, PhD,‡ Branko Kopjar, MD, PhD,† Alexander R. Vaccaro, MD, PhD,§ Paul Arnold, MD,¶ Christopher I. Shaffrey, MD,‡ and Michael G. Fehlings, MD, PhD‖

- Retrospective study of patients > 65 w/type II odontoid fracture from 3 level I trauma centers from 2003–2009
  - Mean age 82
  - 165 operative (mean f/u 851 days)
  - 157 non-operative (mean f/u 648 days)
- Short-term and long-term mortality analysis

Short-term Analysis (30 day)

TABLE 3. 30-day Mortality Rates for 322 Geriatric Patients With Type II Odontoid Fracture, Stratified on the Basis of Sex and Operative *Versus* Nonoperative Treatment

Variable	Died (N = 46)	Alive (N = 276
Sex		
Male	18 (13%)	116 (87%)
Female	28 (15%)	160 (85%)
Treatment		
Operative	11 (7%)	154 (93%)
Nonoperative	35 (22%)	122 (78%)

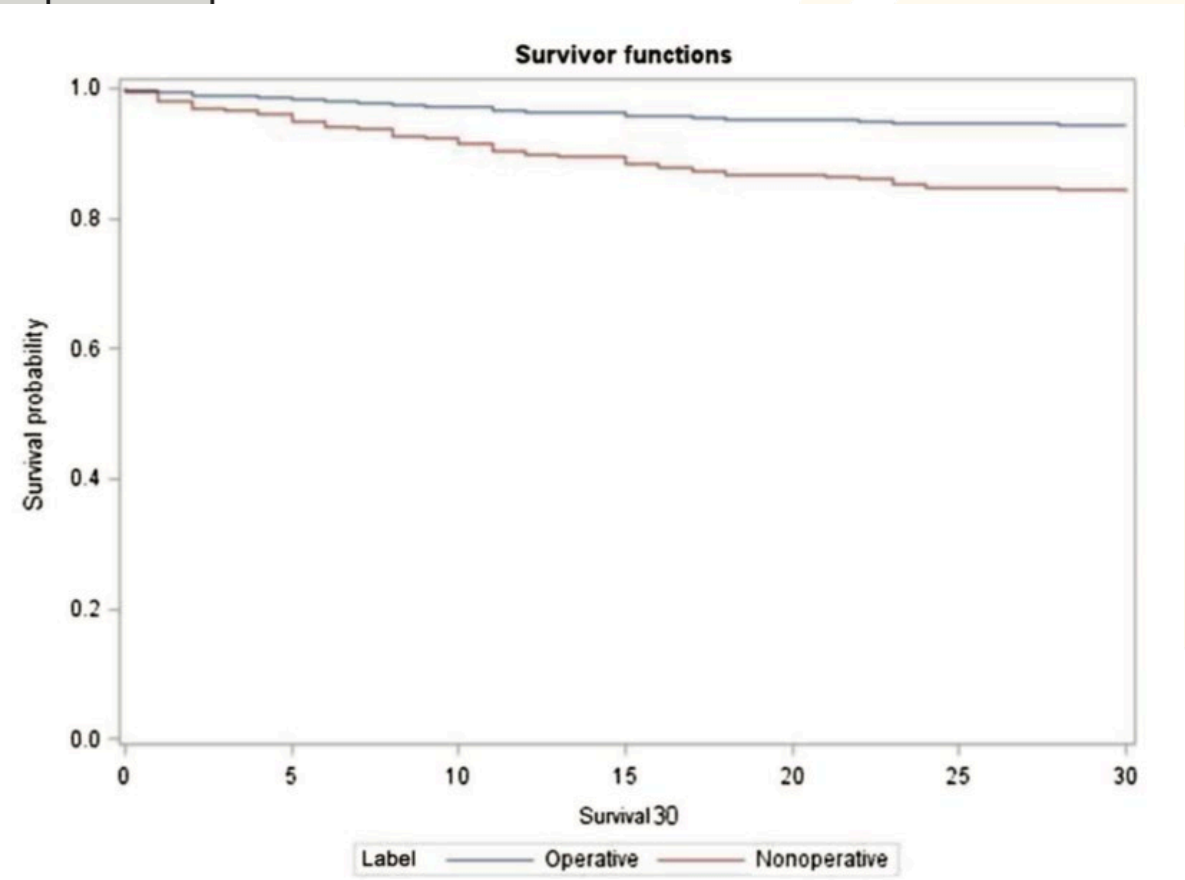

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TABLE 1. Patient Demographics for 322 Geriatric Patients With Type II Odontoid Fracture, Stratified on the Basis of Operative *Versus* Nonoperative Treatment

	All (N = 322)	Operative (N = 165)	Nonoperative (N = 157)	*P*
Age (yr)	81.8 ± 7.8	80.4 ± 7.7	83.2 ± 7.7	0.0014
Sex				0.9395
Male	134 (42%)	69 (42%)	65 (41%)	
Female	188 (58%)	96 (58%)	92 (59%)	
Living arrangements prior to injury				<0.0001
Independent	142 (44%)	56 (34%)	86 (55%)	
Assisted living facility	44 (14%)	16 (10%)	28 (18%)	
Unknown	136 (42%)	93 (56%)	43 (27%)	
Mechanism of injury				0.0097
Fall	296 (92%)	158 (96%)	138 (88%)	
Motor vehicle collision	26 (8%)	7 (4%)	19 (12%)	
Hospital length of stay (d)	11.3 ± 15.0	15.0 ± 18.5	7.4 ± 8.7	<0.0001*
ICU stay (d)	1.3 ± 4.1	1.5 ± 4.4	1.1 ± 3.8	0.0008*
Feeding tube placement	38 (12%)	30 (18%)	8 (5%)	0.0003
Discharge disposition				<0.0001
Skilled nursing facility	81 (25%)	32 (19%)	49 (31%)	
Home	76 (24%)	29 (18%)	47 (30%)	
Rehabilitation facility	29 (9%)	17 (10%)	12 (8%)	
Homeless	1 (<1%)	0 (0%)	1 (1%)	
Died	30 (9%)	9 (5%)	21 (13%)	
Unknown	105 (33%)	78 (47%)	27 (17%)	

**Kruskal-Wallis test.*

ICU indicates intensive care unit.

Long-term Analysis

Collectively, these data, demonstrate that surgical treatment of type II odontoid fracture in this elderly population did not negatively impact survival, even after adjusting for patient age and comorbidities, and, that operative treatment may be associated with a significant 30-day survival advantage compared with nonoperatively treated patients. The observation that this survival advantage seems to diminish to the level of a nonsignificant trend during longer term follow-up may relate to a dilutional effect of deaths occurring due to unrelated comorbid conditions in both groups of this elderly population. It is also important to recognize that, although the

Figure 2. Kaplan-Meier plot of survival at maximum follow-up from presentation stratified based on operative versus nonoperative treatment for 322 geriatric patients with type II odontoid fracture.

Effect of Type II Odontoid Fracture Nonunion on Outcome Among Elderly Patients Treated Without Surgery

SPINE Volume 38, Number 26, pp 2240-2246

Based on the AOSpine North America Geriatric Odontoid Fracture Study

Justin S. Smith, MD, PhD,* Christopher K. Kepler, MD, MBA,† Branko Kopjar, MD, PhD,‡
James S. Harrop, MD,† Paul Arnold, MD,§ Jens R. Chapman, MD,¶ Michael G. Fehlings, MD, PhD,‖
Alexander R. Vaccaro, MD, PhD,† and Christopher I. Shaffrey, MD*

- Subgroup analysis of a prospective multicenter study of elderly patients (≥65 yr) with type II odontoid fracture
  - NDI & SF-36 collected at baseline, 6 & 12 months
- 58 patients treated non-op
  - 8 died within 90 days
  - 35 (70%) with bony/fibrous union
  - 15 (30%) developed primary or secondary non-union
    - 11 (22.0%) developed nonunion → 7 requiring surgery
    - 4/39 (10.3%) patients classified as having "successful union" required surgery due to late fracture displacement

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- All outcome measures demonstrated a significant decline from preinjury baseline in BOTH union and non-union groups
  - no significant differences in outcomes in union and non-union groups
  - However, 12-month outcomes for the non-union patients reflect the status of the patient after delayed surgical treatment in the majority of these cases

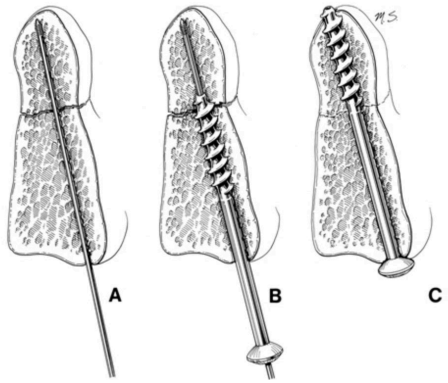
Functional and Quality-of-Life Outcomes in Geriatric Patients with Type-II Dens Fracture

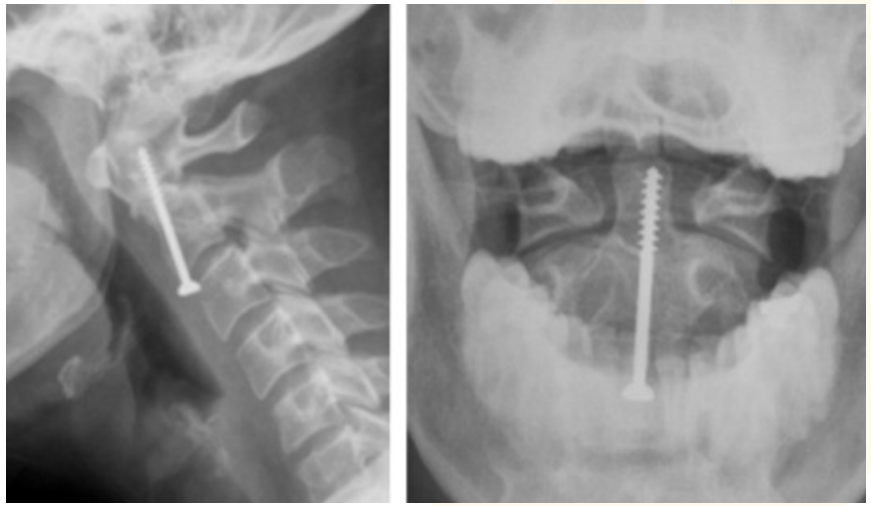
Alexander R. Vaccaro, MD, PhD, Christopher K. Kepler, MD, MBA, Branko Kopjar, MD, PhD, MS, Jens Chapman, MD, Christopher Shaffrey, MD, Paul Arnold, MD, Ziya Gokaslan, MD, Darrel Brodke, MD, John France, MD, Mark Dekutoski, MD, Rick Sasso, MD, S. Tim Yoon, MD, Christopher Bono, MD, James Harrop, MD, and Michael G. Fehlings, MD, PhD

- Mortality rate was 18% at 1 year
  - 26% in non-surgical and 14% in surgical groups (p=0.05)
- NDI had increased (worsened) by 14.7 points in the nonsurgical cohort ($p < 0.0001$)
  - nonsignificant increase (worsening) of 5.7 points in the surgical group ($p = 0.0555$).
- Surgical group had significantly better outcomes based on NDI and SF-36 Bodily Pain dimension compared with the nonsurgical group
- no difference in the overall rate of complications,
- Lower non-union rate in surgical group (5% vs 21%, p=0.003)

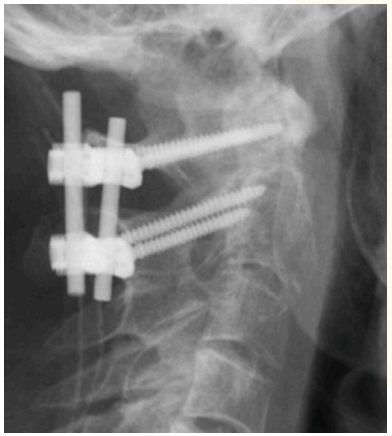
Surgical Treatment Options

- Anterior (odontoid screw)



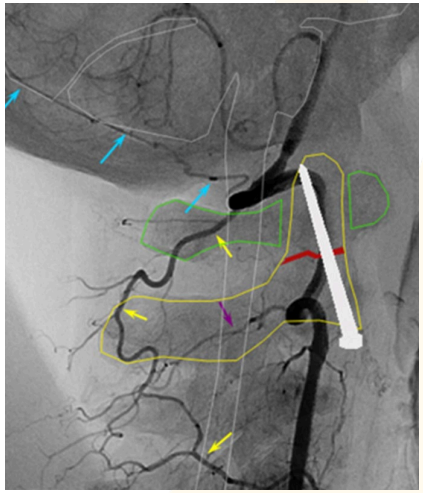


- Posterior (C1-2 posterior spinal fusion)

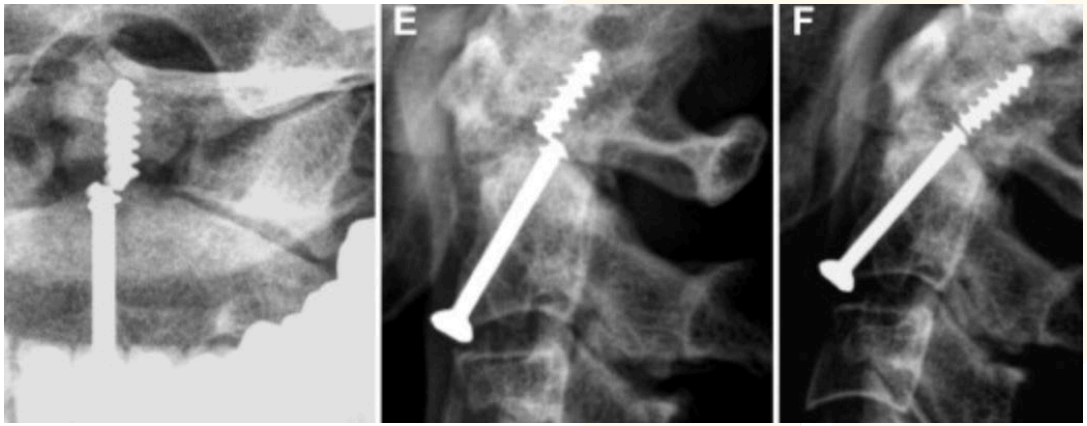


Odontoid Fx - Anterior Fixation

- Benefits:
  - Lower risk of vertebral artery injury
  - Preservation of C1-2 motion
  - Shorter surgical time
  - Avoids prone positioning

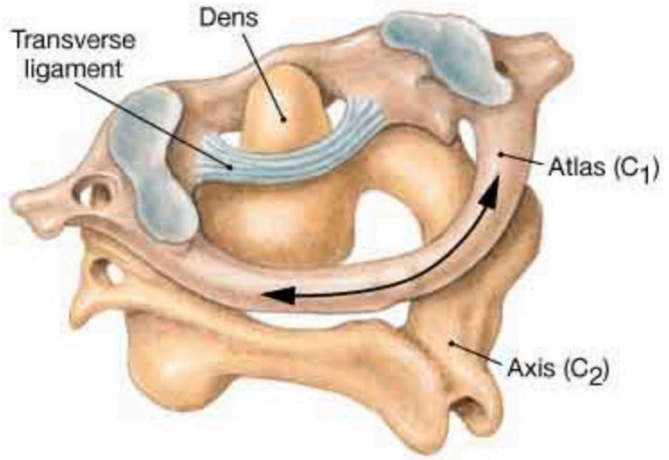


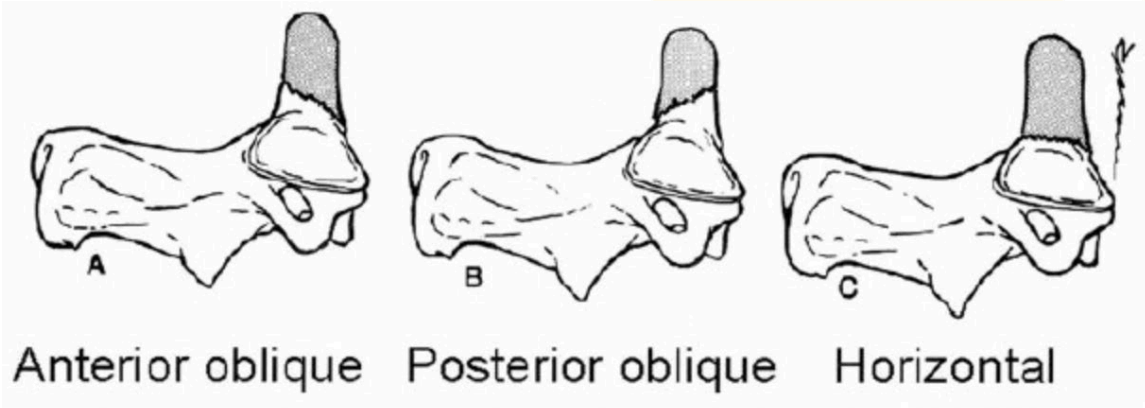
- Risks
  - Loss of Fixation
  - Hardware failure
  - Hardware malpositioning
  - Pseudoarthrosis
  - Dysphagia
  - Aspiration



Odontoid Fractures - Anterior Fixation

- Contraindications:
  - Disruption of transverse ligament
  - C2 body fracture
  - Osteoporosis
  - Pathologic fx
  - Comminution
  - Anterior-oblique fracture orientation
  - C1-2 Arthrosis
  - Chronic fracture





Odontoid Fractures - Anterior Fixation

Acta Orthop Scand. 1997 Aug;68(4):319-24.

Dens fractures in the elderly. Results of anterior screw fixation in 19 elderly patients.

Berlemann U[1], Schwarzenbach O.

- 19 patients > 65 years of age
- 84% (16/19) bony fusion rate
- 2/19 with pseudoarthrosis requiring no treatment

Anterior Screw Fixation of Odontoid Fractures Comparing Younger and Elderly Patients

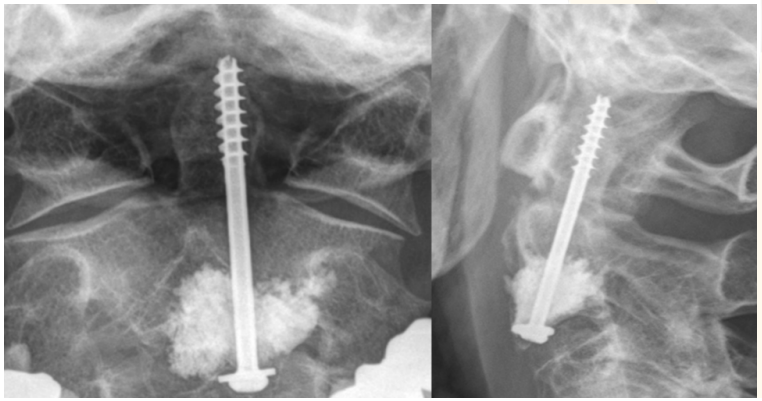
Patrick Platzer, MD, Gerhild Thalhammer, MD, Roman Ostermann, MD, Thomas Wieland, MD, Vilmos Vécsei, MD, and Christian Gaebler, MD

SPINE Volume 32, Number 16, pp 1714–1720

- 96% union in patients < 65 yo
- 88% union in patients > 65 yo

Odontoid Fractures - Anterior Fixation

- Cement Augmentation



H. Kohlhof et al. / The Spine Journal 13 (2013) 1858–1863

Anterior fixation of odontoid fractures in an elderly population

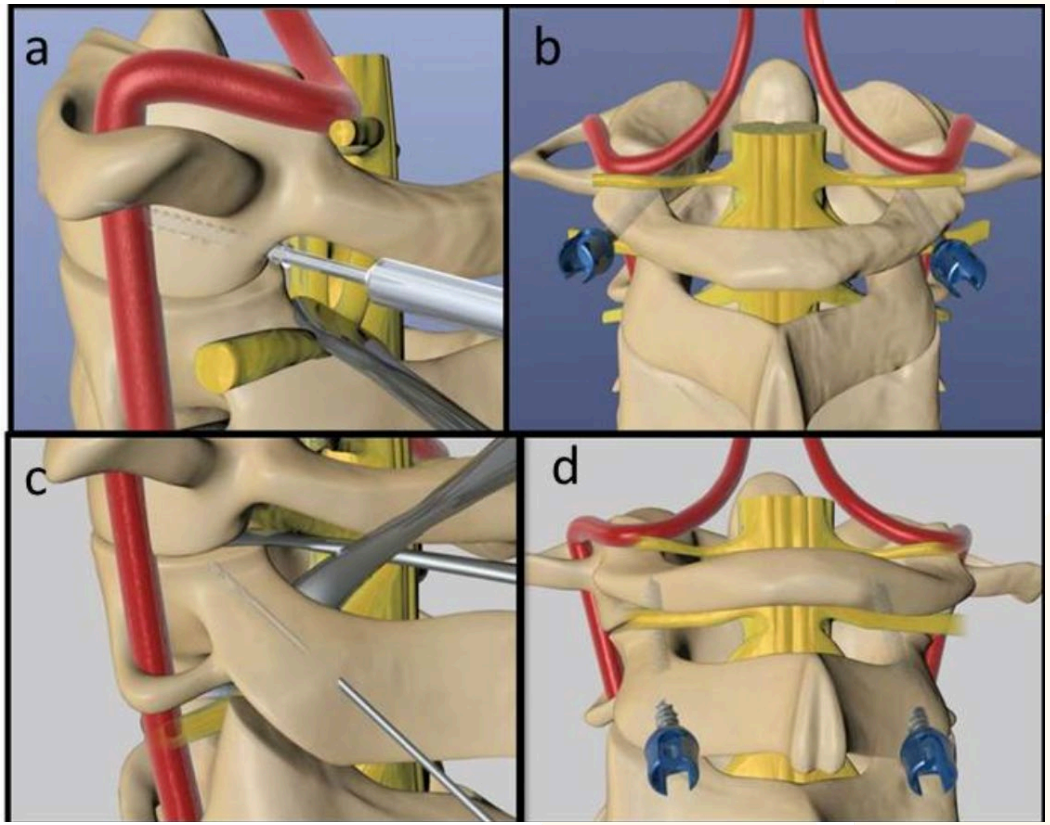
ANDREW T. DAILEY, M.D.,[1] DAVID HART, M.D.,[2] MICHAEL A. FINN, M.D.,[1]
MEIC H. SCHMIDT, M.D.,[1] RONALD I. APFELBAUM, M.D.,[1]

J Neurosurg Spine 12:1–8, 2010

- 1 vs 2 screw technique
  - 96% stability using 2 screws
  - 56% stability using 1 screw
- 35% had dysphagia
- 25% of patients required a feeding tube
- 19% had aspiration pneumonia requiring antibiotics

Odontoid Fx - Posterior Fixation

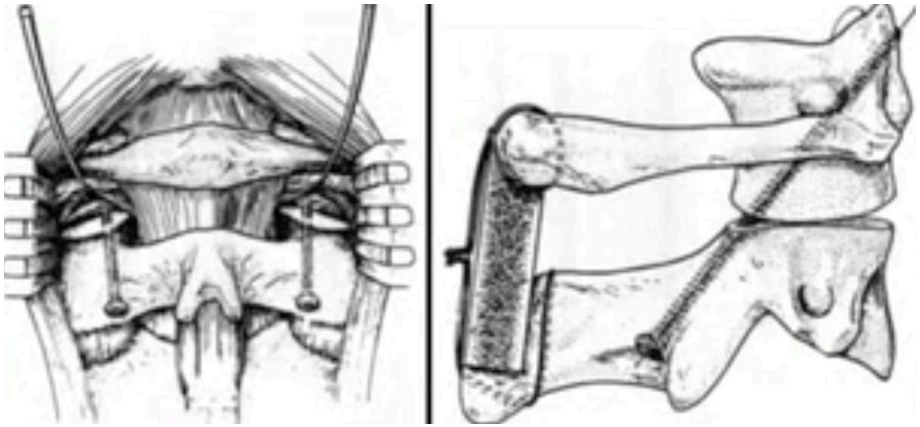
- Benefits:
  - Increased stability
  - Definitive treatment
  - Less dysphagia



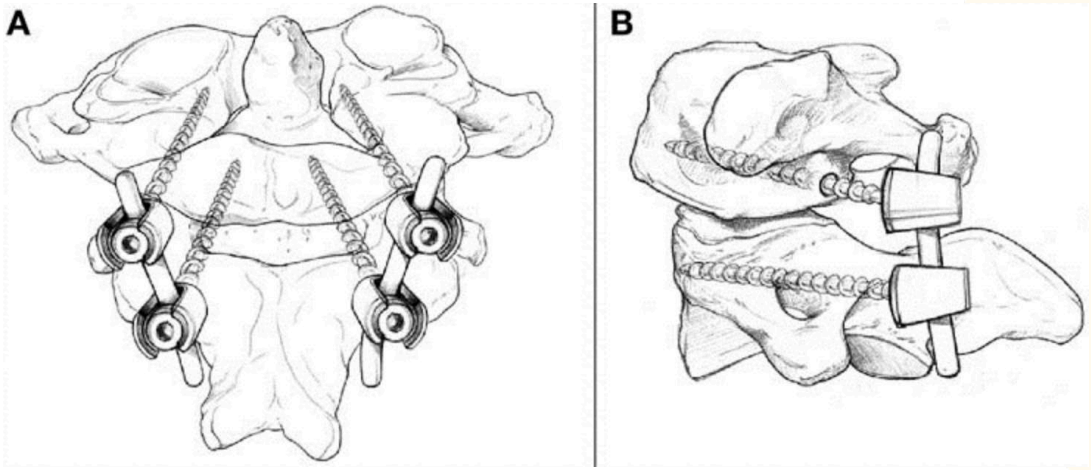
- Risks
  - Pseudoarthrosis
  - Hardware malposition
  - Hardware failure
  - Vertebral artery injury
  - Harvest issues (for autograft)

Odontoid Fx - Posterior Fixation Techniques

- C1-2 transarticular screw



- Harms Technique (C1 Lateral mass + C2 pedicle/pars screws)



Spine (Phila Pa 1976). 2018 Mar 13. doi: 10.1097/BRS.0000000000002637. [Epub ahead of print]

Mortality Rates Following Posterior C1-2 Fusion for Displaced Type II Odontoid Fractures in Octogenarians.

Clark S[1], Nash A, Shasti M, Brown L, Jauregui JJ, Mistretta K, Koh E, Banagan K, Ludwig S, Gelb D.

- Retrospective review of 43 patients from 2006-2016
- Mean fracture displacement was 5.1 ± 3.6mm and mean absolute value of angulation was $19.93 \pm 12.93°$.
- Complications:
  - altered mental status (41.9%, n = 18)
  - dysphagia (27.9%, n = 12) --> 50% (6) required feeding tube
  - Respiratory failure/Reintubation (9.3%, n = 4).
  - 25 of 43 patients expired (58.1%)
    - median survival of 1.76 years from the date of surgery.
- Mortality: 2.3% @ 30 days; 18.6% at 1 year.
- Patients who developed dysphagia were 14.5 times more likely to have expired at 1 year

Summary - Geriatric Odontoid Fractures

- Treatment of type II odontoid fractures in geriatric patients remains highly controversial
- Paucity of high-level evidence
- Treatment should be individualized based on fracture type/pattern, level of function and comorbidities
- Non-operative management has high rates of pseudoarthrosis
  - continued instability, persisting pain, or the development of neurological sequelae are indications for delayed C1-2 PSF
- Protective effect of surgical intervention
  - Most favor posterior approach

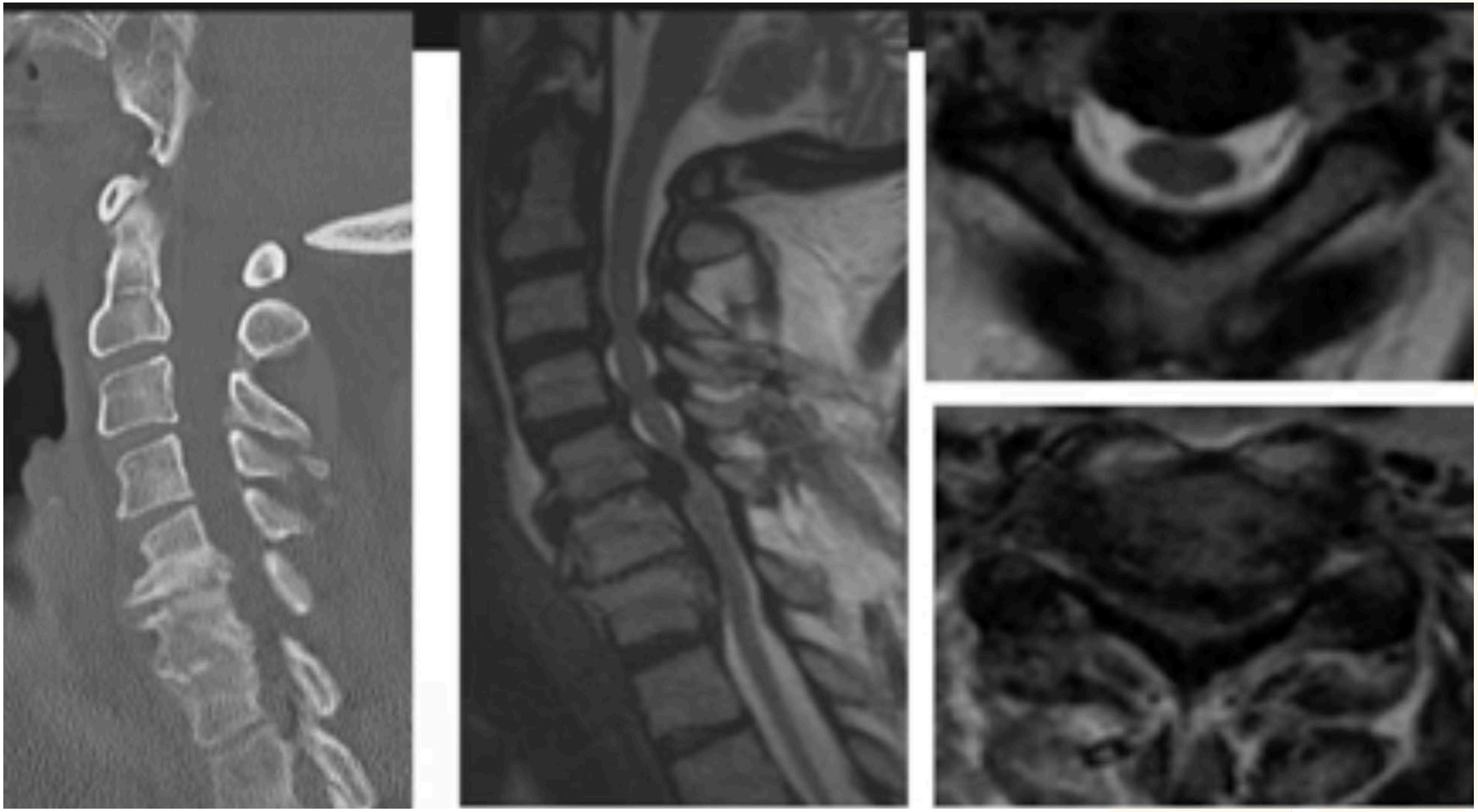
Outline

- The Aging Spine
  - Osteoporosis Evaluation and Treatment
- Geriatric Odontoid Fractures
- **Central Cord Syndrome**

Case Example

- 67 yo F s/p fall at home
  - Tripped over a rug while walking at home
  - Fell and landed on her face
  - Noticed immediate bilateral hand/arm burning pain and weakness
- Exam:
  - AOx3
  - Bilateral UE – 5/5 except 3/5 hand intrinsics
  - +rectal tone and sensation
  - Decreased pinprick C7 and T1
  - B/L UE hyperreflexia
  - +Hoffman's bilaterally

Imaging

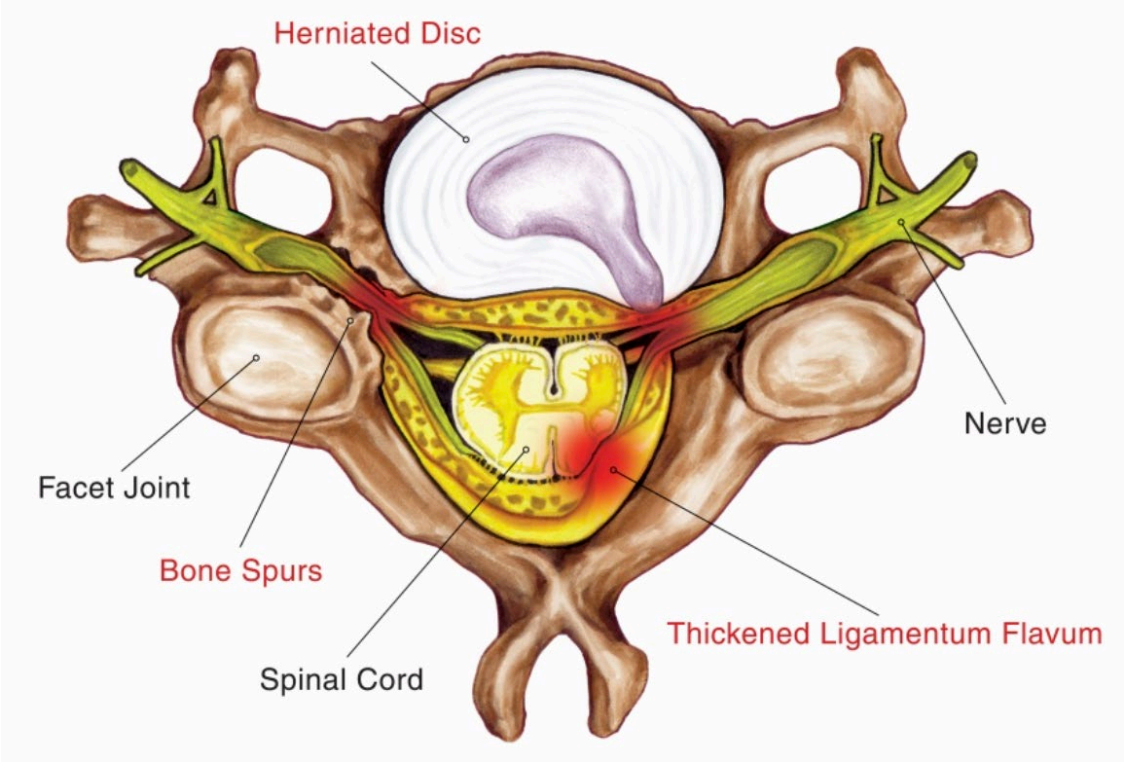


Treatment options?

1. Allow patient to plateau recovery, then operate
2. Place in cervical collar and operate at 6 weeks
3. Treat medically only
4. Operate within 24hours if cleared/stable
5. Operate within 2 week hospitalization

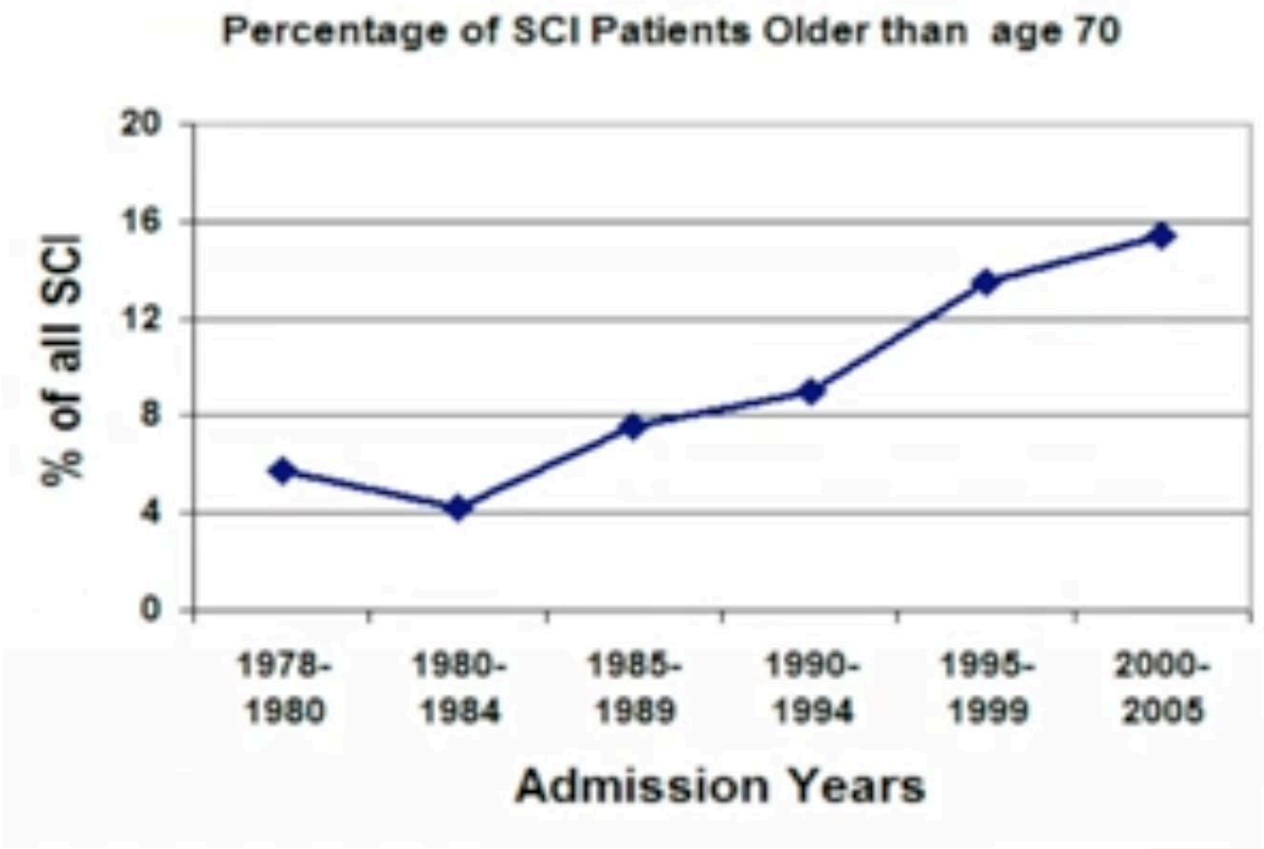
The Geriatric Spine

- Increase prevalence of cervical spinal stenosis
  - Osteophytes
  - Thickening of Ligamentum Flavum
  - 26% incidence of cervical stenosis in patients > 65 yo



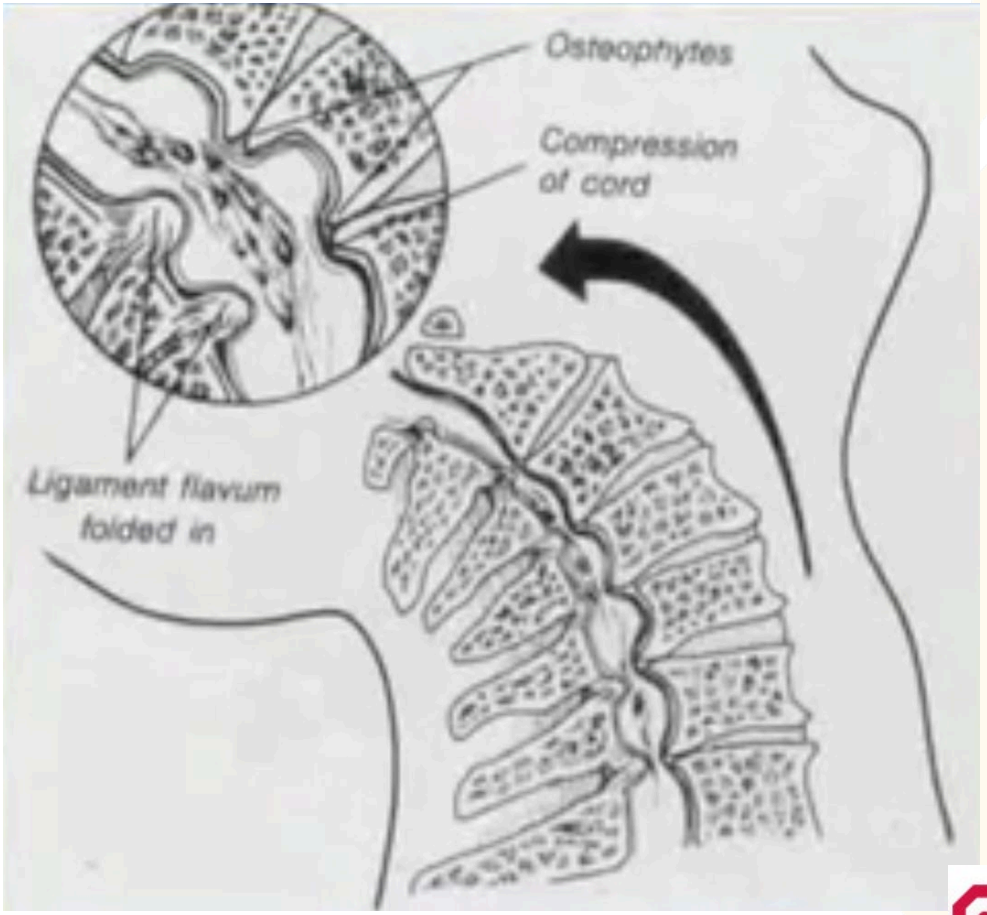
Central Cord Syndrome

- The most common type of incomplete spinal cord injury
  -
- Cl) with pr



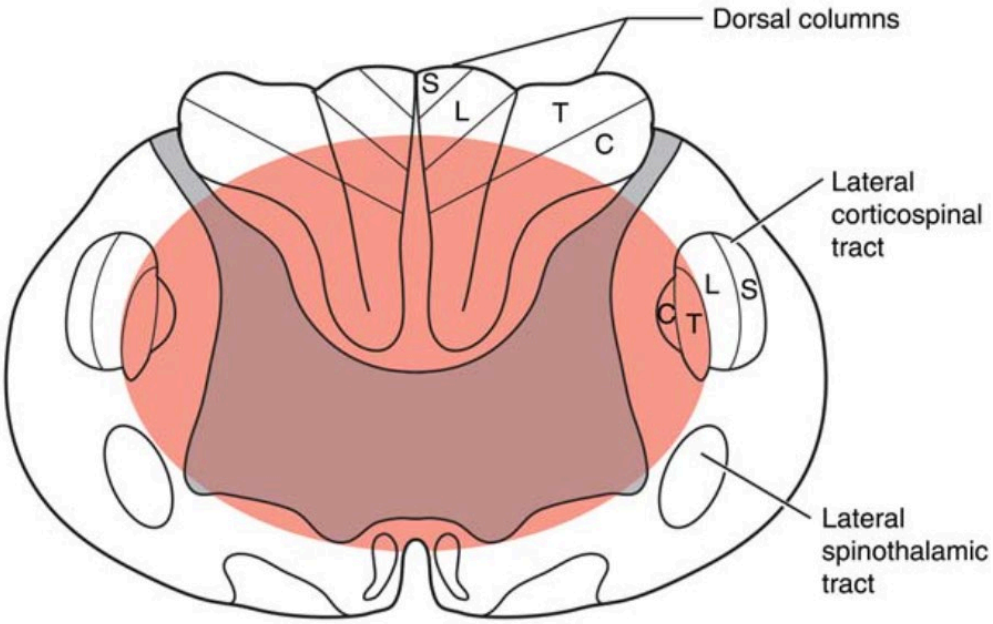
Mechanism of Injury

- Hyperextension Injury
  - Cord is contused/compressed between ligamentum flavum and arthritic spurs/discs



Mechanism of Injury

- Hyperextension Injury
  - Cord is contused/compressed between ligamentum flavum and arthritic spurs/discs
- Primary injury → Lateral corticospinal tracts



Presentation

- CCS presents on a spectrum
  - weakness limited solely to the hands and forearms with sensory preservation
  - complete quadriparesis with sacral sparing as the only evidence of incomplete SCI

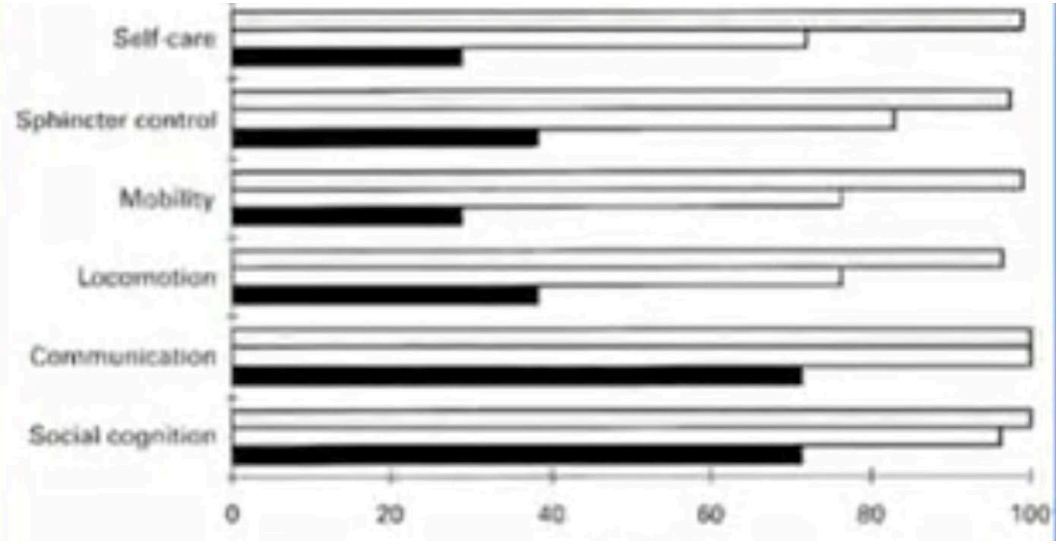
Conservative Treatment

J Bone Joint Surg Br. 2000 Aug;82(6):851-5.

The long-term outcome after central cord syndrome: a study of the natural history.

Newey ML[1], Sen PK, Fraser RD.

- Younger patients (< 50, group 1) improved more
- >70 years of age had poorer outcome
  - 40% ambulatory, 20% bowel/bladder control at late follow-up



Cooper Medical School of Rowan University

Cooper Bone & Joint Institute

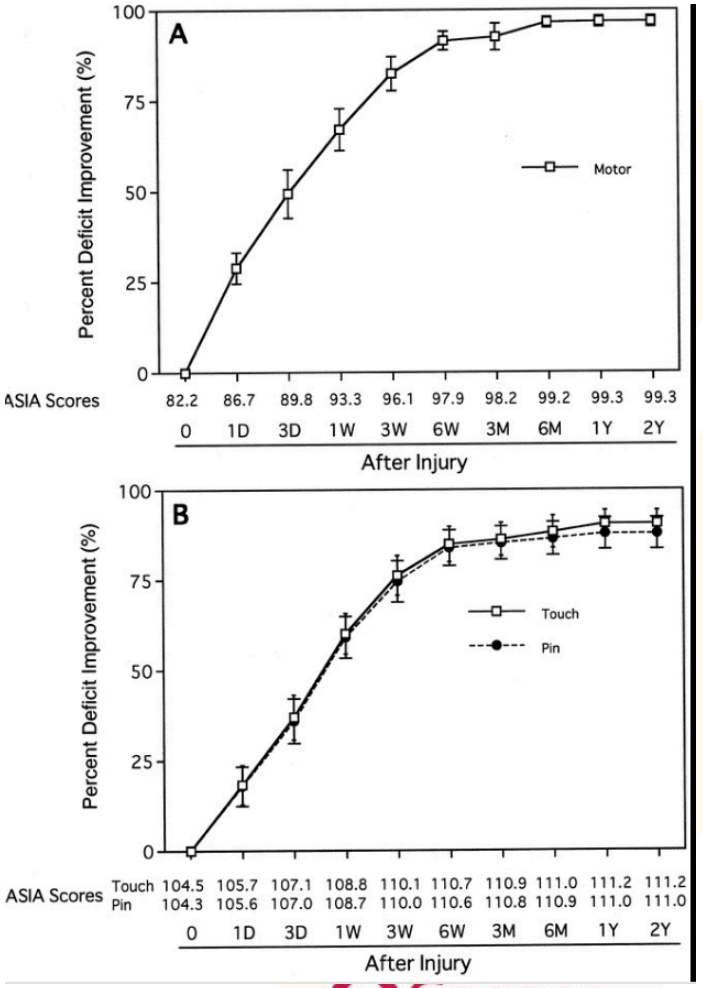
Conservative Treatment

Spine (Phila Pa 1976). 2002 Au Open/close author information list

Predictors of neurologic recovery in acute central cervical cord injury with only upper extremity impairment.

Ishida Y[1], Tominaga T.

- Prospectively followed 22 patients
- Favorable neurological recovery at 6 weeks
- Poorer recovery correlated with older age & more severe initial neurological injury



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Predictors of neurologic recovery in acute central cervical cord injury with only upper extremity impairment.

Ishida Y[1], Tominaga T.

- Absence abnormal signal intensity on MRI associated with better neurological recovery

Table 3. Predictors of Complete Motor Recovery

	Odds Ratio*	95% Confidence Interval	*P* Value
MRI	64	3.25–1261.01	0.006
6W PDI	5.45	1.17–25.46	0.031
ASIA score at injury	3.67	1.00–13.55	0.049
3W PDI	3.50	1.04–11.86	0.044
1W PDI	1.94	1.03–3.67	0.042
Age	1.73	0.86–3.46	0.13
Canal stenosis	0.30	0.35–2.52	0.27
Spondylosis	0.22	0.020–2.42	0.22
OPLL	0.20	0.019–2.03	0.17

Surgical Treatment

Neurosurgery. 1984 Sep;15(3):367-72.

Reanalysis of central cervical cord injury management.

Bose B, Northrup BE, Osterholm JL, Cotler JM, DiTunno JF.

- Retrospective review of 28 patients
  - 14 treated medically (mannitol, dexamethasone, sodium bicarbonate)
  - 14 treated surgically
- Surgical group had:
  - failure to improve progressively after an initial period of improvement
  - persistent compression of neural tissue visualized on myelography
  - instability of the spinal bony elements
- Operative group had significantly better recovery than conservative group

Surgical Timing

Management of patients with an incomplete cervical spinal cord injury

T Asazuma, K Satomi, N Suzuki, Y Fujimura and K Hirabayashi

Spinal Cord (1996) 34, 620–625

Department of Orthopaedic Surgery, Keio University, School of Medicine, 35 Shinanomachi, Shinjuku-ku, Tokyo 160, Japan

- 35 patients with Traumatic CCS
- All patients undergoing surgery within 4 weeks improved at least 1 Frankel grade
  - 84.6% improved 2 or more Frankel grades
- 10 patients (55.6%) who underwent late surgery (> 4 weeks) failed to improve
- Recommend surgery within the first few weeks in the absence of neurological recovery

SPINE Volume 35, Number 21S, pp S180–S186

The Urgency of Surgical Decompression in Acute Central Cord Injuries With Spondylosis and Without Instability

Brian Lenehan, MD, MCh, FRCSI,* Charles G. Fisher, MD, MHSc, FRCSC,* Alex Vaccaro, MD, PhD,† Michael Fehlings, MD, PhD,‡ Bizhan Aarabi, MD,§ and Marcel F. Dvorak, MD, FRCSC*

- Observational analysis of Spine Trauma Study Group
- Early surgical group (< 24hr) had improved total motor score & Functional independence Measure (FIM) score

- It is safe to consider early surgical decompression in patients with profound neurodeficit (ASIA □ C) and persistent spinal cord compression due to developmental cervical spinal canal stenosis without fracture or instability

J Neurosurg. 2002 Jul;97(1 Suppl):25-32.

Traumatic central cord syndrome: results of surgical management.

Guest J[1], Eleraky MA, Apostolides PJ, Dickman CA, Sonntag VK.

- Retrospective review of 50 patients with CCS
- Shorter ICU and LOS in early surgery (24hr) than late surgery (>24hr)
- Greater motor improvement in early surgery (p=0.04) with ongoing cord compression than late surgery
  - Disc herniation
  - Fracture-dislocation
- Similar motor outcome in patients with CCS secondary to stenosis/spondylosis who underwent early or late surgery (p=0.51)

SPINE Volume 35, Number 21S, pp S166–S173

Current Practice in the Timing of Surgical Intervention in Spinal Cord Injury

Michael G. Fehlings, MD, PhD, FRCSC, FACS,*† Doron Rabin, MD, FRCSC,*†
William Sears, MB, BS, FRACS,‡ David W. Cadotte, MSc, MD,*†
and Bizhan Aarabi, MD, FACS, FRCSC§

- The majority of spine surgeons prefer to decompress the acutely injured spinal cord within 24 hours

- Spine surgeons preferred to decompress an incomplete SCI earlier than a complete injury

Surgical Timing - Summary

- Early surgery is safe and more cost effective than late surgery for the treatment of traumatic CCS
  - Shorter hospital LOS
  - Shorter ICU stay
- Early surgery can improve motor recovery in the setting of ongoing spinal cord compression
- In the setting of spinal stenosis or spondylosis, early surgery is safe
  - Reasonable to monitor ASIA D or high-C who has rapid recovery until plateau in neurological status

Thank you!

Cooper Medical School of Rowan University

Cooper Bone & Joint Institute