Managing Cervical Radiculopathy

Your instructor

Jack Miller BSc(PT), Dip MT (NZ), MClSc, DPT, FCAMPT

Jack completed his BSc in Physical Therapy at the University of Toronto. He then spent six years in Australia and New Zealand where he completed an advanced specialty Diploma of Manipulative Therapy. During this program he was directly mentored by both Robin McKenzie and Brian Mulligan. On returning to Canada he competed a Masters of Clinical Science at Western University and a Doctor of Physical Therapy Degree from the University of St. Augustine.

Jack has been the senior editor of the Canadian Physiotherapy Association's Orthopaedic Journal, an executive member of the Orthopaedic Division of CPA, the President of the Canadian Academy of Manipulative Physical Therapy, a founding member of the Mulligan Concept Teacher's Association and a member of the CPA's Specialization accreditation committee.

Jack holds academic appointments as an Adjunct Clinical Professor at McMaster University and Lecturer at the University of Toronto. He currently works as an Advanced Practice Physiotherapist in Ontario and is a Co-Director of Key Clinical Skills.

Welcome

Course goals:

- Build knowledge for a safe and effective clinical practice
- Recognize the medical masqueraders
- Outline the medical and clinical evaluation
- Understand the medical and surgical management
- Build a safe and effective the conservative management program

The course

Recommendations:

- Download the course handouts
- Follow along and make notes on the handouts
- Take your time – you have 10 weeks
- View the units several times (you can go back multiple times)
- Let us know if we have made any mistakes (we are not quite perfect yet)
- Enjoy the course and tell others

The Plan

Unit 1:
Cervical radiculopathy

Unit 2:
Medical pathologies & masqueraders

Unit 3:
Clinical assessment

Unit 4:
Medical investigations

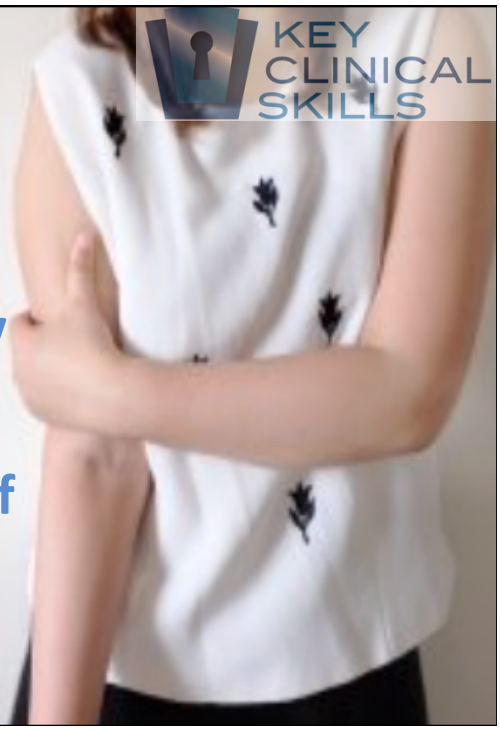
Unit 5:
Medical/ surgical management

Unit 6:
Rehabilitation Management

Managing cervical radiculopathy

Unit 1

Pathophysiology of radiculopathy

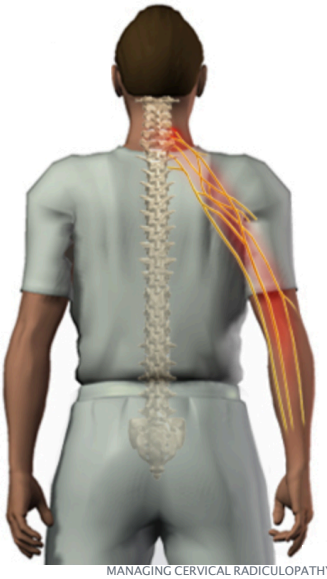


Cervical radiculopathy

Definition

- Pain in one or both of the upper extremities
- Often in the setting of neck pain
- Secondary to compression or irritation of nerve roots in the cervical spine
- It can be accompanied by motor, sensory or reflex deficits

Bono NASS 2011



Cervical radiculopathy

Annual incidence

- 107 per 100,00 men
- 64 per 100,000 women

Prevalence

- 1.14% males
- 1.31% females
- Most prevalent in 50-54 y/o age group

Incidence of cervical radiculopathy in 1420 consecutive surgical cases								
Surgeries for cervical radiculopathy by age and level								
Age	C2	C3	C4	C5	C6	C7	C8	T1
< 40	0	0	16.7	66.7	50.0	33.3	0	0
40-60	0	6.7	27.9	30.0	25.6	43.3	27.8	10.0
> 60	0	10.5	26.3	21.3	26.3	42.1	42.1	10.5
Surgeries for cervical radiculopathy by gender and level								
Female	1.7	6.3	20.4	39.2	64.1	59.4	13.8	3.9
Male	1.4	3.4	23.2	36.4	66.9	63.6	16.1	5.9
Percentages add up > 100 as multiple levels involved								

Radhakrishnan 1994, Childress 2016, Kin 2016, Mansfield 2020

Neural entrapment sites

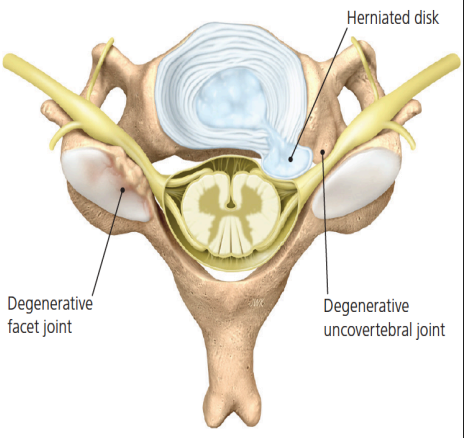
Foraminal encroachment

- 70-75%
- Degenerative uncovertebral joint
- Degenerative facet joint
- Thickened ligmentum flavum

Herniated intervertebral disc

- 20-25%
- Intra-foraminal
- Postero-lateral
- Midline

Onks 2013, Childress 2016



Response to mechanical stress

Callouses

The skin's reaction to gradual and/or regular loading

Unfortunately it can sometimes over-react by excessive amounts of epidermis thickening

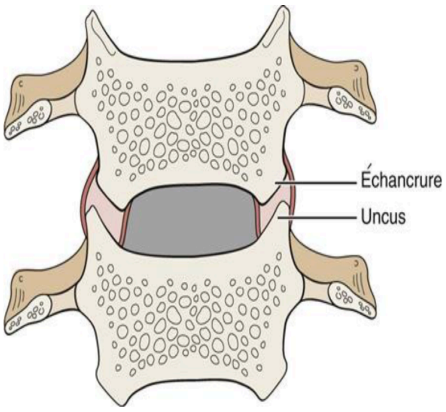
Response to mechanical stress

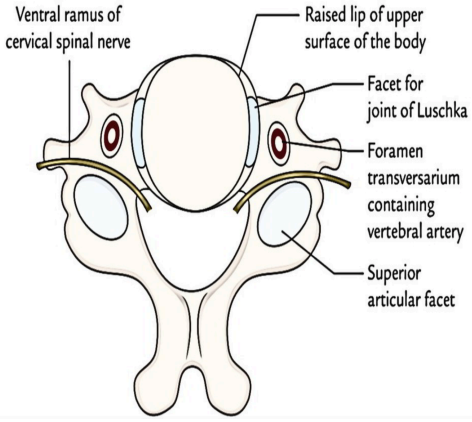
Osteophytes

The bone's reaction to gradual and/or regular loading
Unfortunately it can sometimes over-react by excessive amounts of bony thickening

Foraminal encroachment

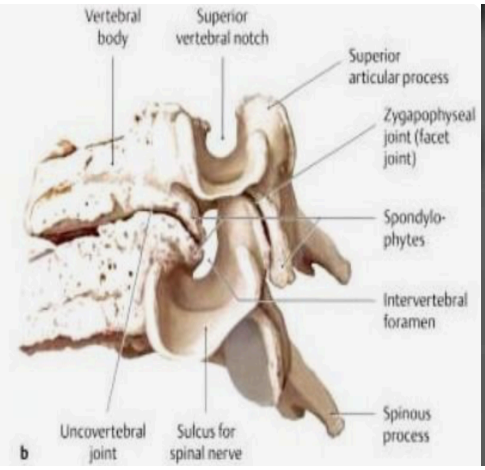
Uncovertebral joint hypertrophy

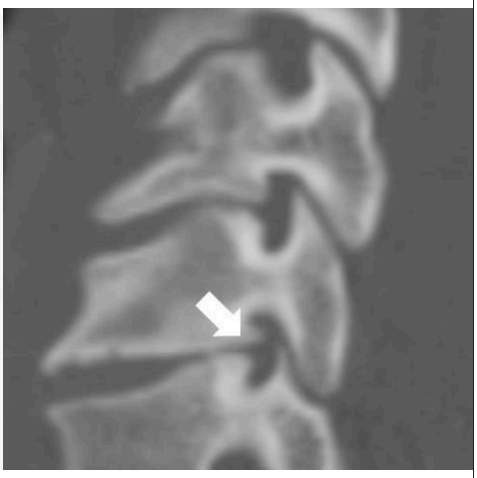




Foraminal encroachment

Uncovertebral joint hypertrophy



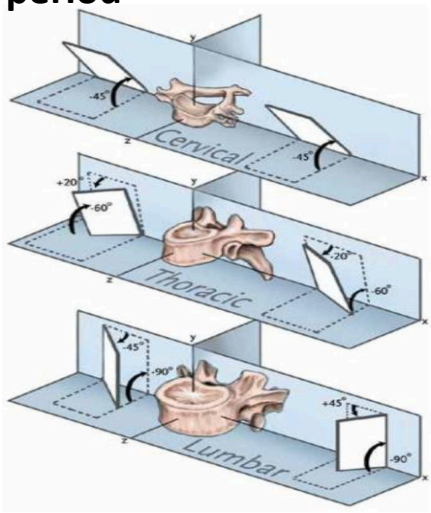


Response to mechanical stress

With 200 N compressive force cervical spinal segments over 2 hrs. period

- Creep reduced overall disc loading by 14% in neutral
- 25% in extension
- Facet joint excision increased disc loading by 14%
- Uncovertebral joint removal further 33%
- Significant most in extended postures

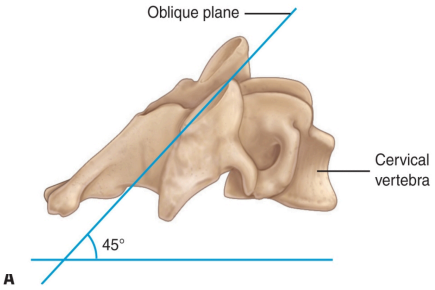
Stefanakis 2018



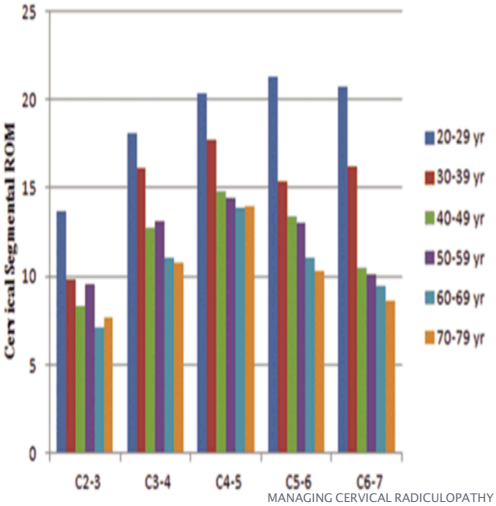
Foraminal encroachment

Cervical facet joints

- Oriented at 45^{O}
- Allow ROM all planes
- ROM decreases with age



Cervical segmental ROM & age



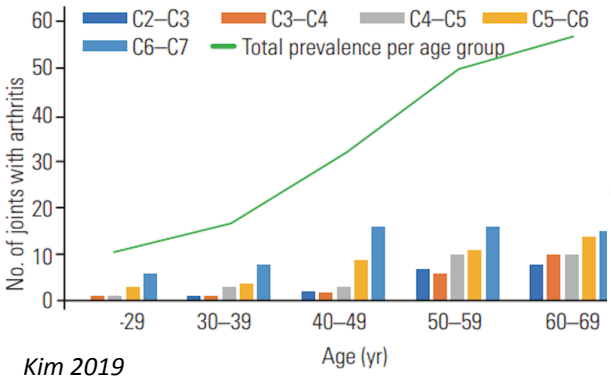
Liu 2015, Muscolino 2015

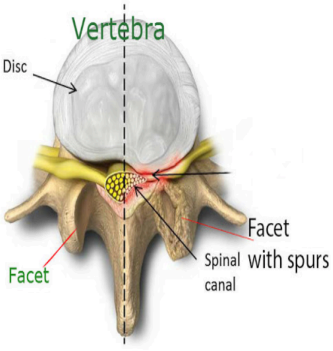
Foraminal encroachment

Facet joint hypertrophy

Retrospective study

- 500 cervical CT scans from 50 subjects



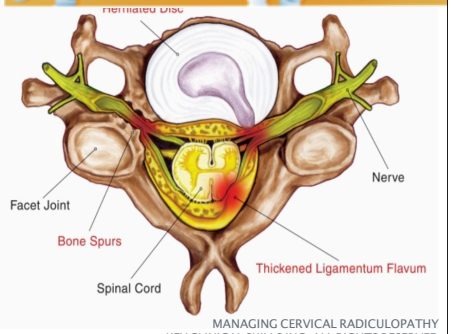


Kim 2019

Foraminal encroachment

Ligmentum flavum hypertrophy

- Decrease elastin content in ligaments
- Decrease tension of ligmentum flavum
- Increase in thickness due to remodeling
- Folding of lig. flavum
- Reduced AP diameter canal & IVF



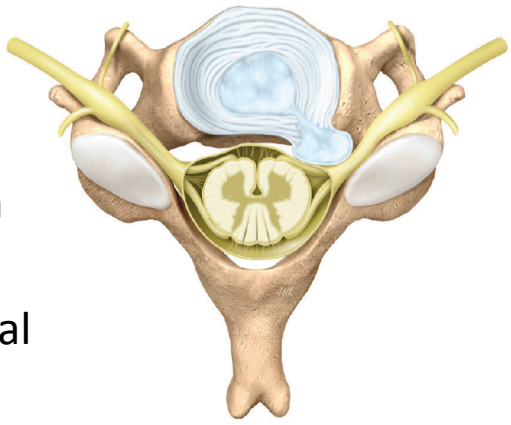
Kuchayev 2018

Intervertebral disc herniation

Intra-foraminal disc herniation

- Most common
- Predominantly pain and paresthesia
- Often in dermatomal distribution

Childress 2016

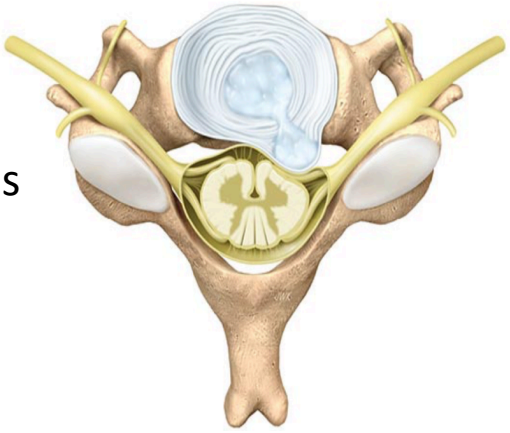


Intra-foraminal

Intervertebral disc herniation

Postero-lateral disc herniation

- Often results in myotomal weakness
- May progress to muscle atrophy



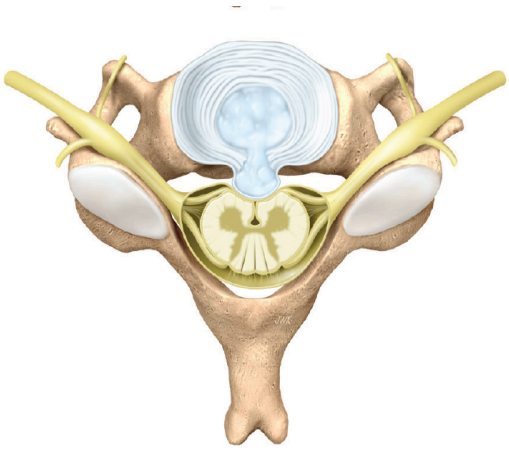
Postero-lateral

Childress 2016

Intervertebral disc herniation

Midline disc herniation

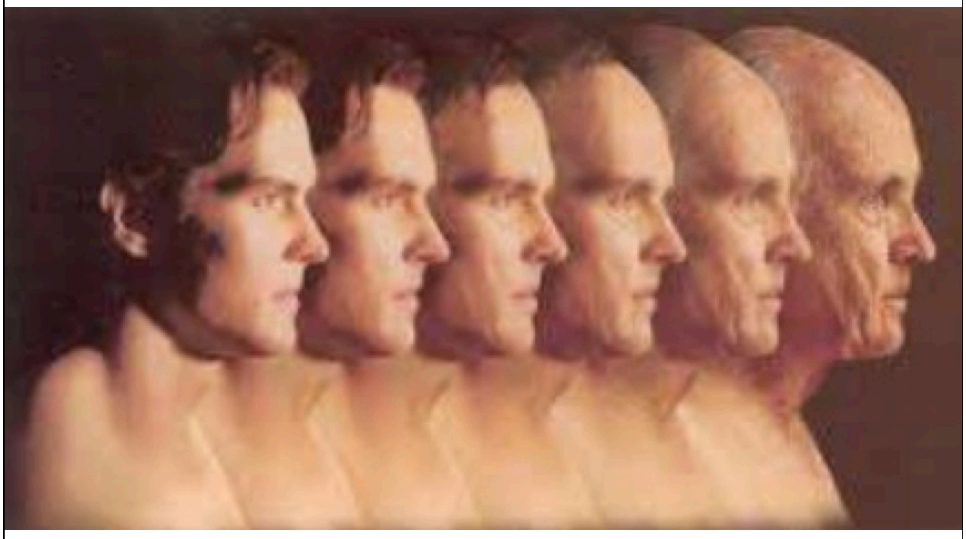
- Rare
- May cause:
  - Myelopathy-like symptoms
  - Urinary incontinence



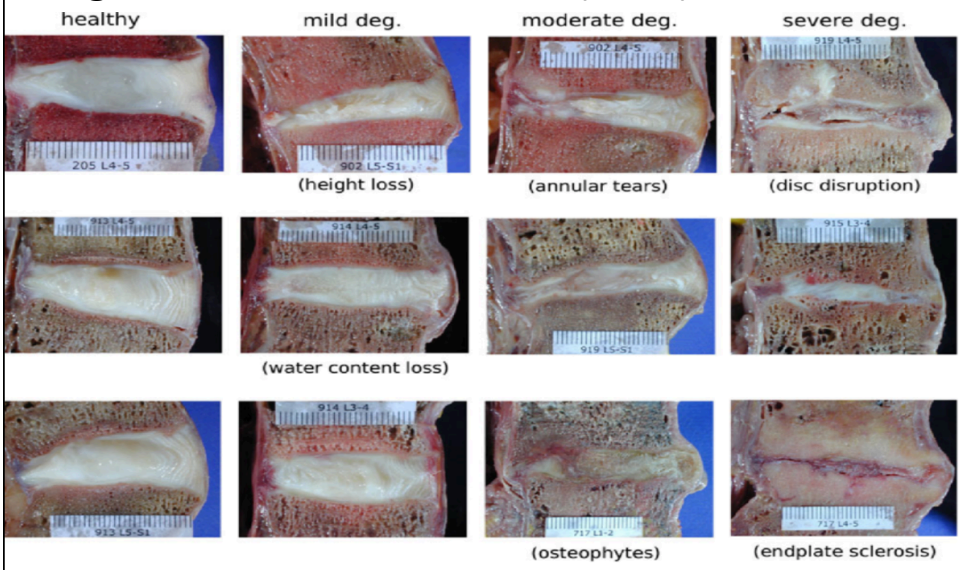
Midline

Childress 2016

We would not call these changes "Degenerative skin disease"



So why call these changes "Degenerative Disc Disease" (DDD)



Position Statement from AAOMPT

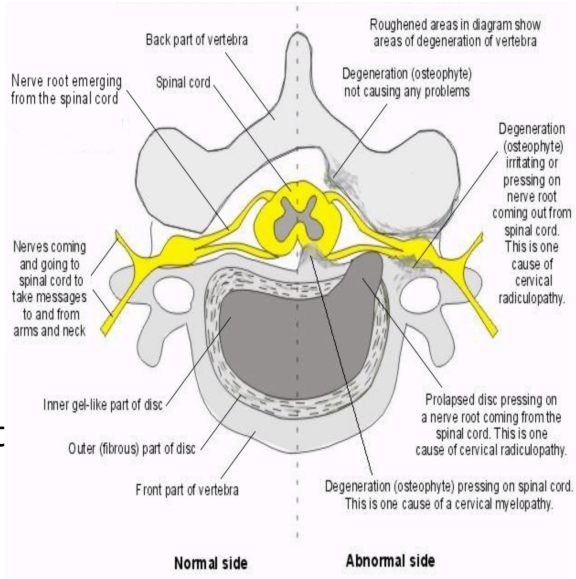
"To discontinue the use of the term degenerative disc diseases and the inaccurate implication of a clinical relationship between age-related changes in the disc and patient symptoms"

AAOMPT 2019

So let's start by call these "Normal Age Related Changes" (NARC)

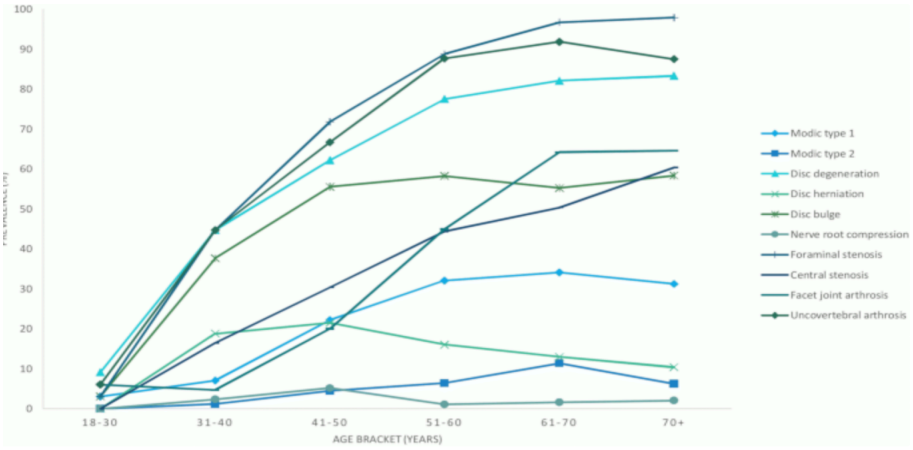
Normal age-related changes

- Disc bulging
- Ligmentum flavum thickening
- Facet joint osteophytes
- Posterior vertebral body osteo-cartilagenous bars
- Uncovertebral joint osteophytes
- Spondylolysthesis



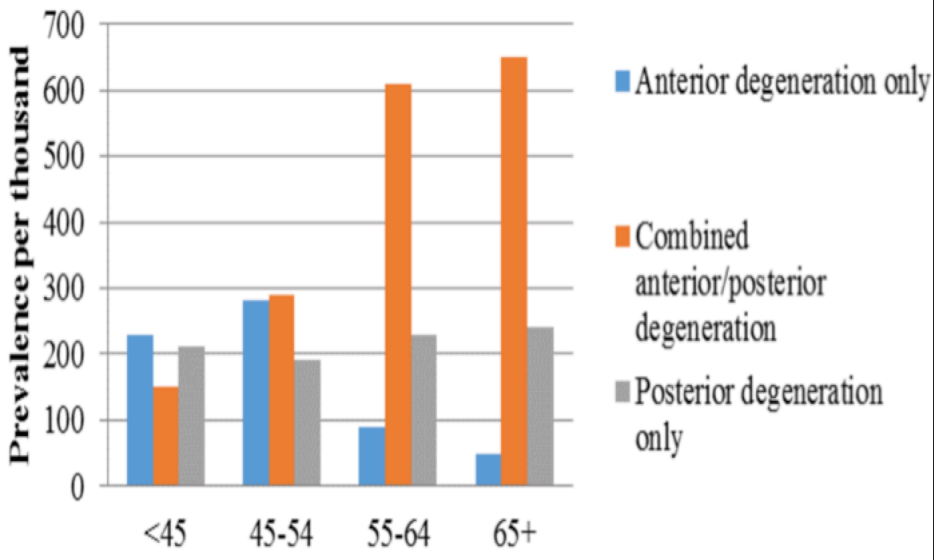
Normal age-related changes

MRI “degeneration” findings
in asymptomatic population



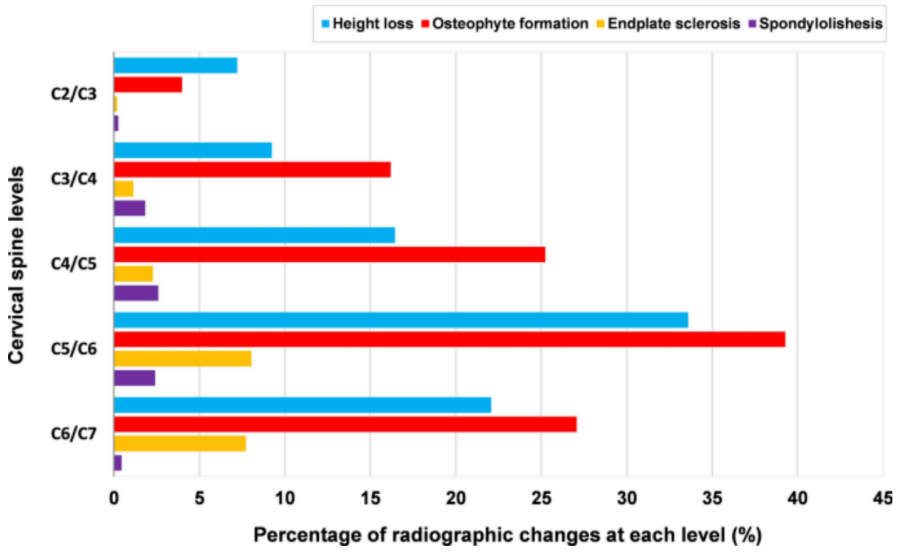
Jensen 2019

Normal age-related changes



Williams 2015

Normal age-related changes

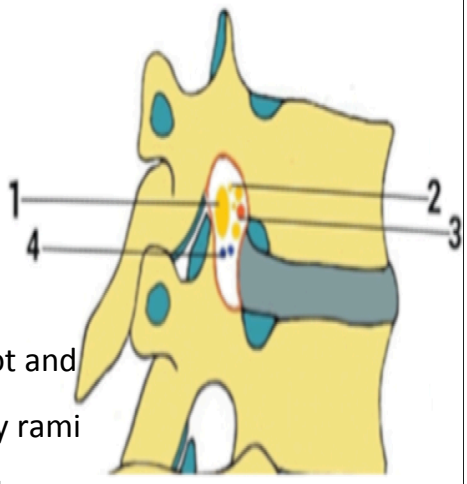


Tao 2020

Cervical intervertebral foramen

Borders:

- Anterior
  - Uncovertebral joints
- Posterior
  - Facet joints
  - Ligmentum flavum
- Superior/inferior
  - Arch of pedicles



Contents:

1. Segmental spinal nerve root and dorsal root ganglion
2. Sinu-vertebral nerve & gray rami communicantes
3. Spinal branch of segmental arteries
4. Intervertebral veins

Cervical intervertebral foramen

MRI assessment of IVF dimensions

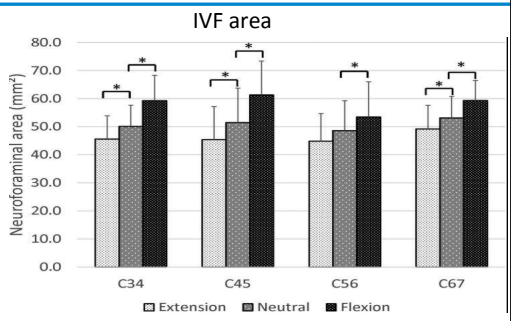
- 10 asymptomatic subjects
- MRI in seated position

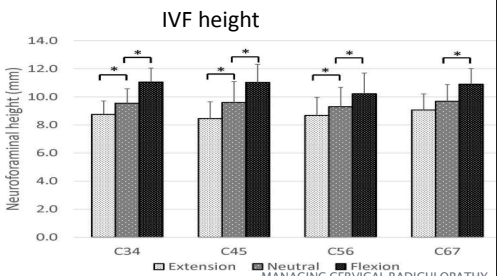
Compared to neutral, all IVF dimensions

- Decreased in extension
- Increased in flexion

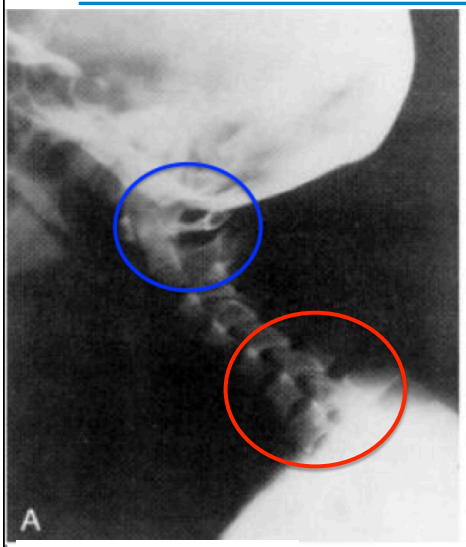
Greatest change at C4/5

Mao 2018

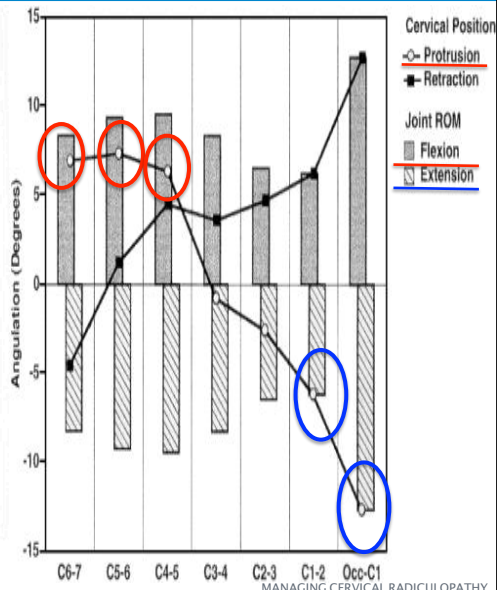




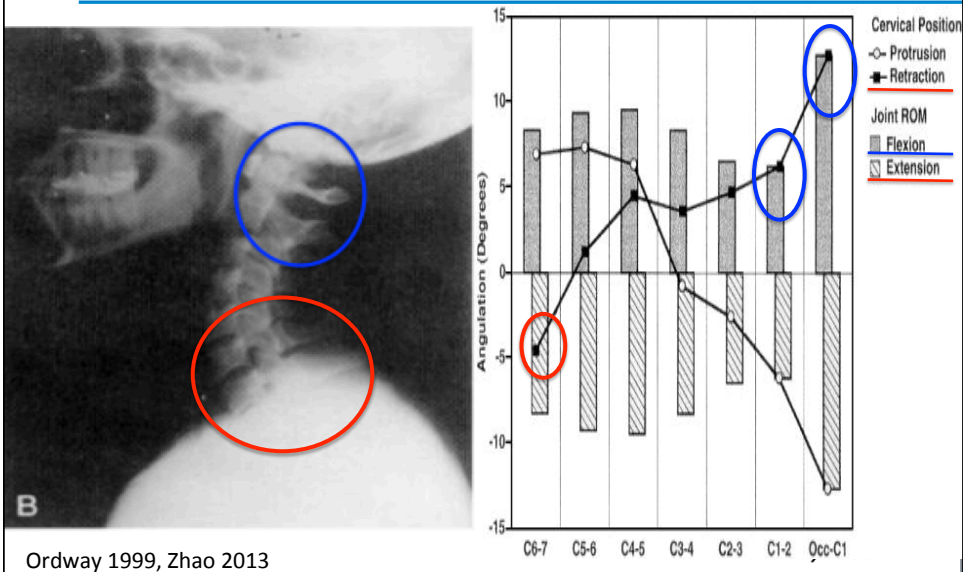
Protraction



Ordway 1999, Zhao 2013



Retraction



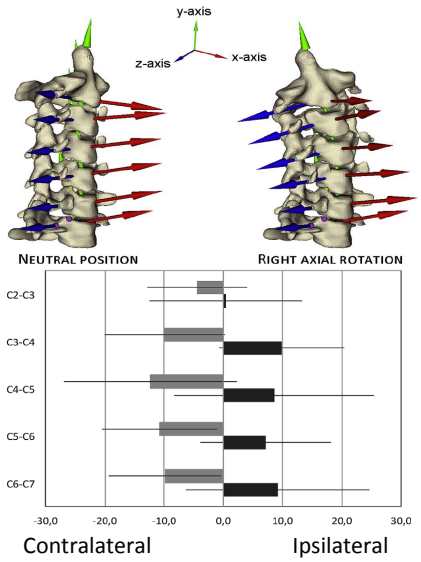
Ordway 1999, Zhao 2013

Cervical intervertebral foramen

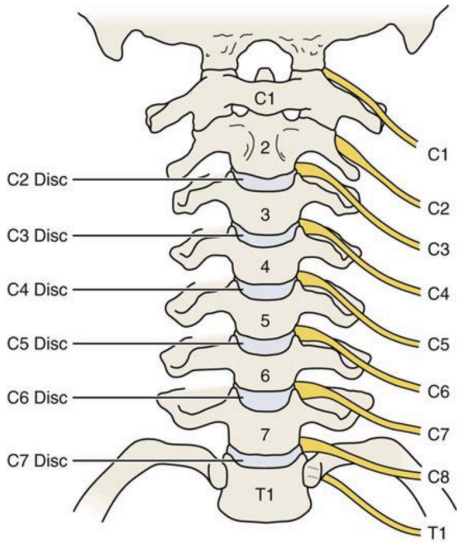
CT assessment of IVF dimensions

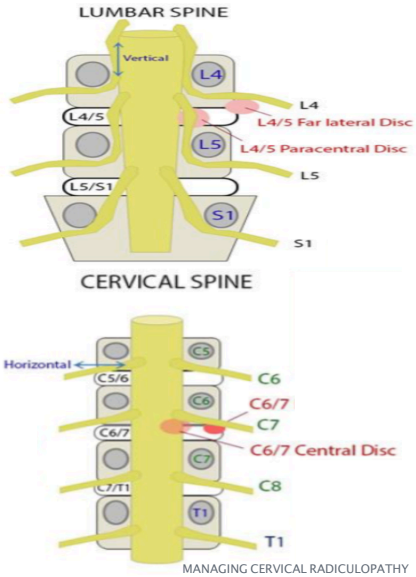
- 30 subjects
- Physiological right rotation
- Ipsilateral IVF
  - Decreased area
- Contralateral IVF
  - Increased area

Digailly 2018



Cervical nerve roots





Grading root compression

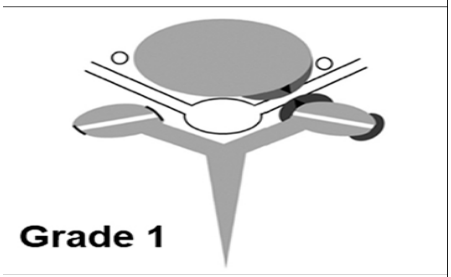
Grade 1:

- Non-severe neuro-foraminal stenosis
- Narrowest width < 50% extra-foraminal nerve root width

Grade 1a:

- Grade 1 stenosis
- Predominant anterior nerve root compression from disc herniation

Kim 2015



Grading root compression

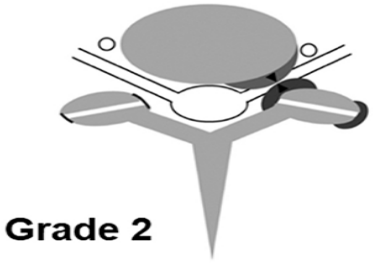
Grade 2:

- Severe neuro-foraminal stenosis
- Narrowest width < 50% of extra-foraminal nerve root width

Grade 2a:

- Grade 2 posterior stenosis
- Anterior nerve root compression from disc herniation

Kim 2015



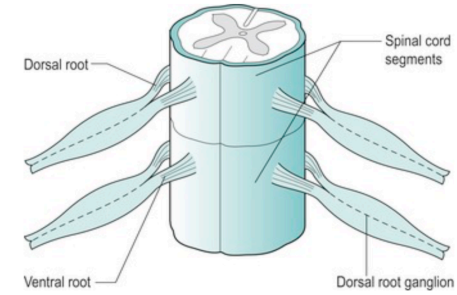
Cervical nerve roots

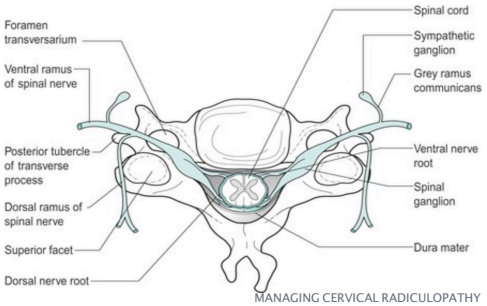
Radicular pain

Caused by mechanical or chemical irritation of:

- The sensory branch of spinal nerve root
- Dorsal root ganglion
- Resulting in generation of ectopic impulses and perception of peripheral pain

Merskey1994, Kim 2015





Cervical nerve roots

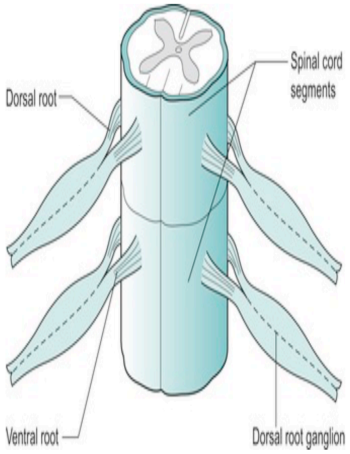
Radicular pain

Not caused by:

- Stimulation of peripheral nerve endings

Not synonymous with:

- Somatic pain
- Somatic referred pain
- Radiculopathy
  - Blocking of conduction in:
    - Sensory axons
    - Motor axons



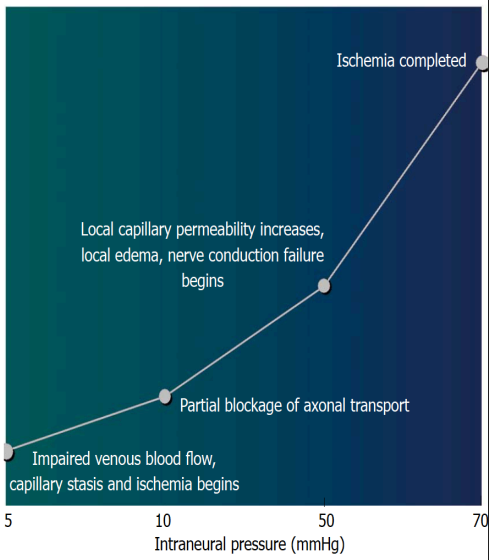
Merskey1994, Kim 2015

Neurobiological cause of pain

Mechanical compression

- Increased intra-neural pressure
- Intra-neural edema
- Compression of peri-radicular venous plexus within foramen
- Venous stasis
- Congestion
- Decrease intra-neural blood flow
- Ischemia
- Hypoxia
- Tissue acidosis

Lin 2014



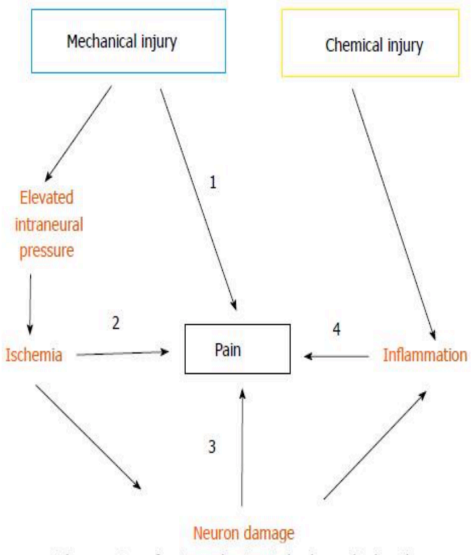
Neurobiological cause of pain

Chemical irritation

Nucleus pulposus material

- Enhances DRG neuron excitability
- Reduced nerve blood flow
- Axonal degeneration
- Intra-neural edema
- Local immune response

Lin 2014



Prognosis

Systematic review

- 3 studies, 319 subjects

"Most patients with symptomatic cervical disc herniations with radiculopathy initially present with intense pain and moderate levels of disability.

However substantial improvements tend to occur within the first 4-6 months post-onset.

Time to complete recovery ranged from 24 to 36 months in approximately 86% of patients.

Patients with a worker's compensation claim appeared to have a poorer prognosis"

Wong 2014

Prognosis

Retrospective case series

- 61 consecutive patients with cervical radiculopathy

Prognostic factors of poorer outcome at 12 months

- Longer duration of symptoms
- Absence of paresthesia
- Higher neck pain intensity at baseline
- Higher baseline disability score
- Lower active rotation towards affected side

Sleijser-Koehorst 2018

What are we going to screen and why?

Medical pathologies

- Neurological
- Vascular
- Visceral referral
- Fracture
- Instability
- Cancer
- Infection
- Musculoskeletal

Why?

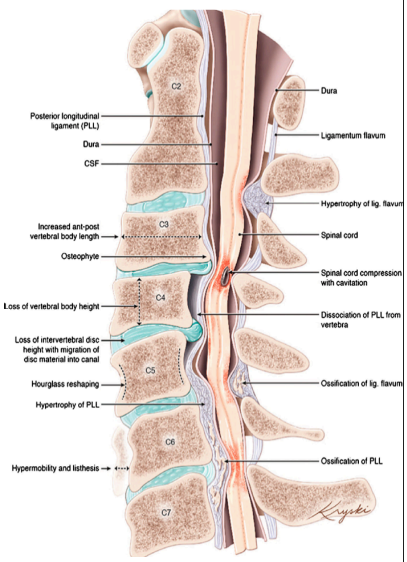
- We don't want to miss these
- Direct patient to medical care
- Decide what tests and treatment to **NOT** do

Neurogenic

Cervical myelopathy

Pathophysiology of cord compression

- Degenerative spondylosis
- Congenital stenosis
- Ossification of posterior longitudinal ligament
- Tumour
- Epidural abscess
- Trauma
- Cervical kyphosis
- RA

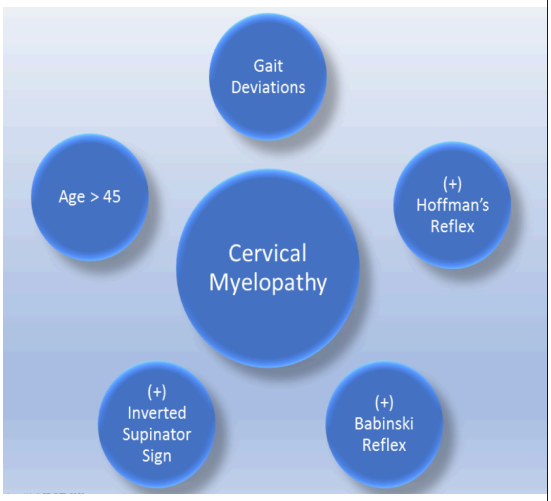


Neurogenic

Cervical myelopathy

Symptoms

- Gait imbalance (worse in dark)
- Neck arm shoulder pain
- Distal weakness
- Clumsiness of hands
- Non-dermatomal paresthesiae in limbs
- Urinary retention (late stage)



Neurogenic

Cervical myelopathy

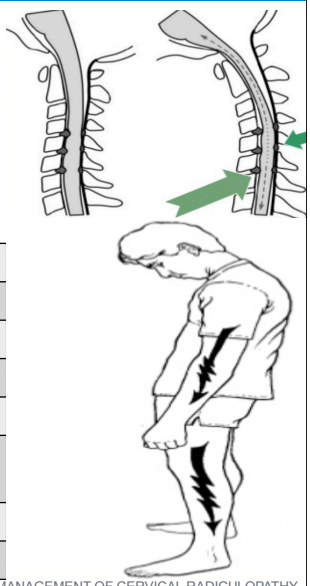
Lhermitte's sign

Sudden electrical sensations in limbs triggered by neck flexion

- **Sensitivity 17%**
- **Specificity 97%**

Causes	
Multiple sclerosis	Syringomyelia
Cervical myelopathy	Vitamin B12 deficiency
Transverse myelitis	Disc herniation
Radiation myelopathy	Systemic lupus
Sub-acute degeneration of cord	Post dural puncture headache
Arnold-Chiari malformation	Herpes zoster
Trauma	Parasitic invasion of cord

Khar 2015



Neurogenic

Cervical myelopathy

Upper motor neuron signs

- Pronator Drift
- Inverted supinator
- Hoffman's reflex
- Babinski
- Clonus
- Rhomberg

Neurogenic

Cervical myelopathy

Clinical Prediction Rule

1. Gait deviation
2. +ve Hoffman's reflex
3. Inverted supinator sign
4. +ve Babinski test
5. Age > 45

Cook 2010

Clustered results	Sens	Spec	+ve LR	-ve LR
1 of 5	0.94	0.31	1.4	0.18
2 of 5	0.39	0.88	3.3	0.63
3 of 5	0.19	0.99	30.9	0.81
4 of 5	0.09	1.0	Infinity	0.91

Neurogenic

Long thoracic nerve palsy

May be caused by:

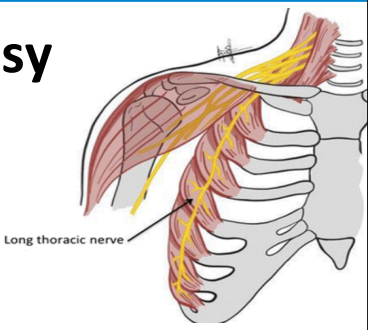
- Direct trauma
- Surgery
- Idiopathic

Most recover over 2 yrs.

Diagnosis by:

- Nerve conduction studies
- Clinical examination

Wiater 1999

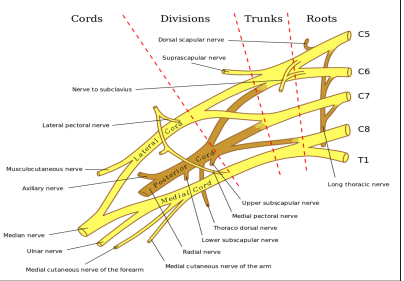


Neurogenic

Parsonage Turner syndrome

- AKA :Acute brachial neuritis"
- Sudden onset shoulder and/or arm pain
- Followed by progressive motor & sensory deficit
- Cause is unknown but may be related to viral infection
- MRI T2 image shows hyper-intensity in nerve root/trunk/ cord/branch of brachial plexus
- 90% recover in 3 years

Schreiber 2009, Feinberg 2010



Neurogenic

Ulnar neuropathy

- AKA cubital tunnel syndrome

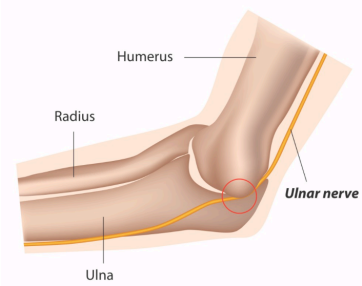
May be caused by:

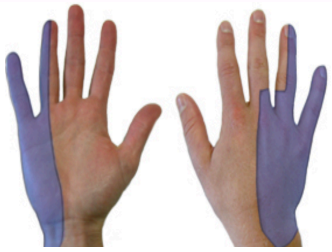
- Trauma
- Repeated irritation

Diagnosed by:

- Nerve conduction studies
- Clinical examination

Cutts 2007





Neurogenic

Median neruropathy

- AKA carpal tunnel syndrome

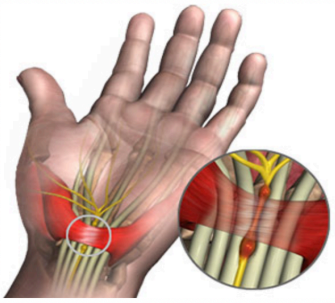
May be caused by:

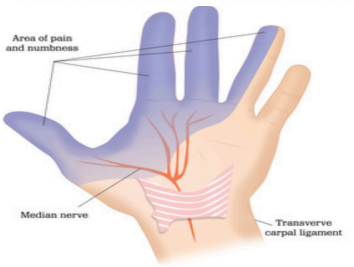
- Trauma
- Repeated irritation

Diagnosed by:

- Nerve conduction studies
- Clinical examination

Butterbaugh 2020



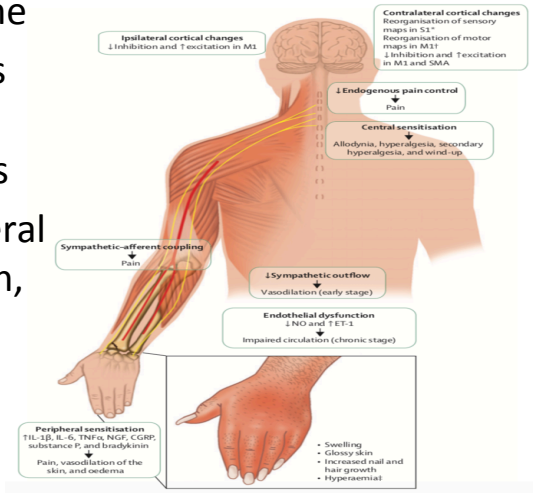


Neurogenic

Complex Regional Pain Syndrome

- Chronic pain syndrome
- Affects 7% of patients with limb fractures, surgery, other injuries
- Contributors: peripheral & central sensitization, autonomic changes, sympathto-afferent coupling

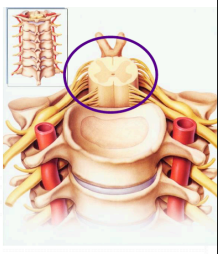
Bruehl 2015, Marinus 2011



Neurogenic

Upper motor neuron diseases

UMN



Multiple sclerosis

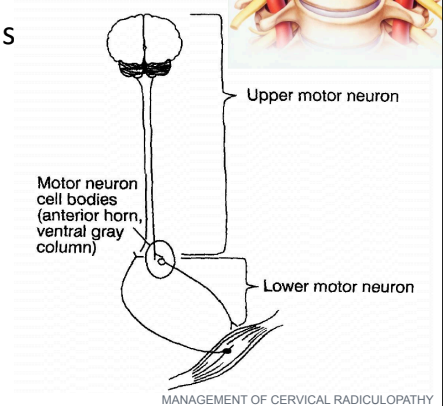
- Autoimmune disease
- Highly variable course
- May present as limb paresthesias weakness, loss dexterity

Motor neuron disease

Degeneration and death of motor neurons

- Amyotrophic Lateral Sclerosis
- Progressive Muscular Atrophy
- Progressive Bulbar Palsy
- Primary Lateral Sclerosis

Muscovich 2016



Vascular

Thoracic outlet syndrome

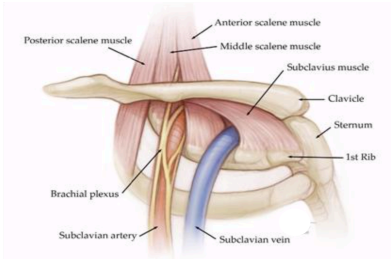
May present as:

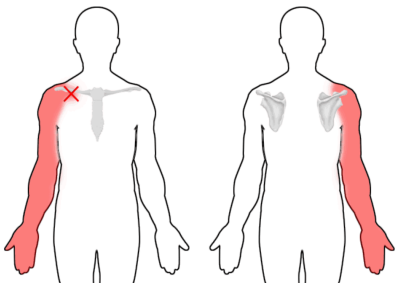
- Neck & arm pain
- Glove-like paresthesia in hand / fingers
- Impaired motor dexterity
- Impaired circulation

Diagnosed by:

- Nerve conduction studies
- Doppler ultrasound
- Clinical findings

Eske 2019





Vascular

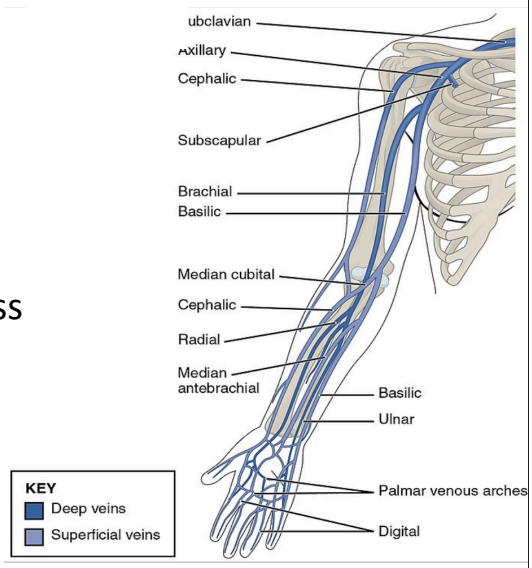
Upper limb DVT

- 4-10% of all DVT's in upper limb

Signs & symptoms

- Shoulder neck pain
- Arm/hand edema
- Supra-clavicular fullness
- Palpable cord
- Cyanosed upper extremity
- Dilated vein
- Jugular vein distension

Heil 2017



Vascular

DVT in Upper Extremity

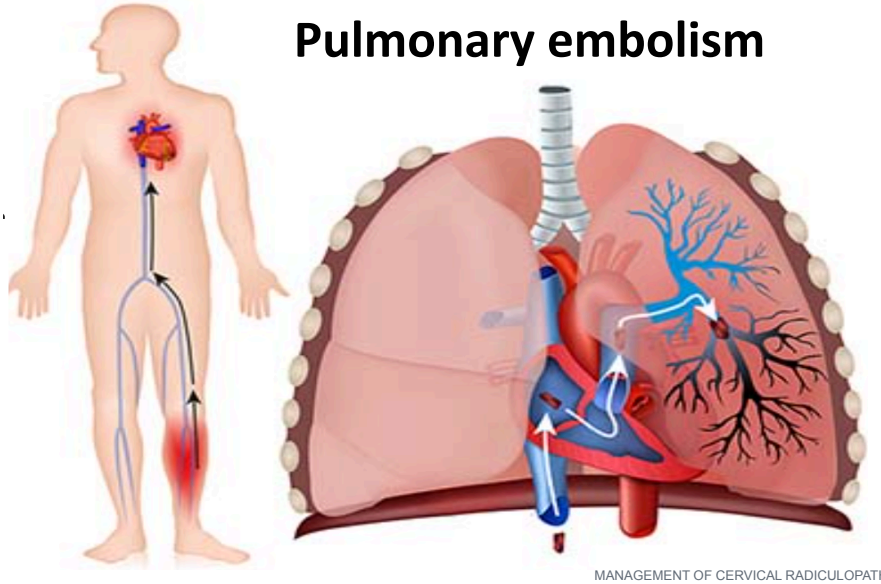
Most commonly

- Internal jugular 45%
- Axillary 45%
- Brachial 25%
- Subclavian 16%

Risk Factor	Comment
Age	> 50 yrs. & increases up to 80
Obesity	BMI > 35
Pregnancy	Third trimester
Solid cancers	Adeno carcinomas & metastatic disease
Hematologic cancers	Acute leukemia
Inherited thromobophilia	Factor V & protein C deficiencies
Recent surgery or trauma	Lasts up to 4 weeks post-op or ICU care
Immobility	Acute limb immobility

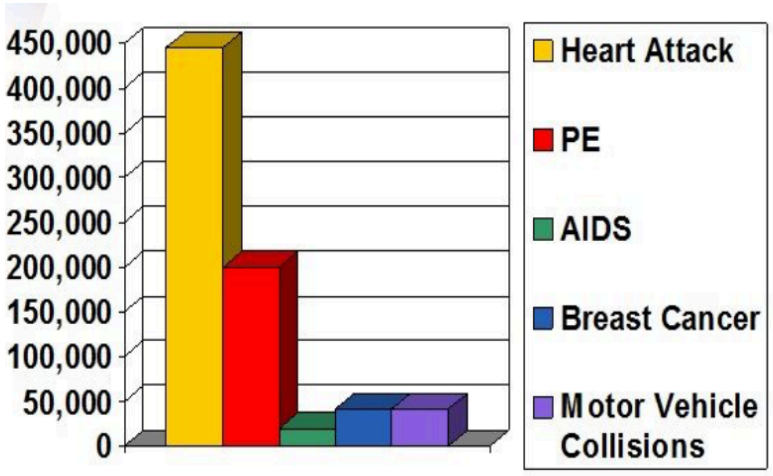
Vascular

Pulmonary embolism



Vascular

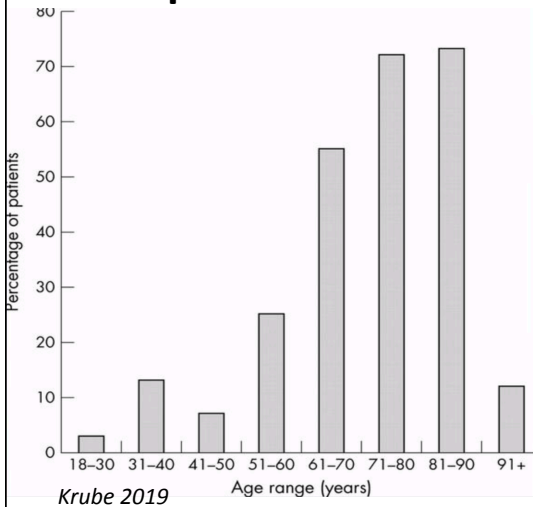
Pulmonary embolism Deaths



Lucena 2009

Vascular

Deep vein thrombosus

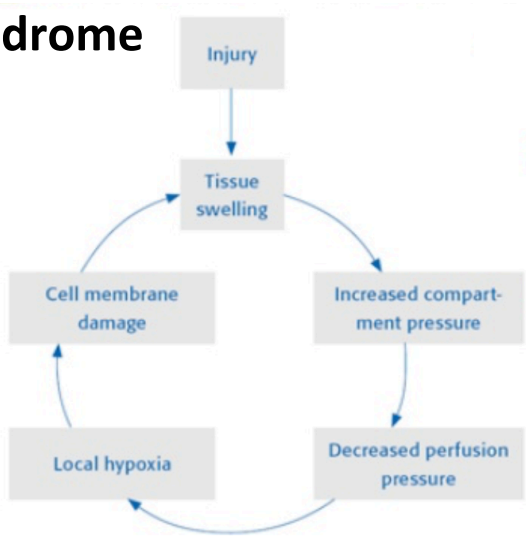


Krube 2019

Risk factors

Vascular

Compartment syndrome



5 presenting "P's"

- **P**ain
- **P**allor
- **P**ulse (absent)
- **P**aralysis
- **P**aresthesia

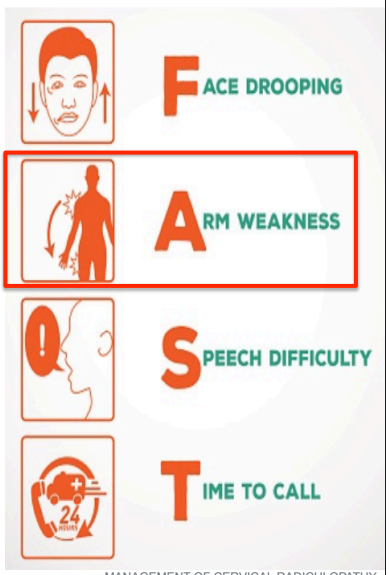
Vascular

Stroke

Systematic review

- 34 studies, 20,590 subjects post CVA
- 90% shoulder pain
- 78% arm weakness
- Impairments continue to progress up to 6 months

Malone 2017



Vascular

Cerebellar stroke

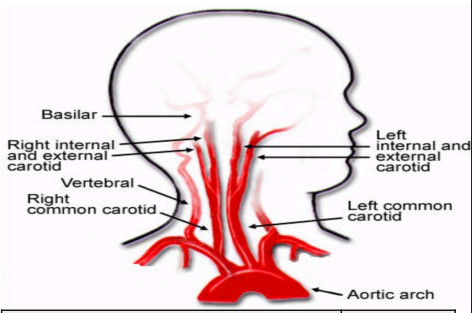
5D's And 3 N's

1. Dizziness
2. Dysphagia
3. Disarthria
4. Diploplia
5. Drop attacks

& Ataxia

1. Nausea
2. Numbness
3. Nystagmus

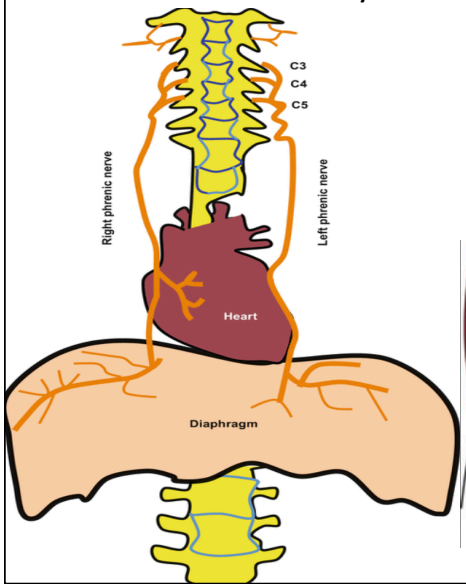
Murphy 2010

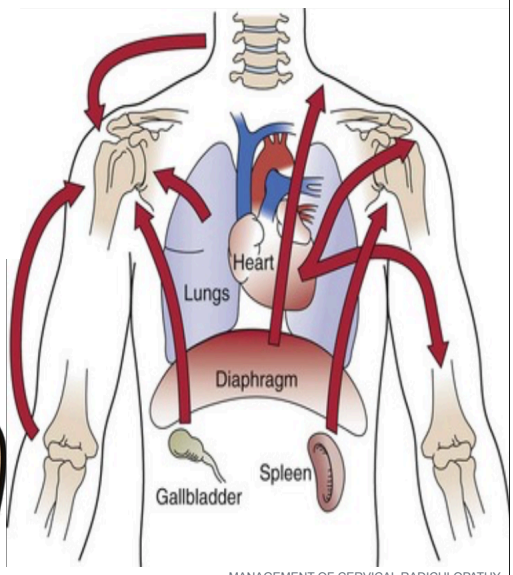


Risk Factor	Dissection CAD %
Recent trauma (mild-moderate, may include OMT)	40-64
Recent infection	22
Hypertension	19
Current or past smoker	30
High cholesterol	23
Family history of stroke	9
Oral contraception	11
Migraine	23
Vascular anomaly	39

Visceral

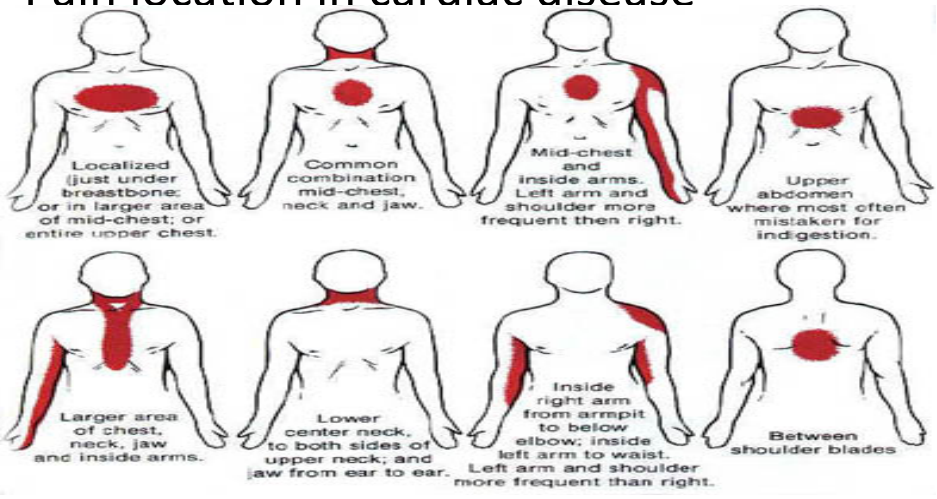
These structures all innervated by C3-C5





Visceral

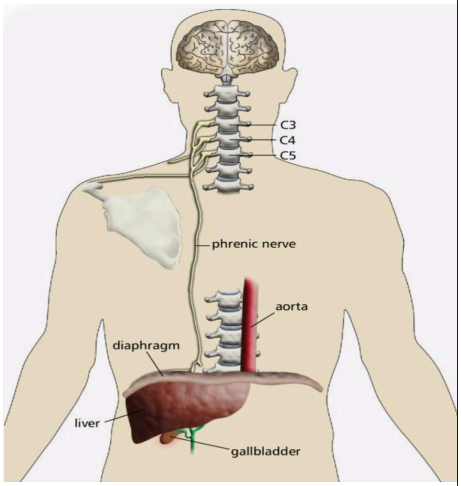
Pain location in cardiac disease



Visceral

Liver & Gallbladder

- Diaphragm innervated by C3, 4, 5
- Central convergence
- Experience of pain:
- Right upper shoulder
- Radiation to upper limb



Endocrine

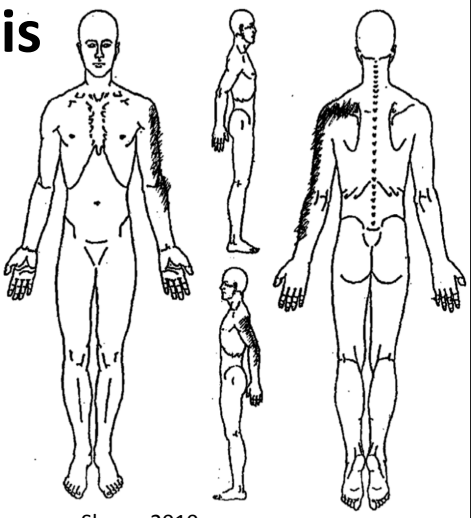
Adhesive capsulitis

Demographics

- Age > 40
- Female gender

Systemic diseases

- Diabetes
- Hyperthyroidism
- Hypothyroidism



Slaven 2010

Endocrine

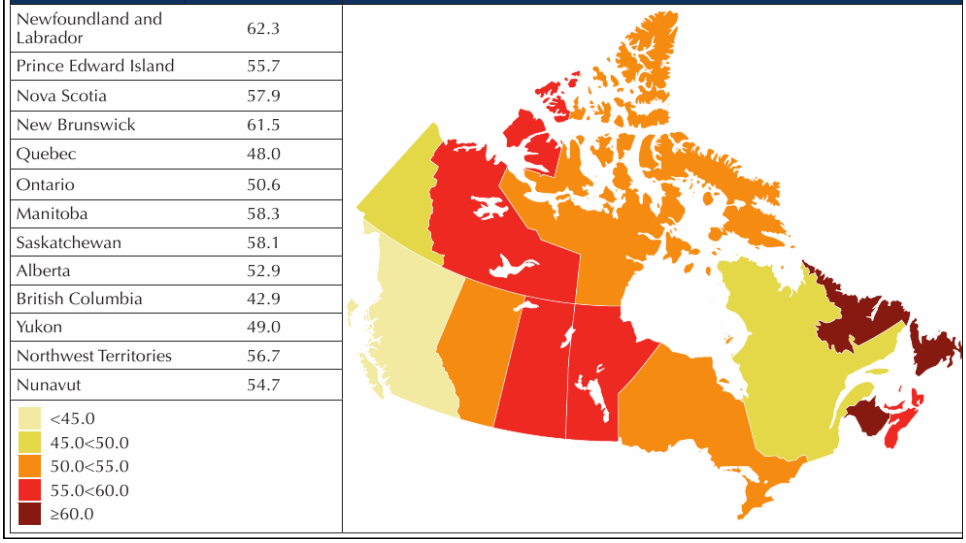
Today, 11 million Canadians live with diabetes or prediabetes

Every three minutes, another Canadian is diagnosed. About 90 per cent have type 2 diabetes, a condition in which the body does not make enough insulin or cannot properly use the insulin it produces.

Signs you may have diabetes can include

Endocrine

	Age-standardized prevalence (%)
Newfoundland and Labrador	62.3
Prince Edward Island	55.7
Nova Scotia	57.9
New Brunswick	61.5
Quebec	48.0
Ontario	50.6
Manitoba	58.3
Saskatchewan	58.1
Alberta	52.9
British Columbia	42.9
Yukon	49.0
Northwest Territories	56.7
Nunavut	54.7

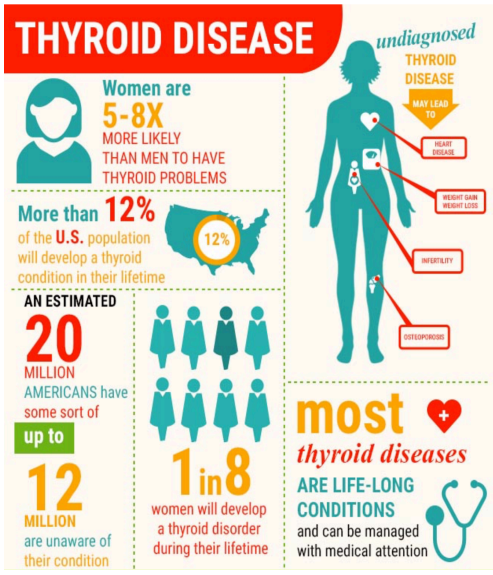


Diabetes prevalence in Canada

Endocrine

Thyroid gland

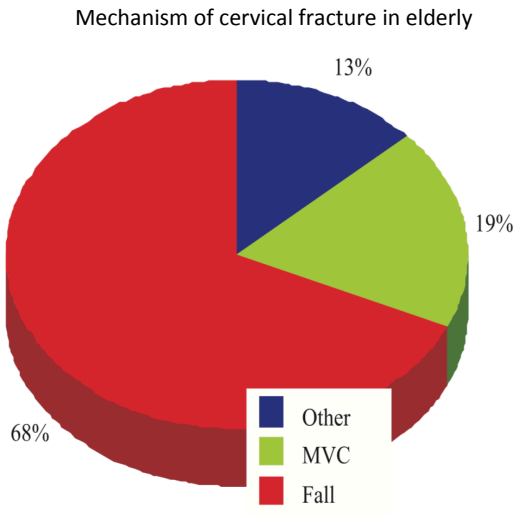
- Produces hormones regulate multiple body functions
- Hypothyroidism much more common than hyperthyroidism
- More common in advanced age



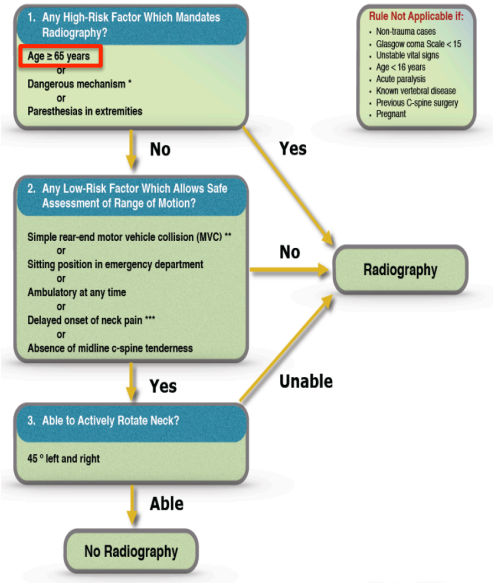
Fractures

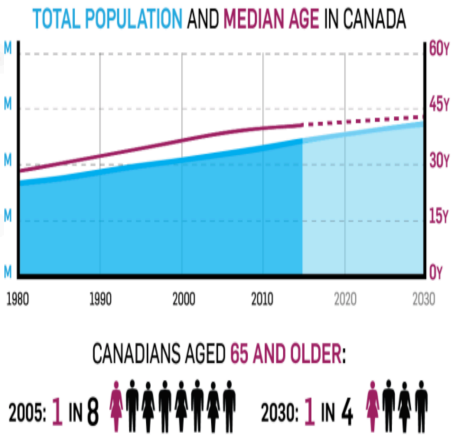
- Blunt trauma victims > 65 yrs 2X more likely than younger to have C-spine #'s
- Odontoid fractures 20% of elderly C-spine vs 5% in younger
- Patients > 65 yrs, included in Canadian C spine rules

Francher 2012

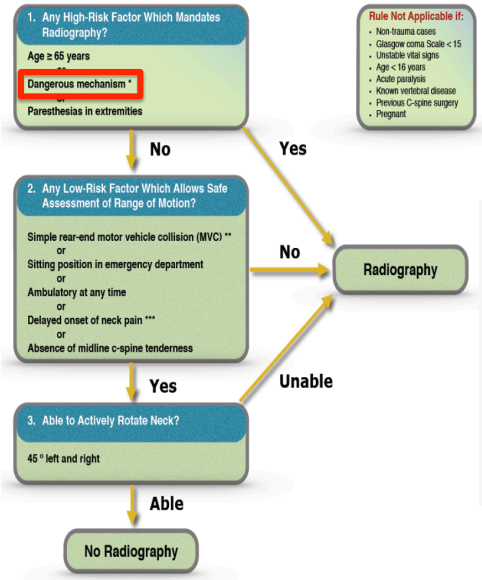


Fractures



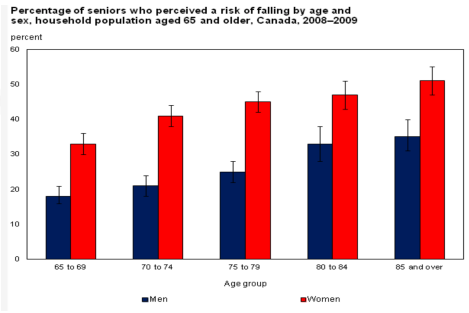


Fractures

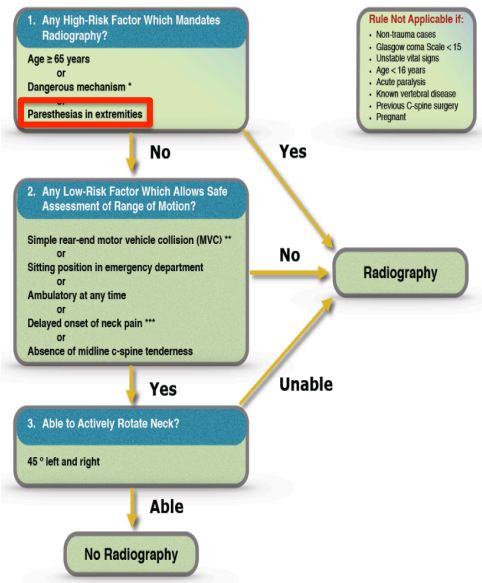


**Dangerous Mechanism*

- Fall from elevation ≥ 3 feet or 5 stairs
- Axial load to head, e.g. diving
- MVC high speed (> 100 km/hr), rollover, ejection
- Motorized recreational vehicles
- Bicycle struck or collision



Fractures

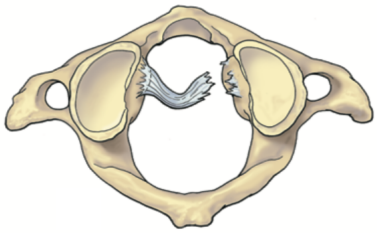


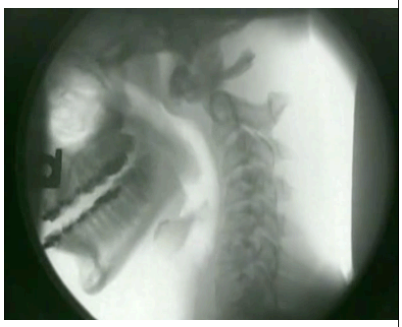
Acute onset	Sub-acute onset	Chronic onset
• Ulnar neuropathy • Peroneal neuropathy • Meralgia paresthetica • Polyarteritis nodosa • Microscopic polyangiitis • Hereditary neuropathy with liability to pressure palsy • Tibial neuropathy • Rheumatoid arthritis • Panic attack with hyperventilation • Cinguaters toxicity • Acute inflammatory demyelinating polyradiculoneuropathy • Diabetic lumbosacral radiculoplexus neuropathy • Brachial plexopathy or plexitis • Cervical radiculopathy • Thoracic radiculopathy • Lumbosacral radiculopathy • Herpes zoster infection • Myelopathy due to spinal cord compression • Multiple sclerosis • Transverse myelitis • Acute disseminating encephalomyelitis • Guillain-Barre syndrome • Stroke/TIA • Migraine with aura • Conversion/somatization disorder • Partial epilepsy • Distal symmetric polyneuropathy (DSP)	• Carpal Tunnel Syndrome • Ulnar neuropathy • Peroneal neuropathy • Meralgia paresthetica • Sarcoidosis • Paraneoplastic neuropathy • Churg-Strauss syndrome • Granulomatosis with polyangiitis (Wegener) • Hypocalcemia • Dysproteinemia (monoclonal gammopathy) • Drug toxicity • Hereditary neuropathy with liability to pressure palsy • Tibial neuropathy • Heavy metal toxicity • Leprosy • Rheumatoid arthritis • HIV infection • Herpes simplex infection • Brachial plexopathy or plexitis • Lumbosacral plexopathy • Cervical radiculopathy • Thoracic radiculopathy • Lumbosacral radiculopathy • Lyme disease • Myelopathy due to spinal cord compression • Multiple sclerosis • Conversion/somatization disorder • Distal symmetric polyneuropathy (DSP) • Peripheral neuropathy after bariatric surgery	• Carpal Tunnel Syndrome • Ulnar neuropathy • Peroneal neuropathy • Diabetic polyneuropathy • Sarcoidosis • Paraneoplastic neuropathy • Inborn errors of metabolism • Uremia • Dysproteinemia (monoclonal gammopathy) • Drug toxicity • Charcot-Marie-Tooth disease or Hereditary Motor and Sensory Neuropathy (HMSN) • Hereditary Sensory and Autonomic Neuropathy (HSAN) • Hexane toxicity • Hypothyroidism • Alcohol neuropathy • Vitamin B12 deficiency • Vitamin B6 deficiency • Vitamin B6 excess supplementation • Vitamin B1 deficiency • Tibial neuropathy • Heavy metal toxicity • Rheumatoid arthritis • Systemic Lupus Erythematosus • Peripheral vascular disease • Chronic inflammatory demeylinating polyradiculoneuropathy • Brachial plexopathy • Lumbosacral plexopathy • Radiation injury

Instability

- Cervical spine injured in 2.4% of blunt trauma victims
- Incidence rate of 64/100,000 with 2 peaks:
  - Second & third decade in males
  - Elderly females
- Most common injury mechanism:
  - Accidental falls
  - MVC
- Cervical spine most common site of spinal cord injury 55% of all cases

Torretti 2007





Instability

Rheumatoid arthritis

Ankylosing spondylitis

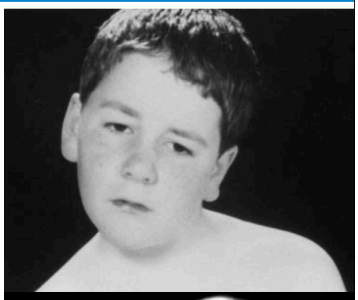
Psoriatic spondylo-arthropathy

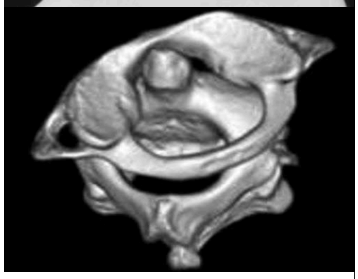
- Involve the C1-2 joint
- Damage the transverse ligament
- Erode the odontoid peg
- Instability of the C1/2 joint
- Subluxation may spontaneously occur following trivial injury

Instability

Gisele's Syndrome

- Long-standing URT infection "Tonsilitis"
- Retro-pharyngeal abscess causes inflammatory laxity of upper cervical ligaments
- Subluxation of C1/2 joint
- "Cock Robin" deformity (contralateral SB/Rot)





Instability

Os odontoideum

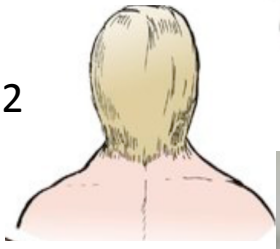
- Congenial non-fusion of C2 odontoid peg

Klippel Fiel

- Congenital fusion of 2 vertebrae

Down's Syndrome

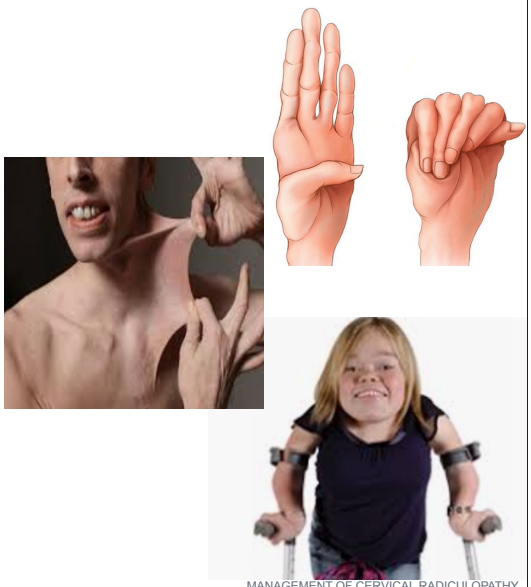
- Congenital abnormalities of C-spine



Instability

Connective tissue disorders

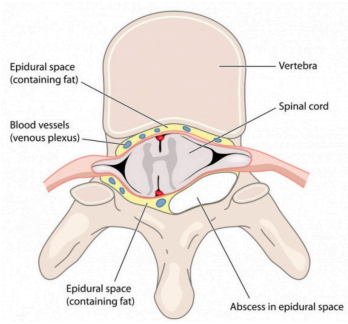
- Marfan's syndrome
- Ehler's Danlos syndrome
- Morquio syndrome



Infection

Epidural abscess

- More common in posterior canal area
- Primary
  - Skin soft tissue
- Secondary
  - Osteomyelitis or discitis
- More common > 50 yrs.
- May cause cord or root compression



Risk factors

- Alcohol abuse
- Diabetes mellitus
- Immuno-suppression
- Trauma
- Spine surgery

Eidelson 2019

Clinical presentation:

- Spine pain (75%)
- Fever (50%)
- Neurologic symptoms (33%)

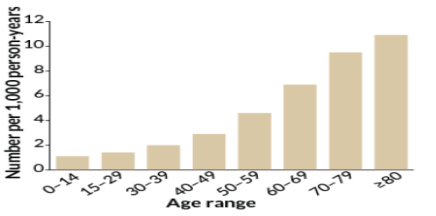
Triplett 2015

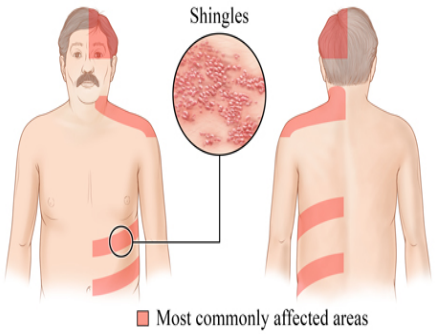
Infection

Herpes zoster

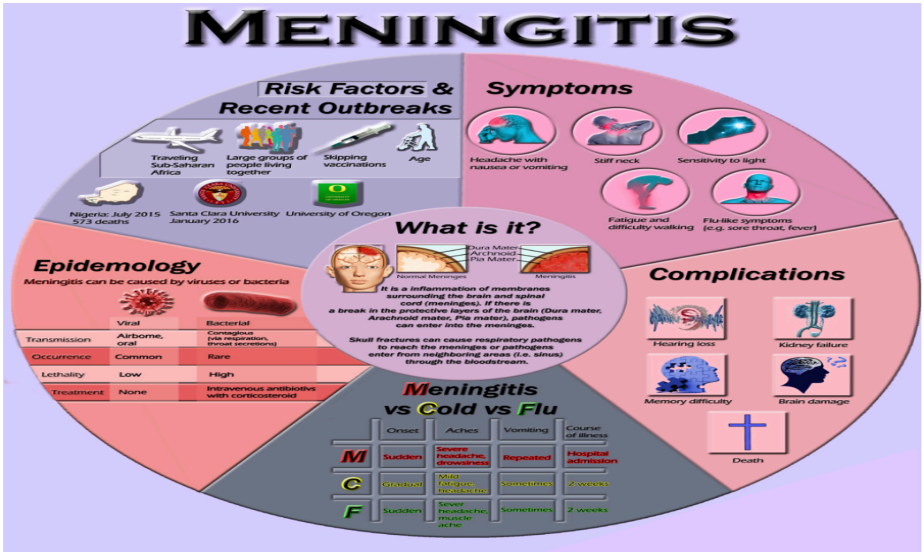
- Viral infection (chicken pox) of
- Pain, burning, numbness
- Sensitivity to touch
- Red rash with fluid-filled blisters
- 10-18% experience post-herpetic neuralgia
- Higher risk in senior population

CDC 2019, Otwell 2005





Infection



Infection

Brudzinski's

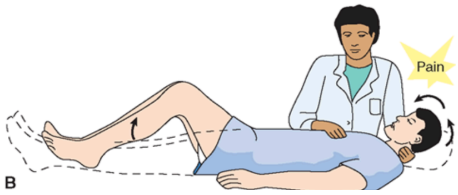
- Sensitivity 66%
- Specificity 74%

Thirunavukkarasu 2013

L'Hermitte's

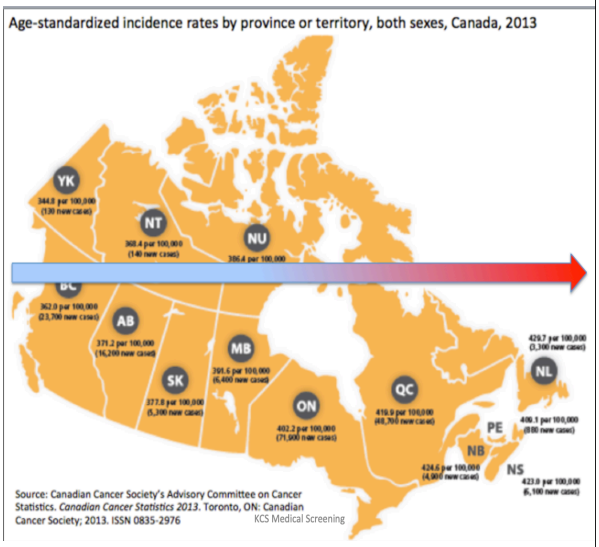
- Sensitivity 17%
- Specificity 97%

Khare 2015



Cancer

- The likelihood of seeing a patient with a serious medical problem is related to the prevalence of that disease in your community.
- Incidence is related to risk factors



Cancer

Spinal tumor growth or bony fracture from weakened bone causes reduction in the blood supply to the spinal cord and/or nerve roots

Origin

- Breast
- Lung
- Prostate
- Lymphoma
- Myeloma

Foran 2014

Cancer

Risk factor	Context	Raised suspicion
Past history of cancer	Approx. 25% of metastatic spinal cord compression cases have no known primary diagnosis	Cancers that do have a predilection to bone metastases (eg. Breast, prostate, kidney, thyroid)

Finucane 2020

Cancer

Symptoms of spinal malignancy

Symptoms	Context	Raised suspicion
Progressive, Severe, constant pain	Metastatic bone disease may way and wane but in later stages tends to be more constant and progressive	Reports of progressive worsening of symptoms
Night pain	Mechanical back pain often worse at night	Waking with pain and having to get up to walk or sit in a chair with minimal relief
Systemically unwell	Symptoms associated with hypercalemia may be related to: • Hyperparathyroidism • Hyperthyroidism • Adrenal insufficiency • Osteoporosis • Immobility • Excess calcium intake (or vit. D)	Reports of fatigue, nausea, stomach pain, fever. Progressive in nature

Finucane 2020

Cancer

Symptoms of spinal malignancy

Symptoms	Context	Raised suspicion
Thoracic pain	Thoracic spine most common site of metastatic spinal cord compression	Pain on percussion over spine May not have a mechanical pattern
Neurological symptoms	Metastatic spinal cord compression may not correspond to the sensory level of pain	Bilateral or quadrilateral neurological symptoms Gait disturbances, Coordination issues, Bowel/bladder disturbances
Unexplained weight loss	> 5% weight loss over a 6 month period considered significant	5-10% weight loss over a 3-6 moth period
Unfamiliar back pain	Many LBP patients have long history of pain that is familiar to them	Description of a new “unfamiliar pain”

Finucane 2020

Cancer

Signs of spinal malignancy		
Sings	**Physical assessment**	**Raised suspicion**
Altered sensation from trunk down	Neurological testing for sensation throughout area described by the patient	Objective signs of altered sensation Dermatomal and/or Non-dermatomal
Neurological signs	Examination of the: • Upper motor neuron system • Lower motor neuron system	People with symptoms in the lower limbs Gait disturbances Changes to bowel/bladder activity
Spine tenderness	Percussion over spine may reveal tenderness Lack of tenderness on percussion does not rule out possibility of metastases Vibration over mid-line spine with 128 Hz tuning fork	Reproduction of pain on percussion and/or vibration

Finucane 2020

Cancer

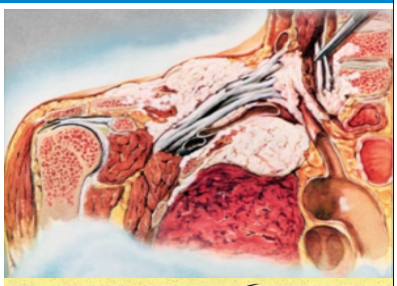
Pancoast tumor

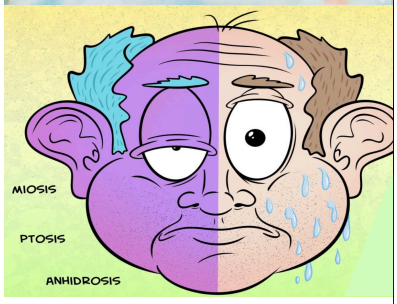
Symptoms

- Upper arm pain & swelling
- Paresthesia hand
- Weakness of hand
- Loss of hand dexterity

Signs

- Horner's syndrome
  - Myosis
  - Facial flushing
  - Anhydrosis hand
  - Pseudo-ptosis





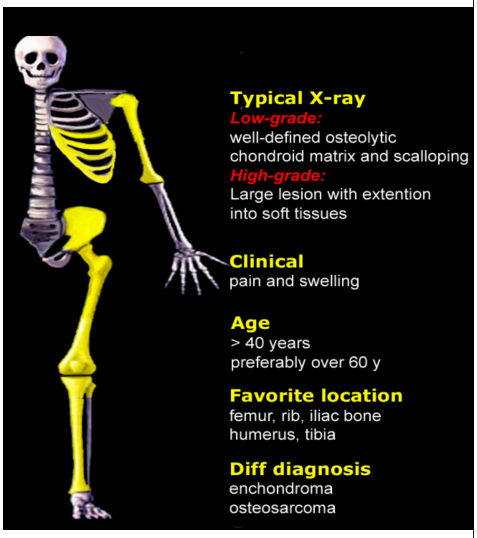
Luo 2019

Cancer

Proximal humerus

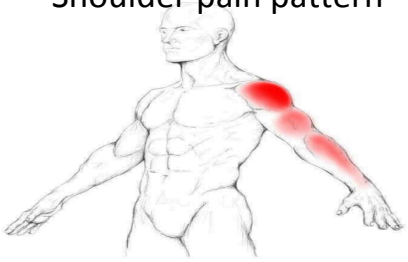
- Osteo & Chondro sarcoma of humerus second most common site (after distal tibia)
- Accounts for 20% of all malignant tumors
- 90% are found in proximal humerus

Ottaviani 2009

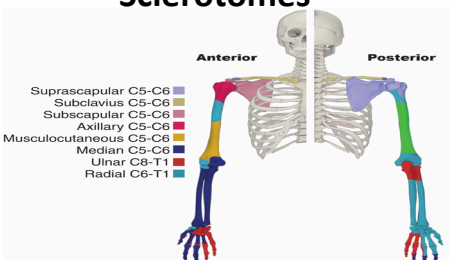


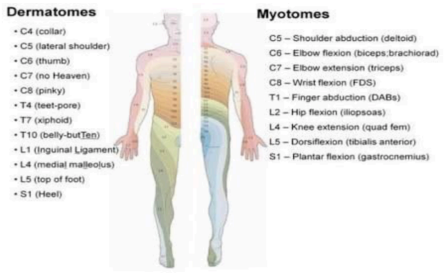
Musculoskeletal

Shoulder pain pattern



Sclerotomes





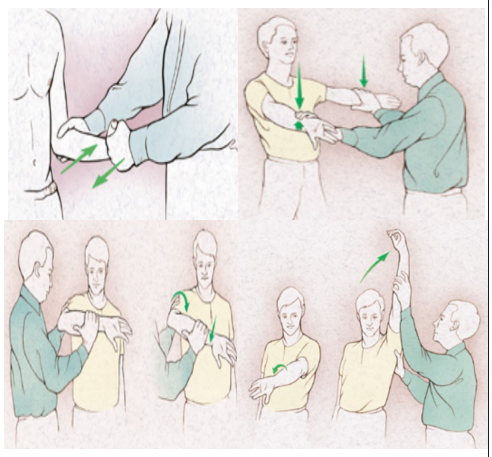
Musculoskeletal

Shoulder muscle / tendon

Clinical tests:

Test	Sensitivity	Specificity
Jobe's	17	68
Full can	70	81
Ext rot lag	27	98
Hornblower's	35	98
Hawkins/ Kennedy	92	25

Jain 2018, Razamjou 2019

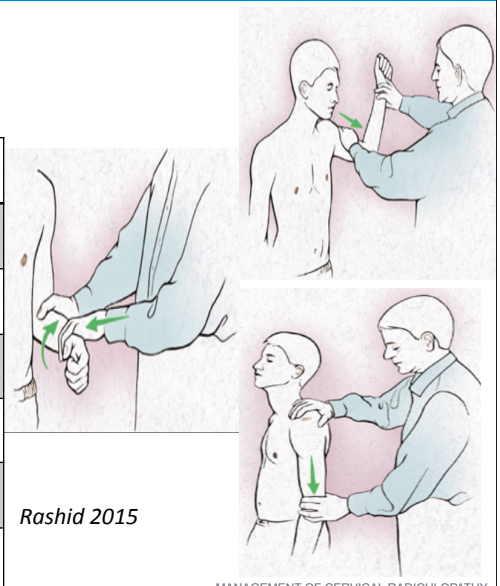


Musculoskeletal

Shoulder instability

Clinical tests:

Test	Sensitivity	Specificity
Apprehension pain provocation	50	56
Apprehension fear provocation	72	96
Relocation pain relief	30	90
Relocation fear relief	81	92
Ant. Drawer pain provocation	28	71
Ant. Drawer instability	53	85

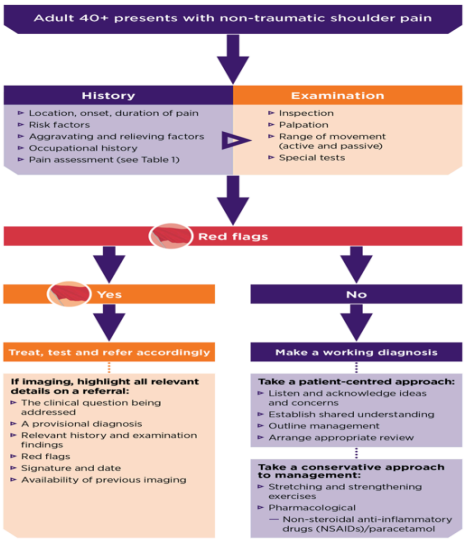


Rashid 2015

Musculoskeletal

- Rheumatoid arthritis
- Osteoarthritis
- Avascular necrosis
- Calcific tendinopathy
- Bursitis
- SLAP lesion
- Polymyalgia Rheumatica
- Gout
- Pseudogout
- Septic arthritis

Lehtinen 2000, Chillemi 2013, McKean 2020



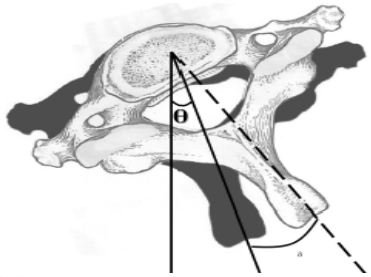
Musculoskeletal

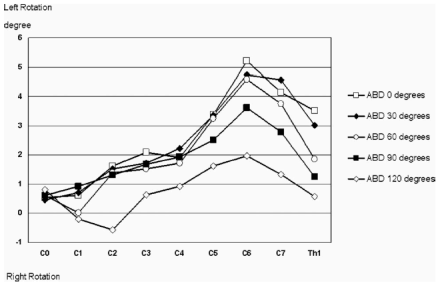
Cervical/shoulder complex

MRI of cervical spine during passive and active resisted right shoulder movement

- Passive shoulder movement does not affect cervical spine
- Active resisted solder abduction at 0º, 30º, 60º, 90º, 120º elevation
- Greatest movement at C6 (5.2º)
- C3- T1 resulted in rotation to left at all angles
- Above 120º rotation C1, C2 to right

Takasaki 2009

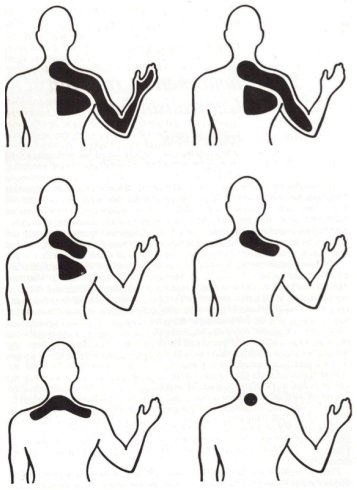




Musculoskeletal

Referred mechanical neck pain

- Generally not arm dominant
- Minimal objective neurological findings
- Displays:
  - –Movement impairment
  - –Directional preference
  - –Centralization



McKenzie 2003

Neurological differential diagnosis

Nt./Post interosseous nerve entrapment	Grip/pinch weakness, no pain
Carpal tunnel syndrome	Thenar weakness, numb/ paresthesia in median nerve fingers
Cervical myelopathy	Decreased dexterity, urinary urgency
Cubital tunnel syndrome	Grasp weakness, numb paresthesia 4^{th} 5^{th} digits
Radial tunnel syndrome	Pain at radial forearm
Brachial plexopathy	Shoulder pain, paresthesia, numbness
Complex regional pain syndrome	Pain, edema skin discoloration
Thoracic outlet syndrome	Pain, edema +ve Adson's Roos test

Non- neurological differential diagnoses

Myocardial infarction	Chest pain, diaphoresis, lightheadedness
Pulmonary embolism	Hypoxia, Tachycardia, chest pain
Spinal abscess	Fever, neurological deficit, immuno-compromised
Extra-spinal malignancy	Fever, History cancer, wt. loss
Herpes Zoster	Vescicular lesions, pain along dermatome
Rotator cuff syndrome	Shoulder pain + drop arm test
Diabetic neuropathy	Paresthesia, numbness
Thrombosis	Swelling, redness, pain, cool extremity

Identifying neuropathic pain

Leeds assessment of neuropathic symptoms and signs (LANSS)

- Patient sensory description
- Physical examination
- Sens 0.83, Spec 0.87

Self-reported Leeds Assessment of neuropathic symptoms and signs (S-LANSS)

- Patient sensory description
- Patient self-examination
- Sen 0.75, Spec 0.88

Gulada 2017

DN4

- Patient reported symptoms
- Physical examination
- Sens 0.70, Spec 0.81

Pain DETECT (PDQ)

- Patient reported symptoms
- Sens 0.82, Spec 0.91

ID Pain Questionnaire

- Patient reported symptoms
- Sens 0.70, Spec 0.81

LANSS

The Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) Pain Scale

Name ..... Date .....

This pain scale can help to determine whether the nerves that are carrying your pain signals are working normally or not. It is important to find this out in case different treatments are needed to control your pain.

A. PAIN QUESTIONNAIRE

- Think about how your pain has felt over the last week.
- Please say whether any of the descriptions match your pain exactly.

1. Does your pain feel like strange, unpleasant sensations in your skin?
   Words like pricking, tingling, pins and needles might describe these sensations.
   a) NO – My pain doesn't really feel like this ..... (0)
   b) YES – I get these sensations quite a lot ..... (5)

2. Does your pain make the skin in the painful area look different from normal?
   Words like mottled or looking more red or pink might describe the appearance.
   a) NO – My pain doesn't affect the colour of my skin ..... (0)
   b) YES – I've noticed that the pain does make my skin look different from normal ..... (5)

3. Does your pain make the affected skin abnormally sensitive to touch?
   Getting unpleasant sensations when lightly stroking the skin, or getting pain when wearing tight clothes might describe the abnormal sensitivity.
   a) NO – My pain doesn't make my skin abnormally sensitive in that area ..... (0)
   b) YES – My skin seems abnormally sensitive to touch in that area ..... (3)

4. Does your pain come on suddenly and in bursts for no apparent reason when you're still?
   Words like electric shocks, jumping and bursting describe these sensations.
   a) NO – My pain doesn't really feel like this ..... (0)
   b) YES – I get these sensations quite a lot ..... (2)

5. Does your pain feel as if the skin temperature in the painful area has changed abnormally?
   Words like hot and burning describe these sensations.
   a) NO – I don't really get these sensations ..... (0)
   b) YES – I get these sensations quite a lot ..... (1)

LANSS

Leeds Assessment of Neuropathic Symptoms and Signs (continued)

B. SENSORY TESTING

Skin sensitivity can be examined by comparing the painful area with a contralateral or adjacent non-painful area for the presence of allodynia and an altered pin-prick threshold (PPT).

1. Allodynia

Examine the response to lightly stroking cotton wool across the non-painful area and then the painful area. If normal sensations are experienced in the non-painful site, but pain or unpleasant sensations (tingling, nausea) are experienced in the painful area when stroking, allodynia is present.

a) NO – Normal sensations in both areas ..... (0)

b) YES – Allodynia in painful area only ..... (5)

2. Altered pin-prick threshold

Determine the pin-prick threshold by comparing the response to a 23-gauge (blue) needle mounted inside a 2ml syringe barrel placed gently onto the skin in a non-painful and then painful areas.

If a sharp pin prick is felt in the non-painful area, but a different sensation is experienced in the painful area, eg. none/ blunt only (raised PPT) or a very painful sensation (lowered PPT), an altered PPT is present.

If a pinprick is not felt in either area, mount the syringe onto the needle to increase the weight and repeat.

a) NO – Equal sensation in both areas ..... (0)

b) YES – Altered PPT in painful area ..... (3)

SCORING:

Add values in parentheses for sensory description and examination findings to obtain overall score.

TOTAL SCORE (maximum 24) .....

If score < 12, neuropathic mechanisms are unlikely to be contributing to the patient's pain.

If score ≥ 12, neuropathic mechanisms are likely to be contributing to the patient's pain.

DN4

DN4 – QUESTIONNAIRE

To estimate the probability of neuropathic pain, please answer yes or no for each item of the following four questions.

INTERVIEW OF THE PATIENT

QUESTION 1:

Does the pain have one or more of the following characteristics?	YES	NO
Burning	☐	☐
Painful cold	☐	☐
Electric shocks	☐	☐

QUESTION 2:

Is the pain associated with one or more of the following symptoms in the same area?	YES	NO
Tingling	☐	☐
Pins and needles	☐	☐
Numbness	☐	☐
Itching	☐	☐

EXAMINATION OF THE PATIENT

QUESTION 3:

Is the pain located in an area where the physical examination may reveal one or more of the following characteristics?	YES	NO
Hypoesthesia to touch	☐	☐
Hypoesthesia to pinprick	☐	☐

QUESTION 4:

In the painful area, can the pain be caused or increased by:	YES	NO
Brushing?	☐	☐

YES = 1 point
NO = 0 points

Patient's Score: /10

Pain DETECT

painDETECT PAIN QUESTIONNAIRE

Date: Patient: Last name: First name:

How would you assess your pain **now**, at this moment?
0 1 2 3 4 5 6 7 8 9 10
none max.

How strong was the **strongest** pain during the past 4 weeks?
0 1 2 3 4 5 6 7 8 9 10
none max.

How strong was the pain during the past 4 weeks **on average**?
0 1 2 3 4 5 6 7 8 9 10
none max.

Mark the picture that best describes the course of your pain:

- Persistent pain with slight fluctuations
- Persistent pain with pain attacks
- Pain attacks without pain between them
- Pain attacks with pain between them

Please mark your **main area of pain**

Does your pain radiate to other regions of your body? yes no
If yes, please draw the direction in which the pain radiates.

Do you suffer from a burning sensation (e.g., stinging nettles) in the marked areas?
never hardly noticed slightly moderately strongly very strongly

Do you have a tingling or prickling sensation in the area of your pain (like crawling ants or electrical tingling)?
never hardly noticed slightly moderately strongly very strongly

Is light touching (clothing, a blanket) in this area painful?
never hardly noticed slightly moderately strongly very strongly

Do you have sudden pain attacks in the area of your pain, like electric shocks?
never hardly noticed slightly moderately strongly very strongly

Is cold or heat (bath water) in this area occasionally painful?
never hardly noticed slightly moderately strongly very strongly

Do you suffer from a sensation of numbness in the areas that you marked?
never hardly noticed slightly moderately strongly very strongly

Does slight pressure in this area, e.g., with a finger, trigger pain?
never hardly noticed slightly moderately strongly very strongly

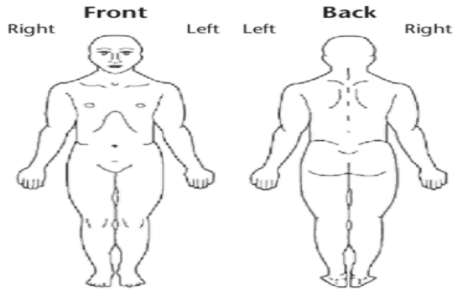
(To be filled out by the physician)

never	hardly noticed	slightly	moderately	strongly	very strongly
x 0 = 0	x 1 =	x 2 =	x 3 =	x 4 =	x 5 =

Total score out of 35

ID pain Questionnaire

On the diagram, below, shade in the areas where you feel pain. If you have more than one area, circle the area that bothers you the most.



Mark 'Yes' to the following items that describe your pain over the past week and 'No' to the ones that do not.

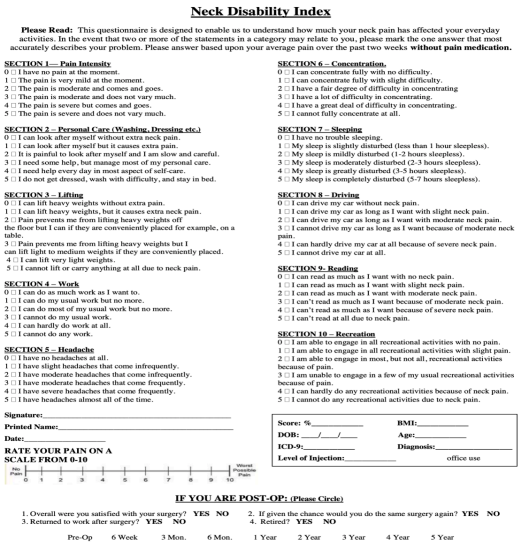
Question	Score	
	Yes	No
1. Did the pain feel like pins and needles?	1	0
2. Did the pain feel hot/burning?	1	0
3. Did the pain feel numb?	1	0
4. Did the pain feel like electrical shocks?	1	0
5. Is the pain made worse with the touch of clothing or bed sheets?	1	0
6. Is the pain limited to your joints?	–1	0

Total score = 3–5: 69% probability of NeP (using c-index)

Neck Disability Index

- Self- administered
- 10 sections
- Very functionally-oriented
- Focuses on neck pain not arm pain
- May not be applicable to cervical radiculopathy
- Sens 0.78
- Spec 0.80
- ICC 0.98
- MDC 5/50
- MCID 19/50

MacDermid 2009



Neck Disability Index

Please Read: This questionnaire is designed to enable us to understand how much your neck pain has affected your everyday activities. In the event that two or more of the statements in a category may relate to you, please mark the one answer that most accurately describes your problem. Please answer based upon your average pain over the past two weeks **without pain medication.**

SECTION 1— Pain Intensity
0 ☐ I have no pain at the moment.
1 ☐ The pain is very mild at the moment.
2 ☐ The pain is moderate and comes and goes.
3 ☐ The pain is moderate and does not vary much.
4 ☐ The pain is severe but comes and goes.
5 ☐ The pain is severe and does not vary much.

SECTION 2 – Personal Care (Washing, Dressing etc.)
0 ☐ I can look after myself without extra neck pain.
1 ☐ I can look after myself but it causes extra pain.
2 ☐ It is painful to look after myself and I am slow and careful.
3 ☐ I need some help, but manage most of my personal care.
4 ☐ I need help every day in most aspect of self-care.
5 ☐ I do not get dressed, wash with difficulty, and stay in bed.

SECTION 3 – Lifting
0 ☐ I can lift heavy weights without extra pain.
1 ☐ I can lift heavy weights, but it causes extra neck pain.
2 ☐ Pain prevents me from lifting heavy weights off the floor but I can if they are conveniently placed for example, on a table.
3 ☐ Pain prevents me from lifting heavy weights but I can lift light to medium weights if they are conveniently placed.
4 ☐ I can lift very light weights.
5 ☐ I cannot lift or carry anything at all due to neck pain.

SECTION 4 – Work
0 ☐ I can do as much work as I want to.
1 ☐ I can do my usual work but no more.
2 ☐ I can do most of my usual work but no more.
3 ☐ I cannot do my usual work.
4 ☐ I can hardly do work at all.
5 ☐ I cannot do any work.

SECTION 5 – Headache
0 ☐ I have no headaches at all.
1 ☐ I have slight headaches that come infrequently.
2 ☐ I have moderate headaches that come infrequently.
3 ☐ I have moderate headaches that come frequently.
4 ☐ I have severe headaches that come frequently.
5 ☐ I have headaches almost all of the time.

Signature:_____
Printed Name:_____
Date:_____

RATE YOUR PAIN ON A SCALE FROM 0-10

No Pain 0 1 2 3 4 5 6 7 8 9 10 Worst Possible Pain

SECTION 6 – Concentration.
0 ☐ I can concentrate fully with no difficulty.
1 ☐ I can concentrate fully with slight difficulty.
2 ☐ I have a fair degree of difficulty in concentrating
3 ☐ I have a lot of difficulty in concentrating.
4 ☐ I have a great deal of difficulty in concentrating.
5 ☐ I cannot fully concentrate at all.

SECTION 7 – Sleeping
0 ☐ I have no trouble sleeping.
1 ☐ My sleep is slightly disturbed (less than 1 hour sleepless).
2 ☐ My sleep is mildly disturbed (1-2 hours sleepless).
3 ☐ My sleep is moderately disturbed (2-3 hours sleepless).
4 ☐ My sleep is greatly disturbed (3-5 hours sleepless).
5 ☐ My sleep is completely disturbed (5-7 hours sleepless).

SECTION 8 – Driving
0 ☐ I can drive my car without neck pain.
1 ☐ I can drive my car as long as I want with slight neck pain.
2 ☐ I can drive my car as long as I want with moderate neck pain.
3 ☐ I cannot drive my car as long as I want because of moderate neck pain.
4 ☐ I can hardly drive my car at all because of severe neck pain.
5 ☐ I cannot drive my car at all.

SECTION 9- Reading
0 ☐ I can read as much as I want with no neck pain.
1 ☐ I can read as much as I want with slight neck pain.
2 ☐ I can read as much as I want with moderate neck pain.
3 ☐ I can't read as much as I want because of moderate neck pain.
4 ☐ I can't read as much as I want because of severe neck pain.
5 ☐ I can't read at all due to neck pain.

SECTION 10 – Recreation
0 ☐ I am able to engage in all recreational activities with no pain.
1 ☐ I am able to engage in all recreational activities with slight pain.
2 ☐ I am able to engage in most, but not all, recreational activities because of pain.
3 ☐ I am unable to engage in a few of my usual recreational activities because of pain.
4 ☐ I can hardly do any recreational activities because of neck pain.
5 ☐ I cannot do any recreational activities due to neck pain.

Score: %_____ **BMI:**_____
DOB: ___/____/____ **Age:**_____
ICD-9:_____ **Diagnosis:**_____
Level of Injection:_____ office use

IF YOU ARE POST-OP: (Please Circle)

1. Overall were you satisfied with your surgery? **YES NO**
2. If given the chance would you do the same surgery again? **YES NO**
3. Returned to work after surgery? **YES NO**
4. Retired? **YES NO**

Pre-Op 6 Week 3 Mon. 6 Mon. 1 Year 2 Year 3 Year 4 Year 5 Year

Cervical radiculopathy impact scale

21 item questionnaire

3 sub-scales:

- Symptoms
- Energy and postures
- Actions and activities

Test-retest reliability

- SEM 6.7 – 11.7
- ICC 0.8

Gartner 2020

Questions

1. Tingling or numb sensation in your arms, hand, fingers
2. Loss of strength in your arm, hand, fingers
3. Stiffness in your neck or shoulder
4. How often do you experience pain in your neck
5. What is the degree of the pain in your neck or as a whole

Yellow flags for acute neck related pain

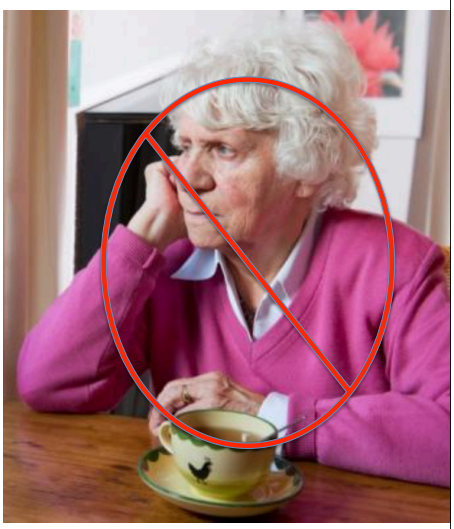
- Belief that neck pain are potentially disabling
- Fear and avoidance of activity or movement
- Tendency to low mood and withdrawal from social interaction
- Expectation to passive treatments rather than belief that active participation will help
- Legal proceedings in MVA or slip and fall
- Concurrent diagnoses of Fibromyalgia, Depression, PTSD

Depression

Risk Factors

- Age: Peak age of onset 20-40 yrs
- Gender: Female: Males 2:1
- Family history: 1.5 – 3 X
- Marital status:
  - Divorced
  - Separated
  - Widowed
  - Married vs unmarried

Stahl 2000



Depression

Screening for depression

Two Questions to ask:

1. Over the past 2 weeks have you ever felt down, depressed or hopeless?
2. Over the past 2 weeks, have you felt little pleasure or interest in doing things?

Sensitivity 96%

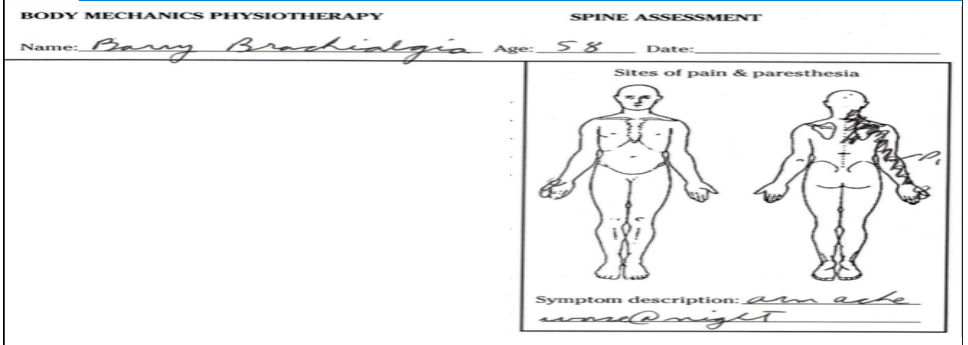
Specificity 57%

Pignone 2002

Other questions:

- How are things at work?
- How are things at home?
- We all have stress in our lies.
- Has your stress level increased lately?
- How are you handling it?

Symptom location


BODY MECHANICS PHYSIOTHERAPY SPINE ASSESSMENT

Name: Barry Brachialgia Age: 58 Date:

Sites of pain & paresthesia

Symptom description: arm ache worse@night

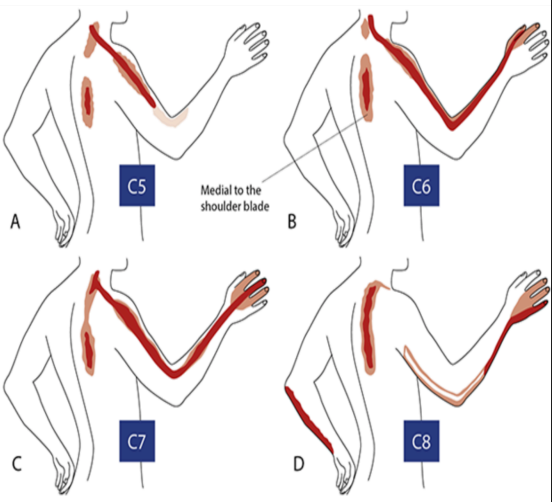
Symptom pattern

Location

- Arm pain: 99.4%
- Neck pain:79.7%
- Scapular pain: 52.5%
- Anterior chest pain: 17.8%
- Headache: 9.7%

Dermatomal pain or paresthesia reported by 53.9%,

Henderson 1983, Mogere 2013



Symptom pattern

239 patients who had an anterior cervical discectomy/fusion

- 54% fit the dermatomal pattern described by Netter
- 46% did not fit dermatomal pattern
- No cervical segmental level difference

Henderson 1986, *McAnany 2018*

Radicular symptoms present in nonstandard versus standard patterns

Level	Nonstandard pattern	Standard pattern	p Value
C3–C4	4 (26.7%)	11 (73.3%)	
C4–C5	9 (37.5%)	15 (62.5%)	
C5–C6	55 (50.9%)	53 (49.1%)	
C6–C7	38 (44.7%)	47 (55.3%)	
C7–T1	4 (57.1%)	3 (42.9%)	
Total	110 (46%)	129 (54%)	.35

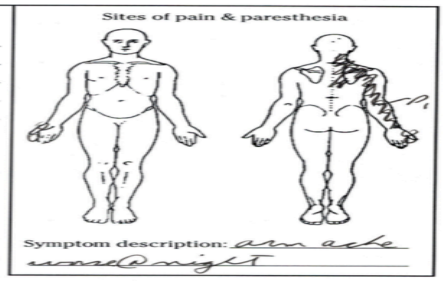
Symptom behaviour

BODY MECHANICS PHYSIOTHERAPY — SPINE ASSESSMENT

Name: Barry Brockridge — Date:

Symptoms: Constant ☒ Intermittent ☐

Sites of pain & paresthesia

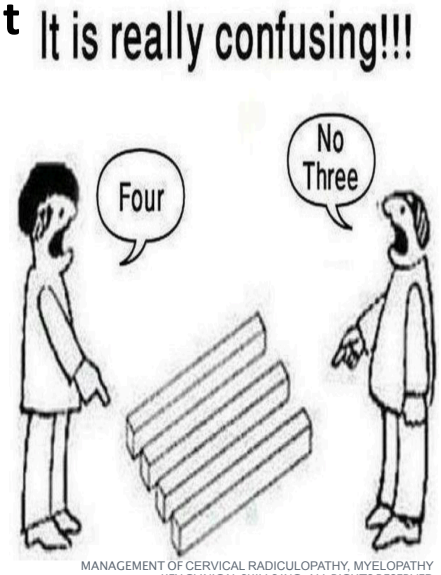


Symptom description: arm ache
worst @ night

Symptom behaviour

Constant vs intermittent

Q: Is your pain constant?
A: Yes
Q: Do you have it 24 hours / day?
A: Yes
Q: Do you have it from the moment you wake to the moment you fall asleep?
A: Yes
Q: Do you have pain now?
A: No

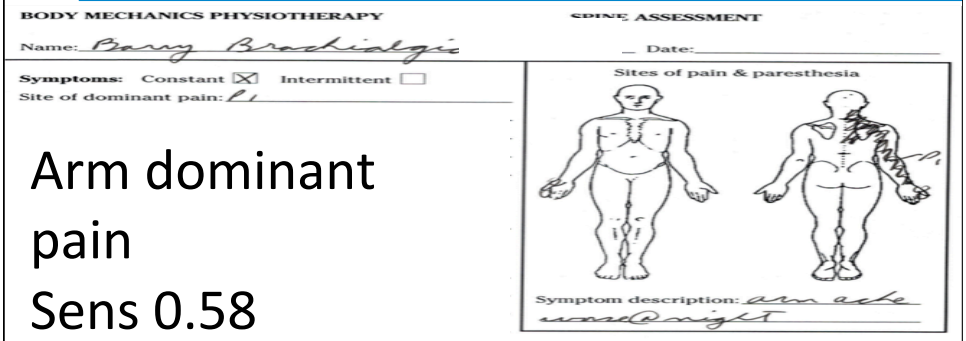


Site of dominant pain & consistency

Dominant pain	Intermittent pain	Constant pain
Neck	Most likely mechanical	Rule out red flags
Shoulder	Referred pain from neck or shoulder	Rule out red flags Examine for cervical pathology Examine for shoulder pathology
Arm	Referred pain form neck or shoulder Unlikely to be radiculopathy	Rule out red flags Assess for radiculopathy

NASS 2010, Alleyne 2016

Symptom behaviour


BODY MECHANICS PHYSIOTHERAPY — SPINE ASSESSMENT

Name: Barry Brachialgia — Date:

Symptoms: Constant ☒ Intermittent ☐

Site of dominant pain: L

Sites of pain & paresthesia

Symptom description: arm ache worse@night

Arm dominant pain

Sens 0.58

Spec 0.81

Sleijer-Koehorst 2021

Arm vs neck pain ratio

- Predictive of outcome post surgically
- Pain SF-36 Mental component

Passias 2018

Symptom behaviour

Site of dominant pain

Q1. Over the past 4 weeks please have the patient rate the pain in the:

Region	None		Minimal		Mild		Moderate		Severe		Excruciating
	0	1	2	3	4	5	6	7	8	9	10
Lower back CervicalThoracic											
Right leg Right arm											
Left leg Left arm											

Q2. If the patient could have treatment directed at the pain in 1 area only which would it be?
Low back / Neck upper back_____ Leg(s)/ Arm(s)_____

Q3. Which situation describes the patient's pain over the past 4 weeks the best?

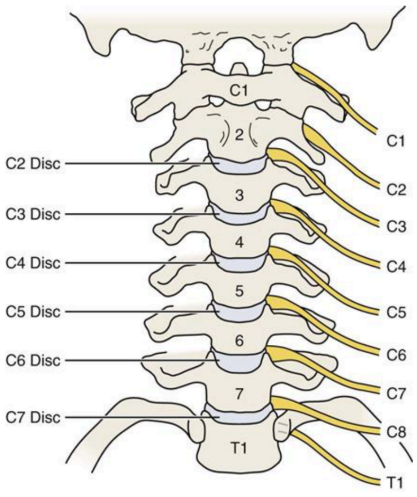
100% of pain in the low back/neck and no leg/arm pain
80% of the pain in the low back/neck and 20% in the leg/arm(s)
60% of the pain in the low back/neck and 40% in the leg/arm(s)
50% of the pain in the low back/neck and 50% in the leg/arm(s)
40% of the pain in the low back/neck and 60% in the leg/arm(s)
20% of the pain in the low back/neck and 80% in the leg/arm(s)
No low-back/neck pain and 100% of the pain in the leg/arm(s)

Scoring
Clearly back-dominant: all 3 questions are back/neck dominant
Intermediate: at least 1 question has equal back-leg /neck-arm pain
(eg. back=8/10, leg = 8/10 and no leg/arm dominant pain
Leg-dominant: at least 1 question is leg/arm dominant

Sen 0.83
Spec 0.73

Simon 2009

Nerve root patterns



C3 Nerve root

- Rare
- Largest foramen
- Smallest root

Clinical symptoms

- Headache
- Upper neck and occiput

Harrop 2007

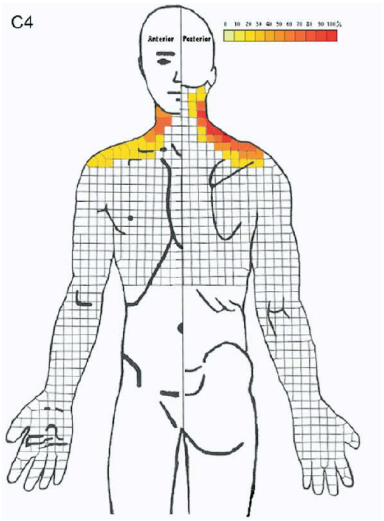
Nerve root patterns

C4 Nerve root

- Uncommon
- Greater mobility
- Smaller foramen

Clinical symptoms

- Posterior neck
- Trapezius
- Anterior chest



Zundert 2006, Harrop 2007

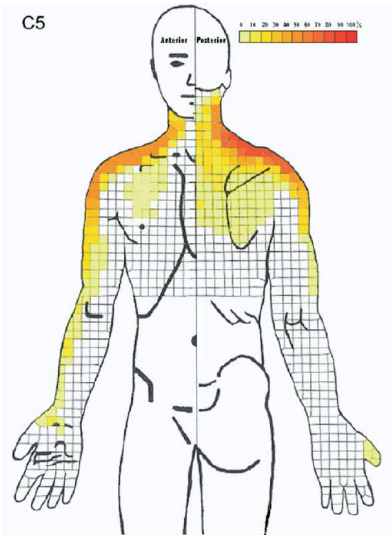
Nerve root patterns

C5 Nerve root

- Moderately common

Clinical symptoms

- Neck
- Upper shoulder
- Proximal lateral arm
- Easily mistaken for shoulder dysfunction



Zundert 2006, Harrop 2007

Nerve root patterns

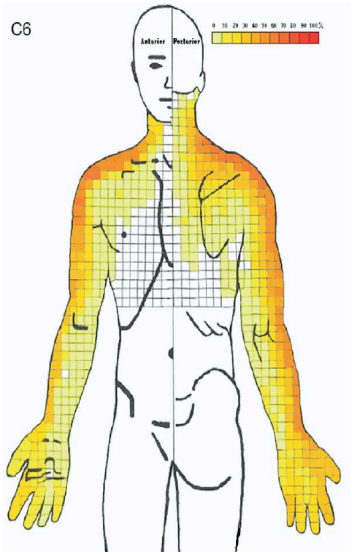
C6 Nerve root

- Most common

Clinical symptoms

- Neck
- Shoulder
- Medial scapula
- Lateral arm
- Radial forearm
- Thumb & index finger

Zundert 2006, Harrop 2007



Nerve root patterns

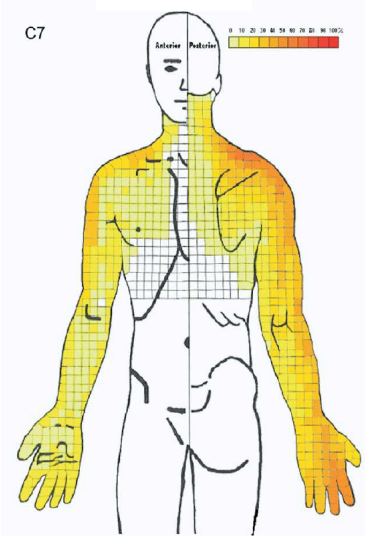
C7 Nerve root

- Common

Clinical symptoms

- Inter-scapular
- Mid-arm
- Mid-forearm
- Middle three fingers
- Horner's syndrome

Zundert 2006, Harrop 2007



Nerve root patterns

C8 Nerve root

- Less common

Clinical symptoms

- Medial aspect forearm
- Medal two fingers
- Horner's syndrome

T1 Nerve root

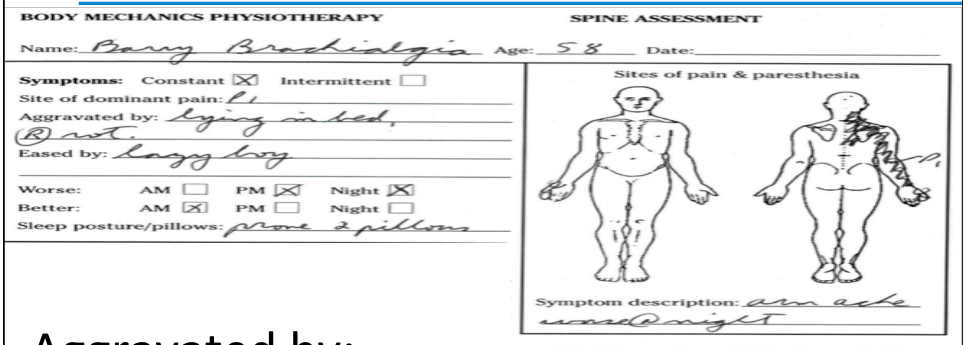
- Rare

Clinical symptoms

- Often minimal pain
- Paresthesia medial border hand and forearm
- Horner's syndrome

Harrop 2007

Symptom behaviour


BODY MECHANICS PHYSIOTHERAPY SPINE ASSESSMENT

Name: Barry Brachialgia Age: 58 Date:

Symptoms: Constant ☒ Intermittent ☐

Site of dominant pain: L

Aggravated by: lying in bed, (R) not.

Eased by: lazy boy

Worse: AM ☐ PM ☒ Night ☒

Better: AM ☒ PM ☐ Night ☐

Sleep posture/pillows: prone 2 pillows

Sites of pain & paresthesia

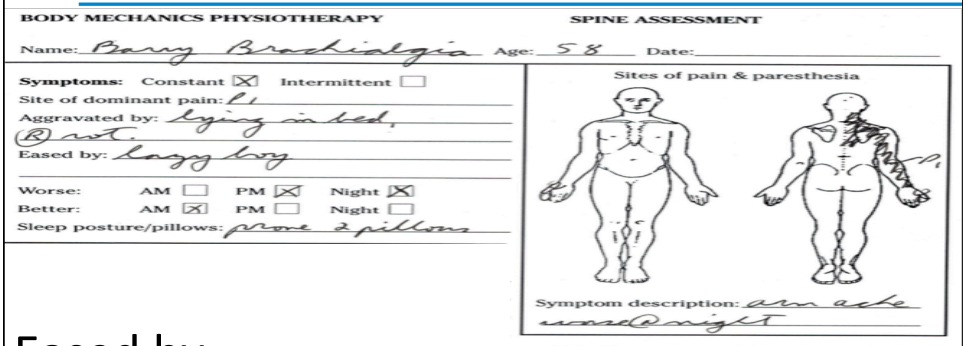
Symptom description: arm ache worst@night

Aggravated by:

- Extension
  Sen 0.61
  Spec 0.41
- Rotation
  Sen 0.47
  Spec 0.28
- Lying down
  Sen 0.59
  Spec 0.46

Sleijser-Koehorst 2021

Symptom behaviour



BODY MECHANICS PHYSIOTHERAPY — SPINE ASSESSMENT

Name: Barry Brachialgia Age: 58 Date:

Symptoms: Constant ☒ Intermittent ☐

Site of dominant pain: R

Aggravated by: lying in bed, R rot.

Eased by: lazy boy

Worse: AM ☐ PM ☒ Night ☒

Better: AM ☒ PM ☐ Night ☐

Sleep posture/pillows: prone 2 pillows

Sites of pain & paresthesia

Symptom description: arm ache worst @ night

Eased by:

- Hand in pocket
  Sens 0.14
  Spec 0.85
- Hand on head
  Sens 0.50
  Spec 0.75

Wainner 2003, Eubanks 2010, Sleijser-Koehorst 2021

Identifying Possible Responders to Mechanical Cervical Traction

Variables:

1. Age > 55
2. + shoulder abduction test
3. + ULTT A
4. Symptom peripheralization with lower cervical (C4-C7) P-A motion testing
5. + Neck distraction test

> 4 variables present:
+LR = 11.7

Raney 2009

History of onset

BODY MECHANICS PHYSIOTHERAPY **SPINE ASSESSMENT**

Name: Barry Brachialgia Age: 58 Date:

Symptoms: Constant ☒ Intermittent ☐
Site of dominant pain: R
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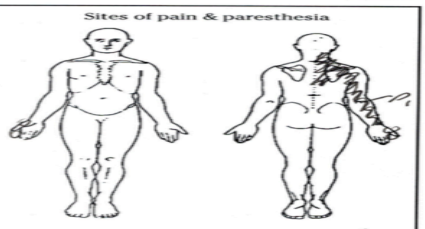
Worse: AM ☐ PM ☒ Night ☒
Better: AM ☒ PM ☐ Night ☐
Sleep posture/pillows: prone 2 pillows

Personal Hx:
Occupation: engineer
Work status: reduced hours
Work availability:
ADL:
General health: cardiac Hx ~~bowel/bladder, vertigo, night pain, weight loss~~

Sites of pain & paresthesia



Symptom description: arm ache worse@night

History:
Date symptoms started: 4 weeks Behavior since: Easing, Static, (Worsening)
History of onset: neck pain then scapula then arm then neck pain eased now hand paresthesia & arm weakness

Investigations

BODY MECHANICS PHYSIOTHERAPY **SPINE ASSESSMENT**

Name: Barry Brachialgia Age: 58 Date:

Symptoms: Constant ☒ Intermittent ☐
Site of dominant pain: R
Aggravated by: lying in bed, R rot.
Eased by: lazy boy

Worse: AM ☐ PM ☒ Night ☒
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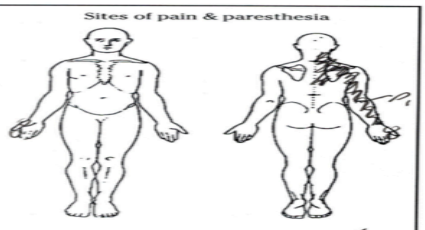
Sites of pain & paresthesia

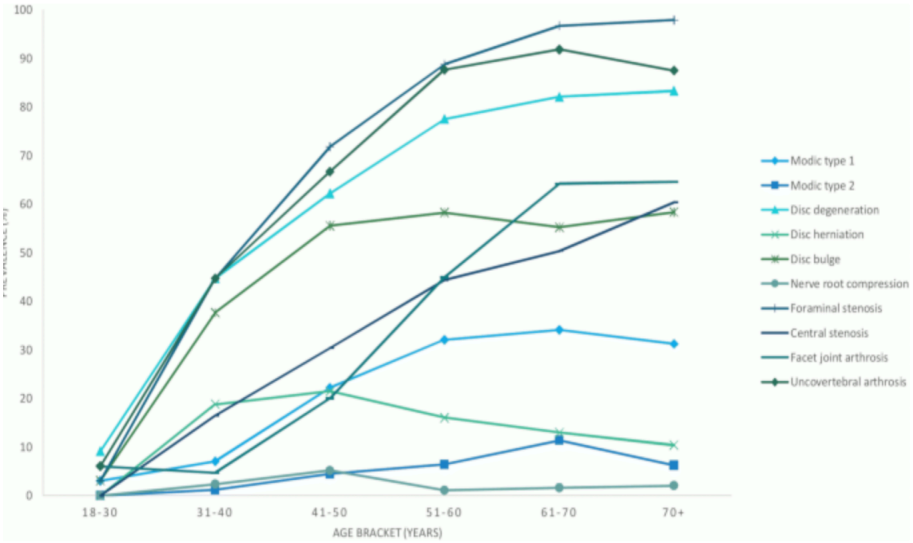


Symptom description: arm ache worse@night

History:
Date symptoms started: 4 weeks Behavior since: Easing, Static, (Worsening)
History of onset: neck pain then scapula then arm then neck pain eased now hand paresthesia & arm weakness

Investigations: X-ray, CT, (MRI) bone scan, EMG,US **Results:** NAD or: not reported
Previous Rx: Physio, (Chiro) Mass, Accu, Meds, Inject **Effect:** temp relief, no change, (worse)
Past Hx: None or: neck pain episodes 2-3 x/yr chiro with good outcomes over 10 years
Analysis of subjective: **Irritability level:** High, Med, Low

MRI findings in asymptomatic population



Jensen 2019

Root compression on MRI compared to clinical findings

78 patients with clinical evidence of cervical radiculopathy < 1 month duration

2 radiologists reviewed images

Clinically affected root was evaluated as:

- 73% compressed
- 15% normal

10% asymptomatic roots compressed

- MRI findings should be interpreted together with clinical findings as false-positive and negatives MRIs occur frequently"

Kuijper 2011

Finding	Radiologist 1	Radiologist 2
Single root compression	47.7%	47.7%
By herniated disc	32.1%	30.8%
By foraminal stenosis	12.8%	5,1%
By both	2.6%	11.5%
Multiple root compression	39.7%	37.2%
By herniated discs	9.0%	3.8%
By foraminal stenosis	23.1%	16.1%
By both	7.7%	16.7%
Normal MRI	12.8%	15.4%

Active range of motion

Purpose:

To test for the presence or absence of cervical radiculopathy.

Procedure:

Patient requested to actively move neck to end of available range

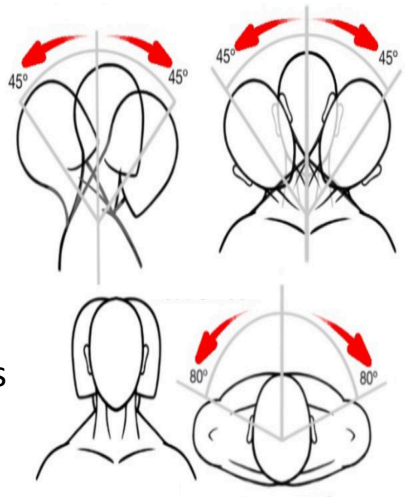
Positive test:

Less than 60° rotation towards painful side

Sens 0.47

Spec 0.28

Wainner 2003, Sleijser-Koehart 2021



Spurlings A

Purpose: To test for the presence or absence of cervical radiculopathy.

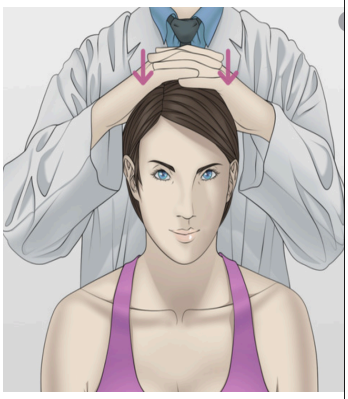
Description: The patient is seated. The examiner sidebends the neck towards the affected side and applies approximately 7 kg of *compression* force.

Positive Test: The test is considered positive if symptoms are reproduced.

Sens 0.59

Spec 0.84

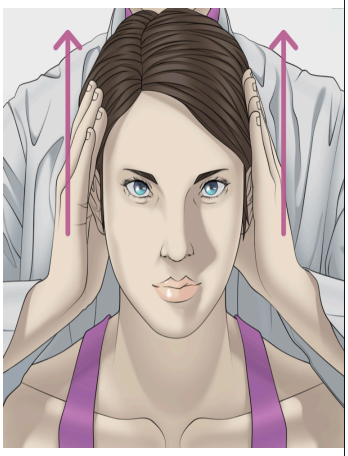
Wainner 2003, Sleijser-Koehart 2021



Distraction

Purpose: To test for the presence of cervical radiculopathy.

Description: The patient is supine and the examiner is seated. The examiner grasps under the chin and occiput while slightly flexing the patient's neck and applies a distraction force of ~ 14 lbs.



Positive Test: The test is considered positive if symptoms are reduced.

Sens 0.44

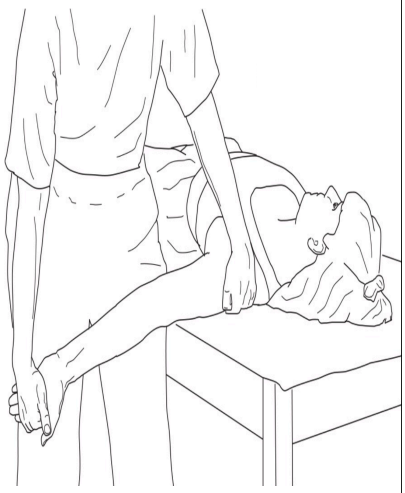
Spec 0.71

Wainner 2003, Sleijser-Koehart 2021

ULTT#1

Positive Test: The test is positive if one or more occurs:

- Symptoms reproduced
- Side to side difference in elbow extension greater than 10 degrees
- Contralateral cervical side bending increases symptoms, or ipsilateral side bending decreases symptoms



NOTE: (Negative ULTT #1 essentially <u>rules out</u> CR)

Sens 0.67

Spec 0.67

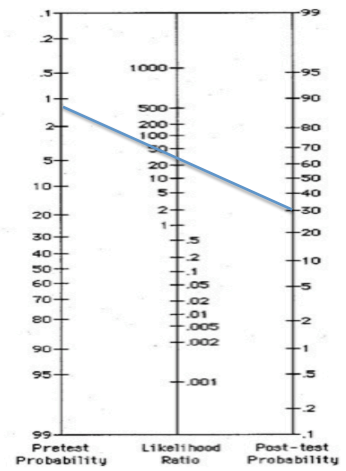
Wainner 2003, Sleijser-Koehart 2021

Clinical Prediction Rule

(Level 4 CPR)

- Ipsilateral cervical rotation < 60 deg.
- +ve Spurlings
- +ve Neck Distraction
- +ve Median nerve ULTT#1

# Variables	Sensitivity	Specificity	+ve LR	Post test probability
2	0.39	0.56	0.88	21%
3	0.39	0.94	6.10	65%
4	0.24	0.99	30	09%



Prevalence 1.14 males 1.31 females

Wainner 2003, Mansfielf 2020

Deep tendon reflex

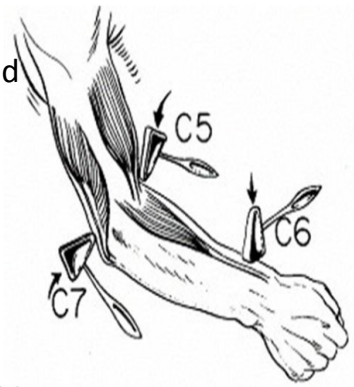
Procedure:

- Brisk percussion of tendon with reflex hammer for biceps & triceps
- May be enhanced by Jendrassik maneuver (patient performs unrelated isometric contraction)

Positive test:

- Reduced or absent reflex

Sens	Spec	+ve LR	-ve LR
84	31	1.2	0.51



(For any combination of DTR, motor power, sensation)

Lauder 2000, Cook 2013

Motor power

Procedure:

- Strong isometric contraction
- Resistance graded on Oxford scale 0-5

Positive test:

- Grade 3 or less on Oxford scale

Sens	Spec	+ve LR	-ve LR
84	31	1.2	0.51

(For any combination of DTR, motor power, sensation)

Lauder 2000, Cook 2013

Level	Key muscle action
C4	Shoulder shrug
C5	Shoulder abduction
C6	Wrist extension
C7	Wrist flexion
C8	Thumb extension
T1	Finger abduction

Sensibility

Procedure:

- Light touch sensibility tested with soft brush, sharp/dull tested with sterile pin

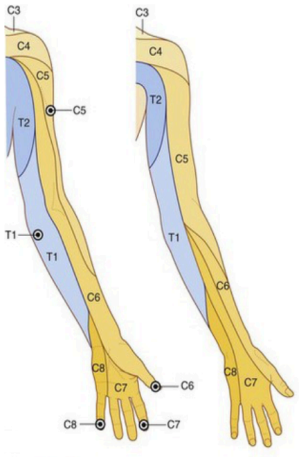
Positive test:

- Inability to report light touch and/ or discriminate between sharp & dull

Sens	Spec	+ve LR	-ve LR
84	31	1.2	0.51

(For any combination of DTR, motor power, sensation)

Lauder 2000, Cook 2013



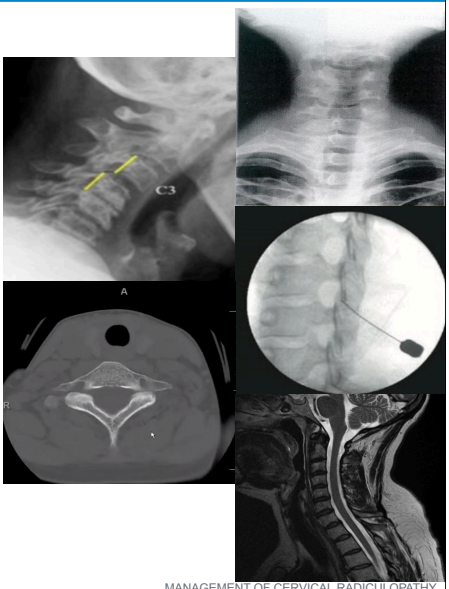
Nerve root patterns

Root	Pain distribution	Motor	Sensory	Reflex
C4	Lower neck Trapezius	Usually none	Upper shoulder girdle	N/A
C5	Neck, shoulder, Lateral arm	Deltoid, Supraspinatus Infraspinatus	Lateral arm	Biceps
C6	Neck, radial arm thumb	Biceps, brachioradialis, wrist extensors	Lateral forearm & thumb	Brachioradialis
C7	Neck Lateral forearm Middle finger	Triceps, Wrist flexors, Finger extensors	Dorsal mid-forearm, 3rd digit	Triceps
C8	Neck Medial forearm Ulnar fingers	Finger flexors	4 th 5th digits, medial hand & forearm	N/A
T1	Ulnar forearm	Hand intrinsics	Proximal ulnar forearm	N/A

Imaging

- Plain radiography
- Flexion-extension views
- Selective root blocks
- CT scan
- MRI

Bono 2011, NASS



Imaging

Plain radiography recommendations

- Indicated in trauma or suspected fracture
- First diagnostic test for neck & limb symptoms
- AP, Lateral & oblique views should be ordered
- Open mouth views to rule out upper cervical acute trauma
- Swimmer's view when C7 cannot be fully visualized

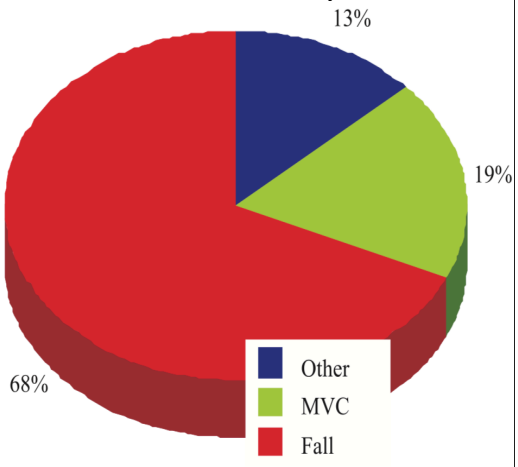
Bono 2011, Malanga 2018

Fractures

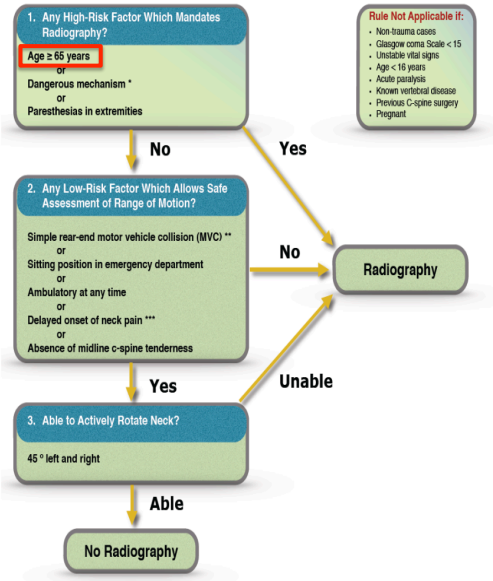
- Blunt trauma victims > 65 yrs 2X more likely than younger to have C-spine #'s
- Odontoid fractures 20% of elderly C-spine vs 5% in younger
- Patients > 65 yrs. included in Canadian C spine rules

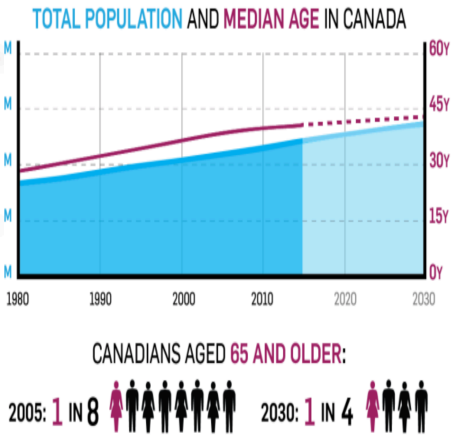
Francher 2012

Mechanism of cervical fracture in elderly

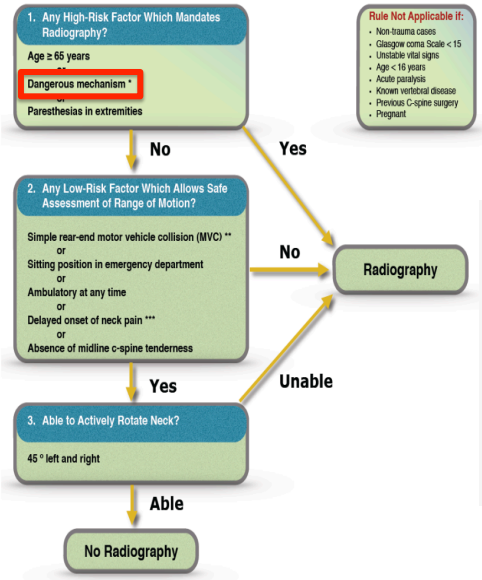


Fractures



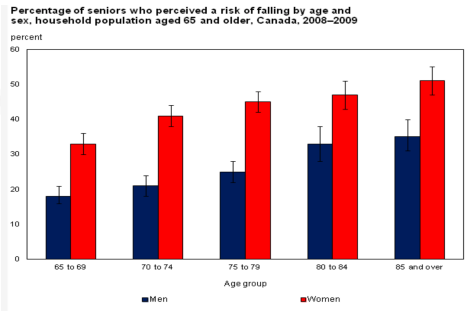


Fractures

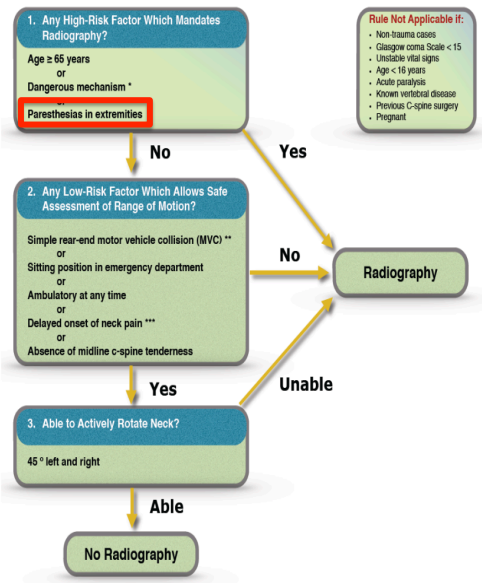


***Dangerous Mechanism**

- Fall from elevation ≥ 3 feet or 5 stairs
- Axial load to head, e.g. diving
- MVC high speed (> 100 km/hr), rollover, ejection
- Motorized recreational vehicles
- Bicycle struck or collision

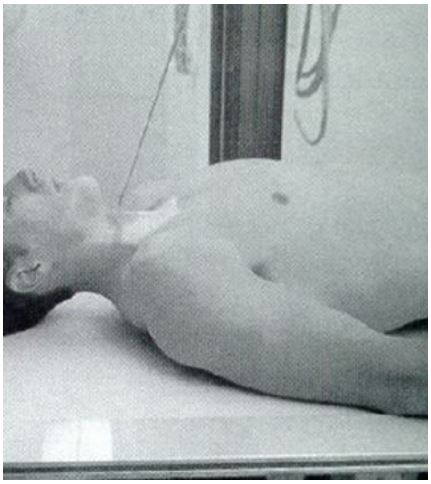


Fractures

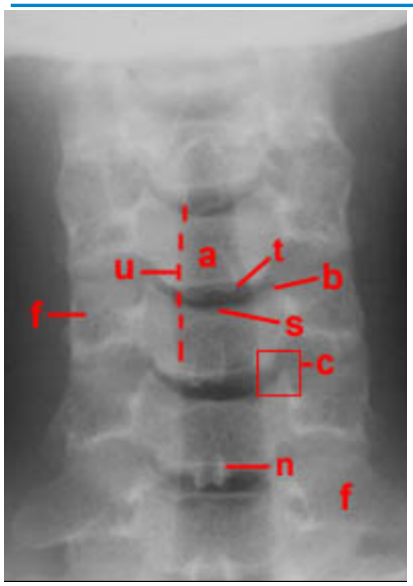


Acute onset	Sub-acute onset	Chronic onset
• Ulnar neuropathy • Peroneal neuropathy • Meralgia paresthetica • Polyarteritis nodosa • Microscopic polyangiitis • Hereditary neuropathy with liability to pressure palsy • Tibial neuropathy • Rheumatoid arthritis • Panic attack with hyperventilation • Cinguaters toxicity • Acute inflammatory demyelinating polyradiculoneuropathy • Diabetic lumbosacral radiculoplexus neuropathy • Brachial plexopathy or plexitis • Cervical radiculopathy • Thoracic radiculopathy • Lumbosacral radiculopathy • Herpes zoster infection • Myelopathy due to spinal cord compression • Multiple sclerosis • Transverse myelitis • Acute disseminating encephalomyelitis • Guillain-Barre syndrome • Stroke/TIA • Migraine with aura • Conversion/somatization disorder • Partial epilepsy • Distal symmetric polyneuropathy (DSP)	• Carpal Tunnel Syndrome • Ulnar neuropathy • Peroneal neuropathy • Meralgia paresthetica • Sarcoidosis • Paraneoplastic neuropathy • Churg-Strauss syndrome • Granulomatosis with polyangiitis (Wegener) • Hypocalcemia • Dysproteinemia (monoclonal gammopathy) • Drug toxicity • Hereditary neuropathy with liability to pressure palsy • Tibial neuropathy • Heavy metal toxicity • Leprosy • Rheumatoid arthritis • HIV infection • Herpes simplex infection • Brachial plexopathy or plexitis • Lumbosacral plexopathy • Cervical radiculopathy • Thoracic radiculopathy • Lumbosacral radiculopathy • Lyme disease • Myelopathy due to spinal cord compression • Multiple sclerosis • Conversion/somatization disorder • Distal symmetric polyneuropathy (DSP) • Peripheral neuropathy after bariatric surgery	• Carpal Tunnel Syndrome • Ulnar neuropathy • Peroneal neuropathy • Diabetic polyneuropathy • Sarcoidosis • Paraneoplastic neuropathy • Inborn errors of metabolism • Uremia • Dysproteinemia (monoclonal gammopathy) • Drug toxicity • Charcot-Marie-Tooth disease or Hereditary Motor and Sensory Neuropathy (HMSN) • Hereditary Sensory and Autonomic Neuropathy (HSAN) • Hexane toxicity • Hypothyroidism • Alcohol neuropathy • Vitamin B12 deficiency • Vitamin B6 deficiency • Vitamin B6 excess supplementation • Vitamin B1 deficiency • Tibial neuropathy • Heavy metal toxicity • Rheumatoid arthritis • Systemic Lupus Erythematosus • Peripheral vascular disease • Chronic inflammatory demeylinating polyradiculoneuropathy • Brachial plexopathy • Lumbosacral plexopathy • Radiation injury

Cervical Antero-Postero (A-P)

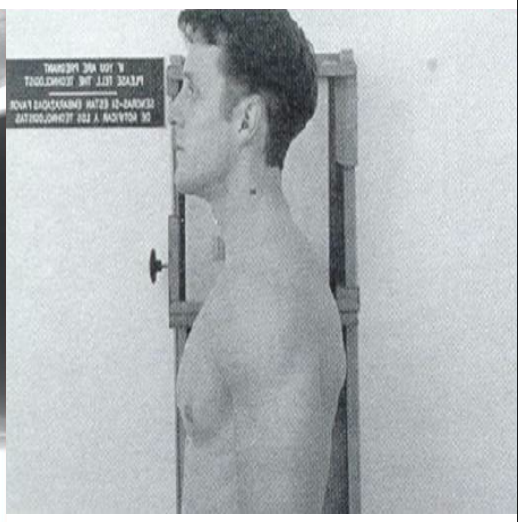


What does the A-P show us?

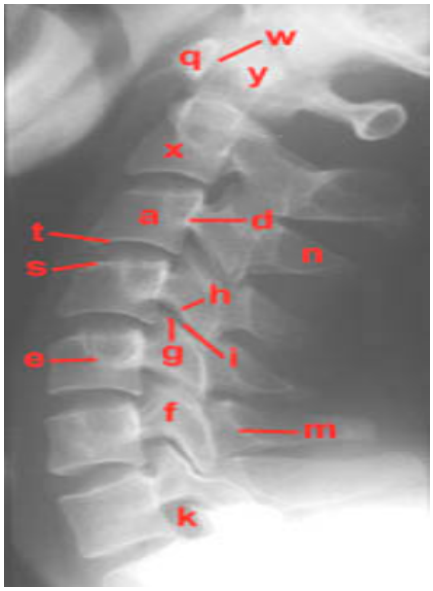


a	vertebral body
b	uncinate process
c	uncovertebral joint
u	tracheal wall
s	superior end-plate
n	spinous process
t	inferior end-plate
f	articular mass (lateral column)

Cervical Lateral



What does a lateral show us?

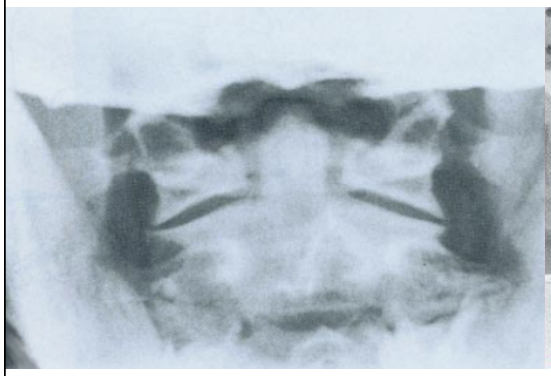


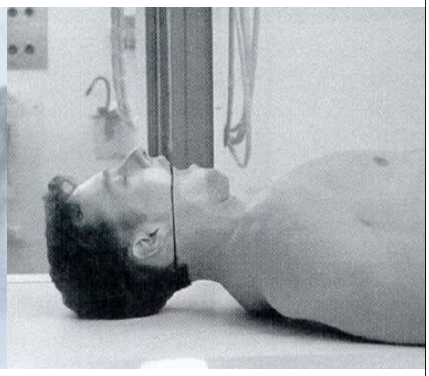
a	body
t	inferior end plate
s	superior end plate
v	disk space
e	transverse process
q	anterior arch, C1
y	dens
w	anterior atlanto-odontoid interval
x	axis vertebra, C2
d	pedicle
n	spinous process
h	inferior facet
i	interfacetal joint
g	superior facet
f	articular mass
m	spinolaminal line
k	intervertebral foramen

Atlantodental Interval

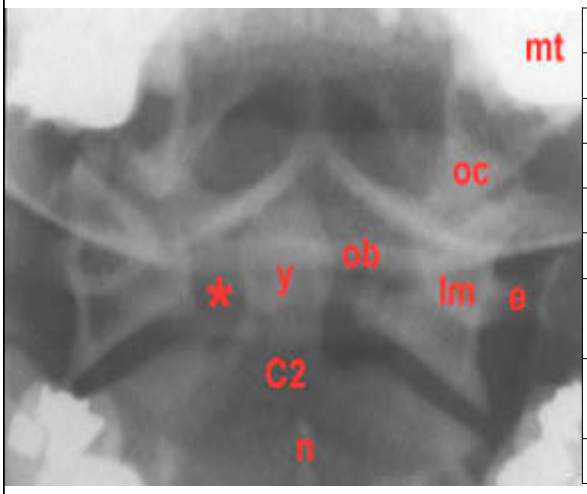
- On the lateral view, measure the distance between the:
  - posterior margin of the anterior tubercle and
  - the anterior surface of the odontoid.
- The space should be no more than 3mm.
- If the distance is more than 3mm, instability could be present and further workup is indicated prior to initiating PT.
- Most frequent causes of increased ADI include trauma, Down's syndrome, AS, RA, psoriatic arthritis, and Reiter syndrome.
- **Indicative of mechanical instability**

Upper cervical Open mouth





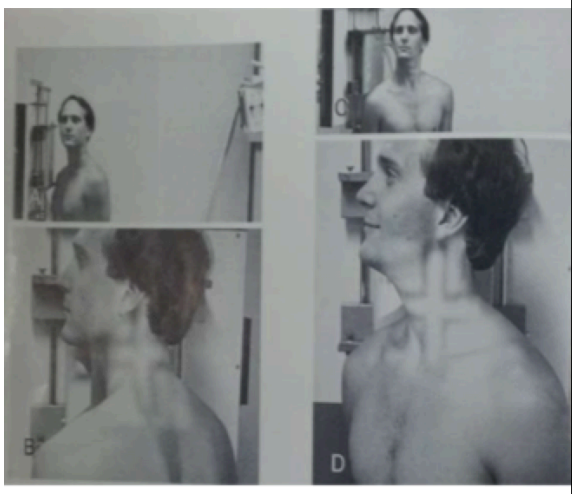
What does an open mouth show us?



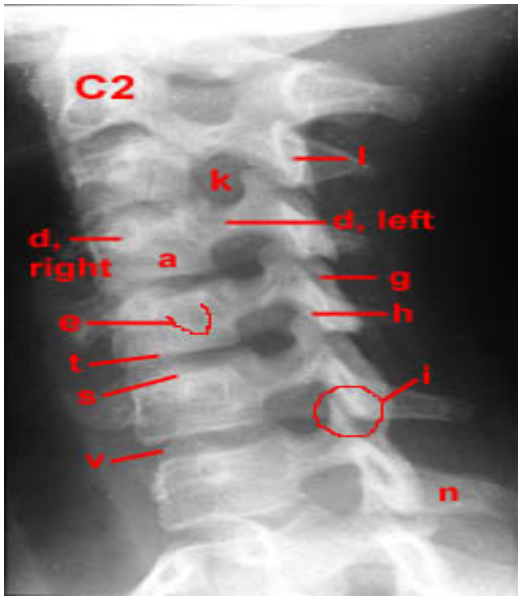
mt	maxillary teeth
oc	occipital condyle
ob	occipital bone
y	odontoid
C2	axis body
n	C2 spinous process
*	lateral atlanto-odontoid interval
e	C1 transverse process
lm	C1 lateral mass

Oblique view

- Patient is rotated 45 deg. to one side (to left to demonstrate right neural foramen)
- Central beam directed to C6



What does the oblique view show us?



l	lamina
k	intervertebral foramen
d	pedicle
a	vertebral body
g	superior facet
h	inferior facet
e	transverse process
t	inferior end-plate
s	superior end-plate
i	interfacetal joint
r	disk space
n	spinous process

Oblique view

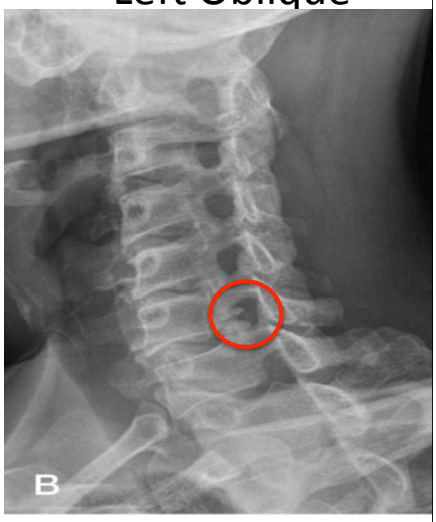
Right Oblique

Left Oblique

Oblique view

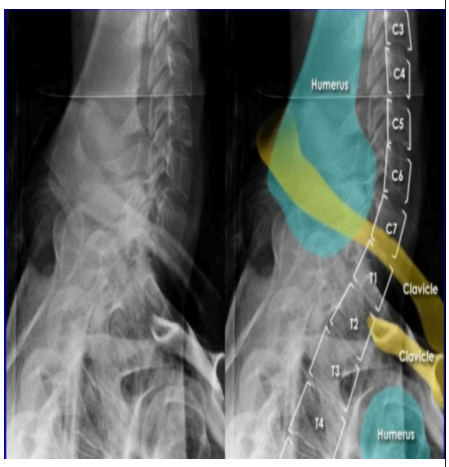
Right Oblique

Left Oblique



Swimmer's view (CT Jnt)

Used to visual C7/T1



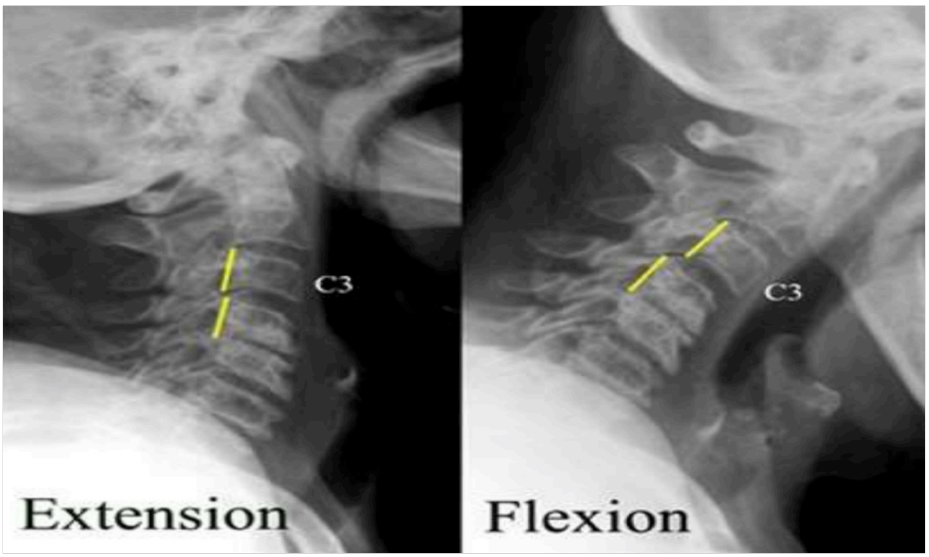
Flexion – Extension views

Flexion – extension views recommendations

- Used to demonstrate normal AP movement spinous processes should elevate on and separate on flexion, depress and approximate on extension
- A-P luxation indicative of dynamic instability
- May reveal increased atlanto-dental interval in upper cervical instability

Bono 2011, Malanga 2018

Flexion – Extension views



Fluoroscopy

- Dynamic flexion extension views
- Guided selective root block

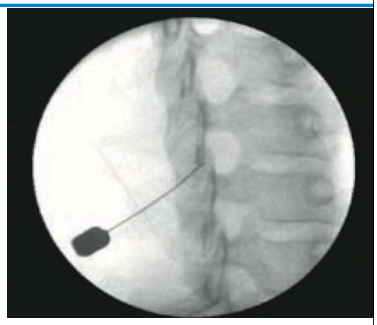
Fluoroscopy

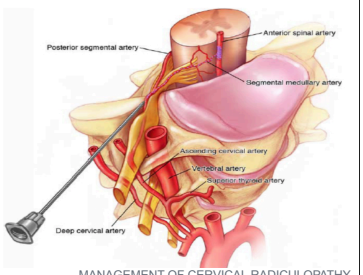
Selective root block

- Fluoroscopy guided
- Reproduction of typical pain with insertion
- Alleviation of typical pain when local anesthetic injected
- Relief consistent with ½ life of local anesthetic

Sens 42%
Spec 36%

North 1996, Windsor 2003, Candido 2018





Clinical utility of CT

- Subtle fractures
- Degenerative changes
- Serious trauma
- Cervical myeolopathy
- Accurate measurement of osseous alignment in any plane
- Claustrophobic patients (less “tight” than MRI)

Advantages disadvantages of CT

Advantages

- Less expensive
- Faster image times
- Thinner slices
- Less loss of image quality (motion)
- Greater resolution power for cortical bone
- Easier imaging for patients with ferous metal implants

Brix 2003

Disadvantages

- Poor imaging of soft tissues
- Significant radiation exposure (equivalent to 105 chest x-rays)

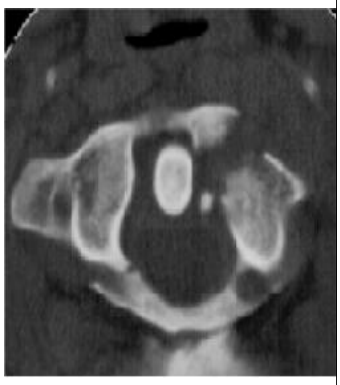
Nexus criteria

- Midline cervical spine tenderness
- Focal neurological deficit
- Intoxication
- Painful distracting injury
- Altered mental status
  - GCS <15
  - Disorientation in time, place person or event
  - Inability to recall 3 objects at 5 minutes
  - Delayed in inappropriate response to stimulus

Sensitivity 0.90
Specificity 0.46

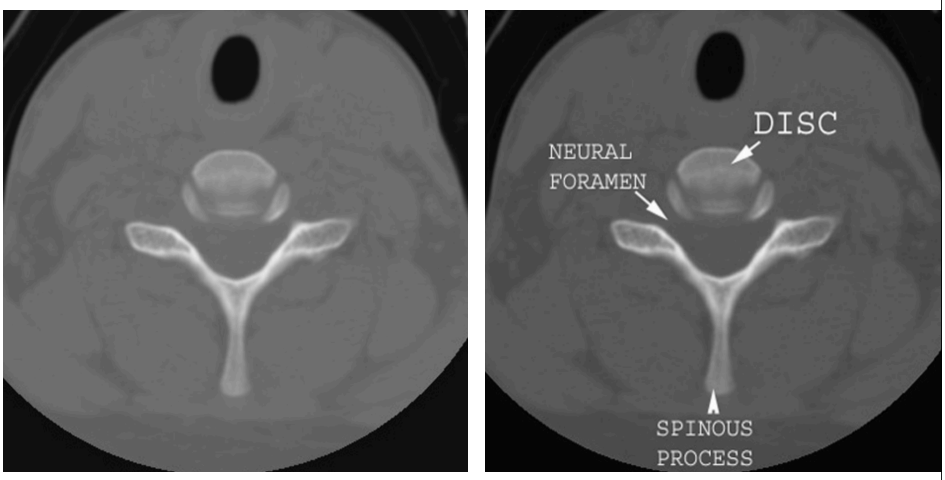
Michaleff 2012

If +ve CT indicated



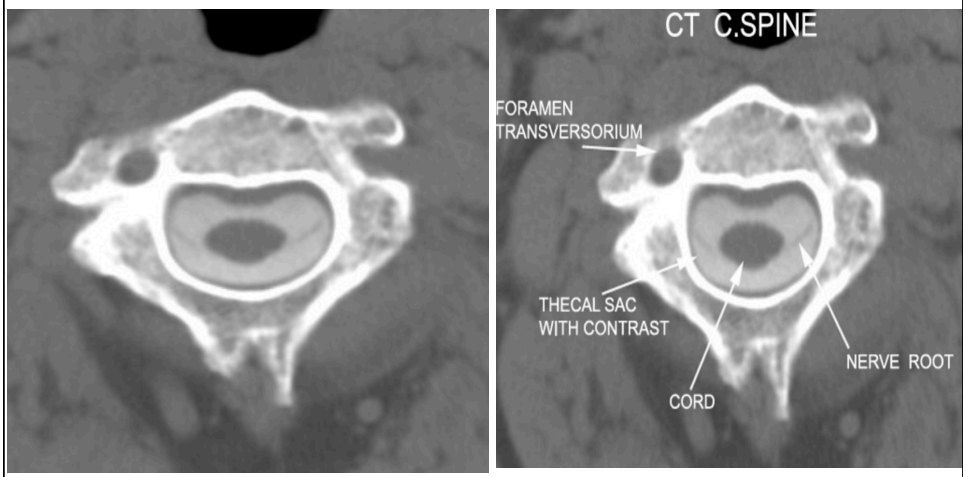
Interpreting CT images

Can you identify the intervertebral foramen?



CT Myelogram

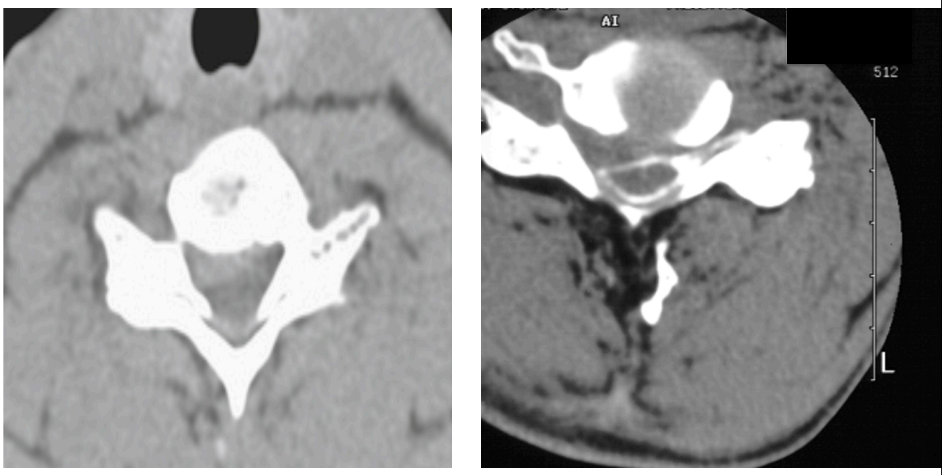
CT can be enhanced by injecting contrast into epidural space



CT Cervical Disc herniation

Without contrast

With contrast



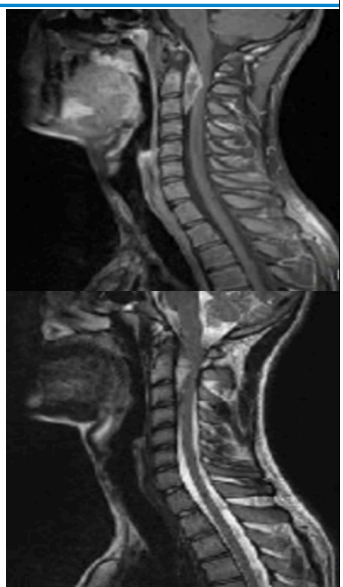
Clinical Utility of MRI

- Sensitive to changes in bone marrow
- 3 dimensional capability means can stage neoplasms
- More sensitive than bone scan for bone metastases
- Differential diagnosis of disc herniation and other nerve root impingements

Advantages of MR

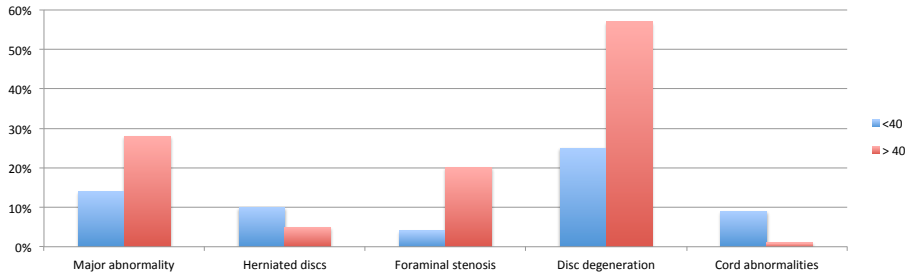
- Greater contrast resolution for soft tissue imaging
- No ionizing radiation
- No artifacts from interfering bone
- Less risk of missing disease as pathology missed on T1 is found on T2 and vice versa
- Greater image quality in non-axial planes

Brix 2003



Disadvantages of MRI

Prevalence MR pathology in asymptomatics

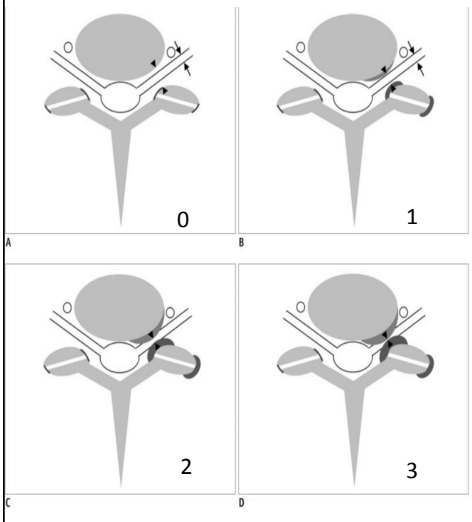


Abnormality	<40	> 40
Major abnormality	14%	28%
Herniated discs	10%	5%
Foraminal stenosis	4%	20%
Disc degeneration	25%	57%
Cord abnormalities	9%	1%

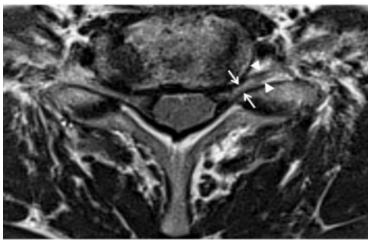
Faubel 1990

MRI foraminal entrapment

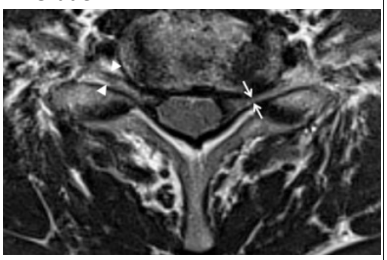
Foraminal stenosis grading



Grade 1

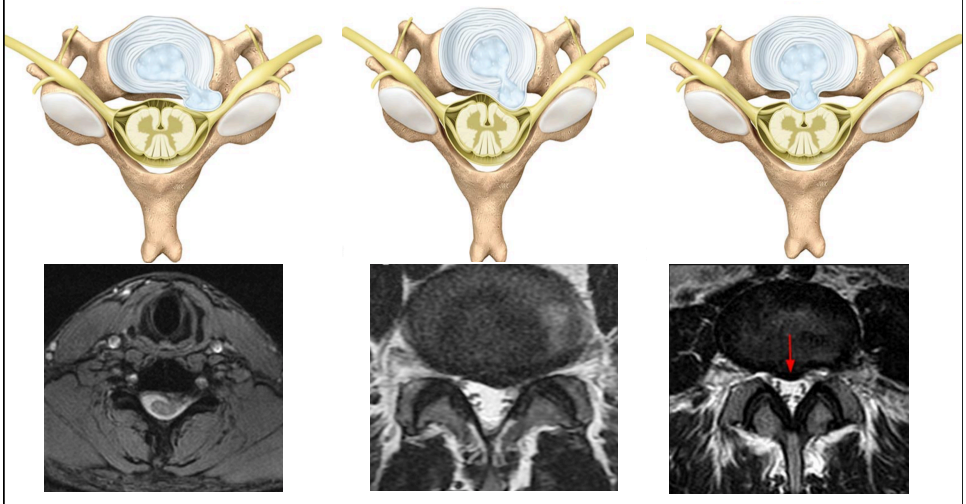


Grade 2

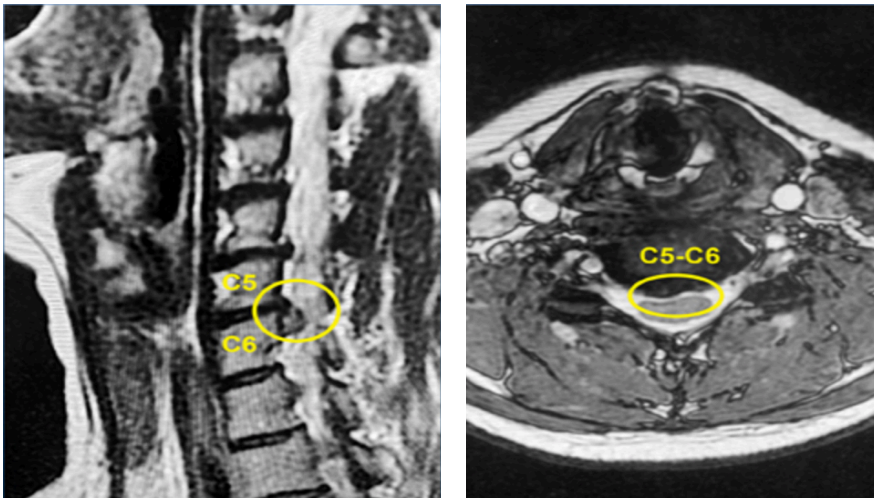


MRI disc herniation

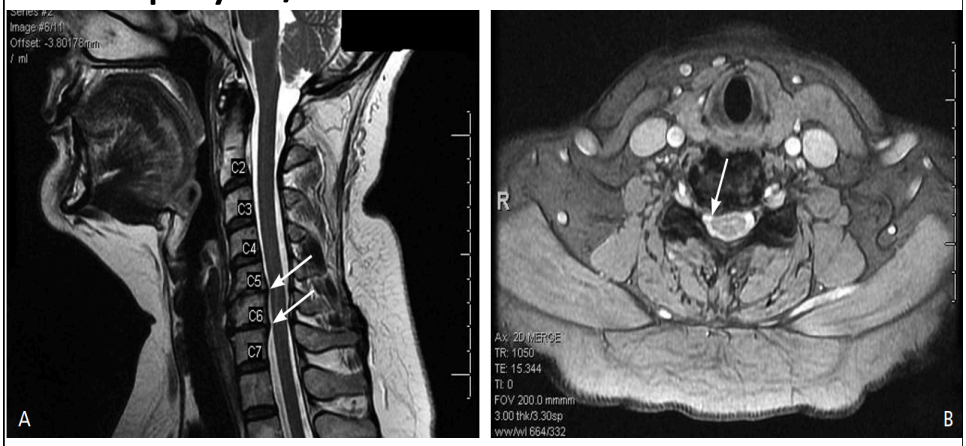
Intra-foraminal | Postero-lateral | Midline



MRI disc herniation



MRI combined osteophyte/herniation



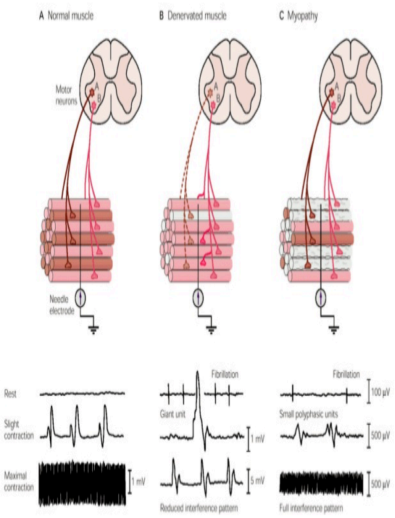
T2 weighted MR

A. Sagittal view spondylosis at C5/6, C6/7
B. Axial view right sided disc-osteophyte at C5/6

Eubanks 2010

Electromyography

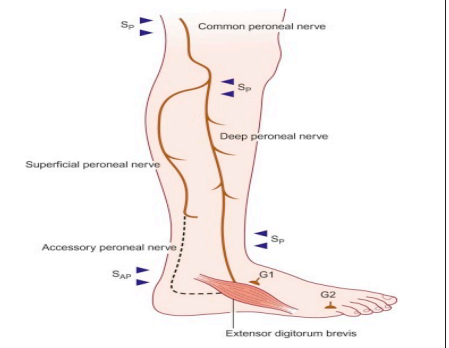
- Evaluates the electrical activity produced by muscles when excited by nerve impulses
  - Intramuscular EMG involves inserting thin needle probe into muscle belly
  - Surface EMG uses electrodes on skin over muscle
- Useful in differentiating radiculopathy vs peripheral neuropathy

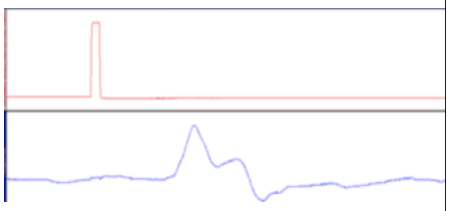


Adamova 2013

Nerve conduction velocity

- Nerves stimulated by small electrical impulses
- Time to travel from one electrode to second measured
- Generally done concurrent with EMG
- Slower speed indicates peripheral nerve damage
- Normal speed may indicate central conduction deficit (ie stenosis)

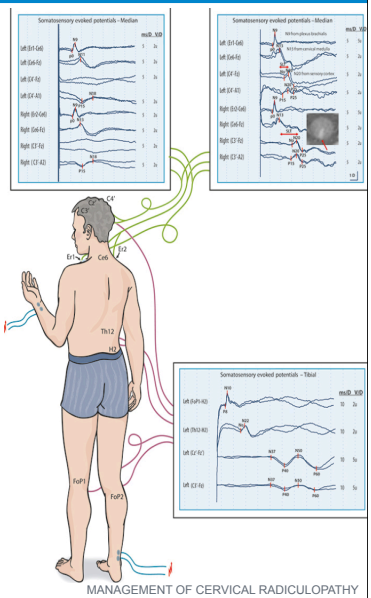




Adamova 2013

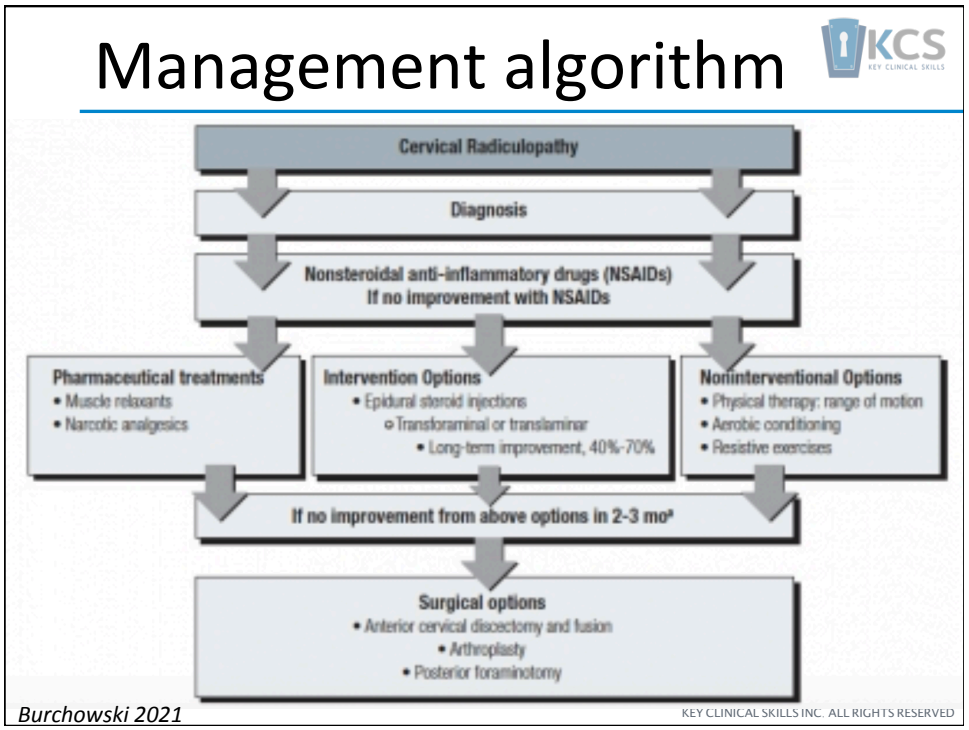
Somatosensory Evoked Potential

- Measures electrical conduction of sensory signals from the body to the spinal cord and cortex
- Combined with EMG & NCV test
- Useful in diagnosing demyelinating disorders (ie MS) & monitor sensory function of spinal cord during surgery



Adamova 2013


KEY CLINICAL SKILLS
Managing cervical radiculopathy
Unit 5
Medical/Surgical management
MANAGEMENT OF CERVICAL RADICULOPATHY, MYELOPATHY
KEY CLINICAL SKILLS INC. ALL RIGHTS RESERVED


Management algorithm
KCS
KEY CLINICAL SKILLS
Cervical Radiculopathy
Diagnosis
Nonsteroidal anti-inflammatory drugs (NSAIDs)
If no improvement with NSAIDs
Pharmaceutical treatments
• Muscle relaxants
• Narcotic analgesics
Intervention Options
• Epidural steroid injections
o Transforaminal or translaminar
• Long-term improvement, 40%-70%
Noninterventional Options
• Physical therapy: range of motion
• Aerobic conditioning
• Resistive exercises
If no improvement from above options in 2-3 mo[a]
Surgical options
• Anterior cervical discectomy and fusion
• Arthroplasty
• Posterior foraminotomy
Burchowski 2021
KEY CLINICAL SKILLS INC. ALL RIGHTS RESERVED

Medical/Surgical management

Medications

- NSAIDs
- Analgesics
- Muscle relaxants
- Anti-inflammatories
- Gabapentanoids
- Anti-depressants

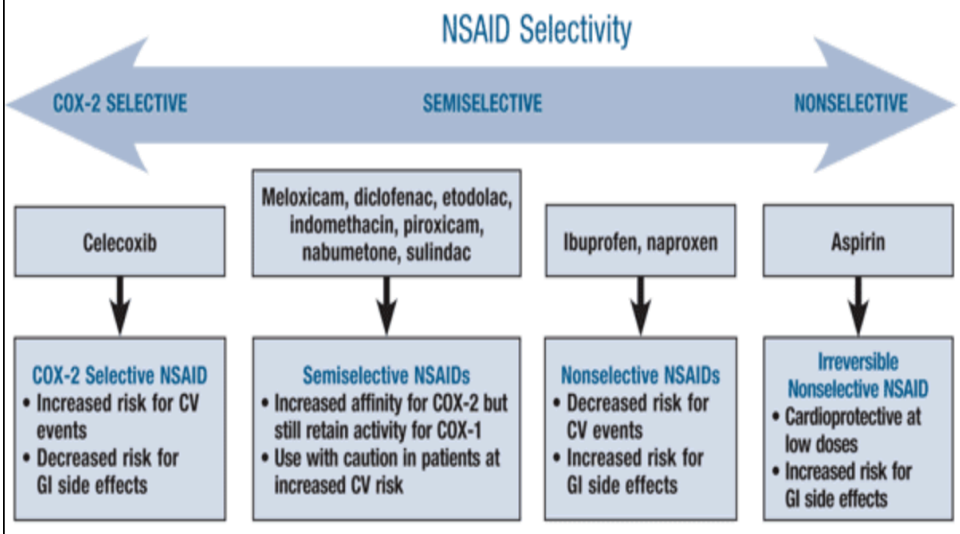
Interventions

- Injections
  - Facet
  - Nerve block
  - Prolotherapy
  - Sympathetic block
  - Stem cells

Surgery

- Discectomy/fusion

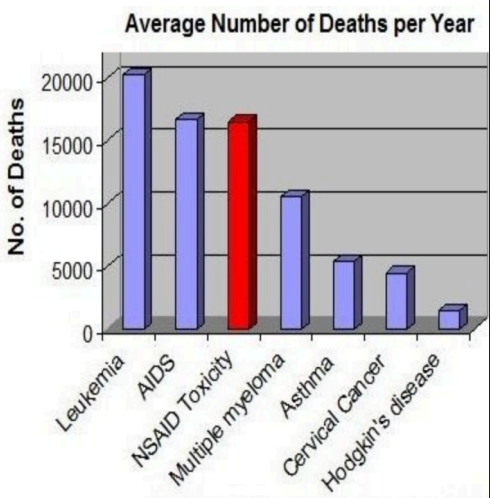
Non-steroidal anti-inflammatories



Non-selective NSAIDs

Signs & Symptoms of Acute GI bleed

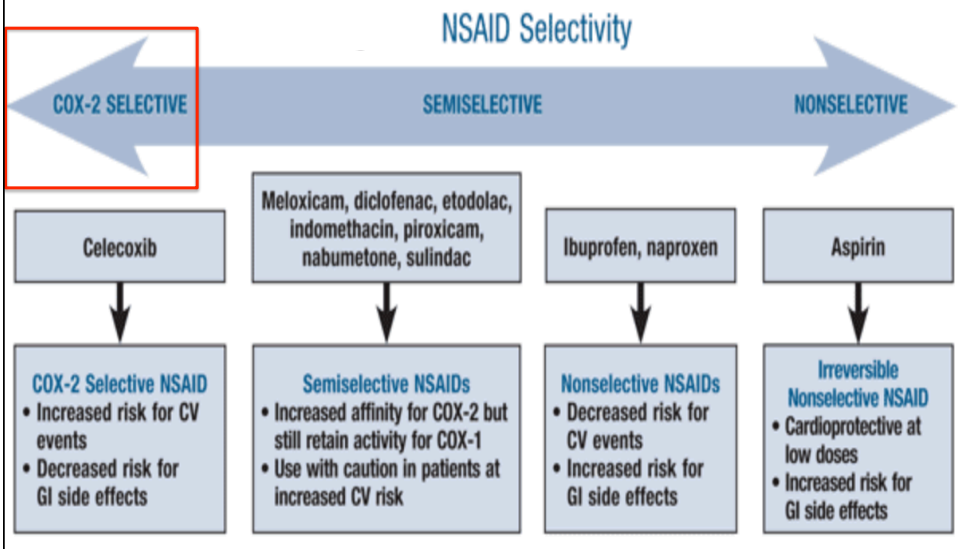
- Coffee ground vomit
- Bloody diarrhea
- Stool colour may vary between:
  - –Bright red blood
  - –Black tarry



New England Journal of Medicine, June 1999.

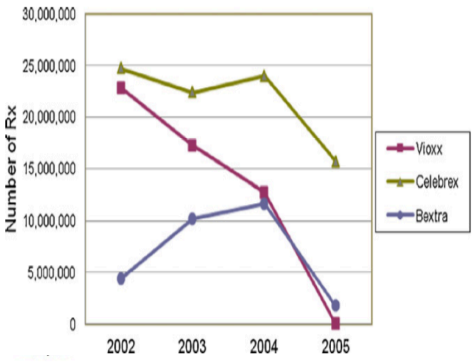
Goodman 2007, Deyo 1999

Selective NSAIDs



Selective NSAIDs

- Most popular selective COX2 inhibitor Vioxx
- Estimated 88,000 heart attacks linked to Vioxx
- Removed from market 2004



Vioxx group	**7.3 events per 1000 person-years**
Naproxen group	**1.7 events per 1000 person-years**

$$\frac{7.3}{1.7} = 4.2$$

Prakash 2007, Collins 2013

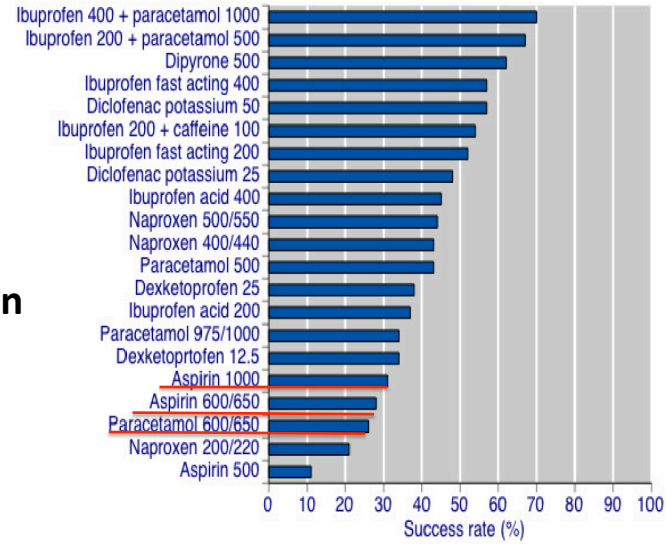
Oral analgesics

Salycylates

- ASA
- Aspirin
- Bufferin
- Excedrin

Acetaminophen

- Paracetemol
- Tylenol



Cochrane 2011

Salicylates

USES:

Pain & inflammation

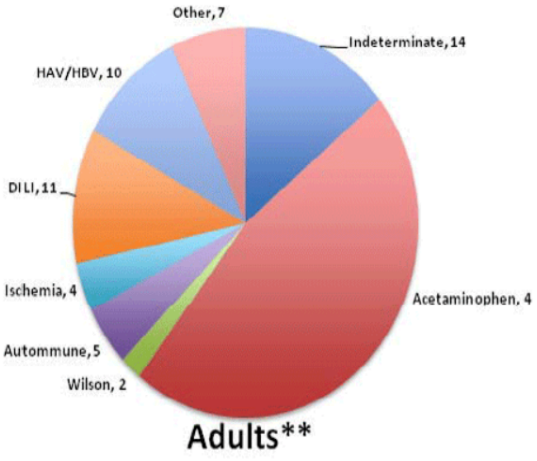
- Especially useful in treating pain & inflammation of MSK system

Salicylate toxicity signs & symptoms	
Hyperactivity	Nausea/vomiting
Irritability	Tinnitus
Agitation	Hearing loss
Vertigo	Hyperventilation
Slurred speech	Tachypnea
Delirium	Pulmonary edema
Hallucinations	Hyperthermia
Lethargy	Tachycardia
Stupor	Volume depletion
Seizures	Arrhythmias
Coma	Diaphoresis

Fertel 2008

Acetaminophen

- Preferentially inhibits CNS
- Minimal effect on peripheral prostaglandin formation
- Equally as effective as ASA in analgesia



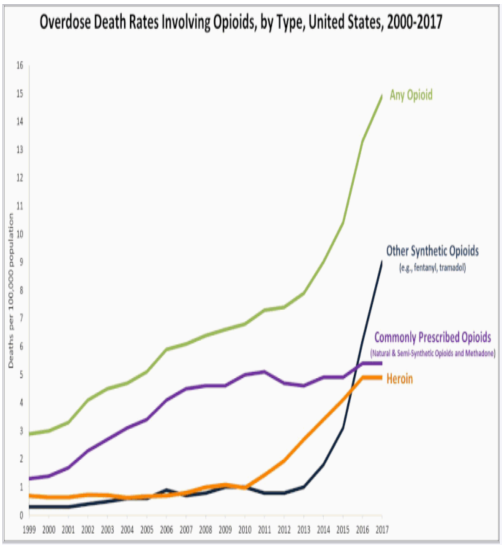
Rothaus 2017

Opioid analgesics

Natural opium alkaloids
- Opium
- Morphine

Semi-synthetic opiods
- Heroin
- Oxymorphone
- Pholcodein

Synthetic opiods
- Pethidine
- Fentalyn
- Methadone
- Tramadol



CDC 2018

Muscle relaxants

Centrally acting

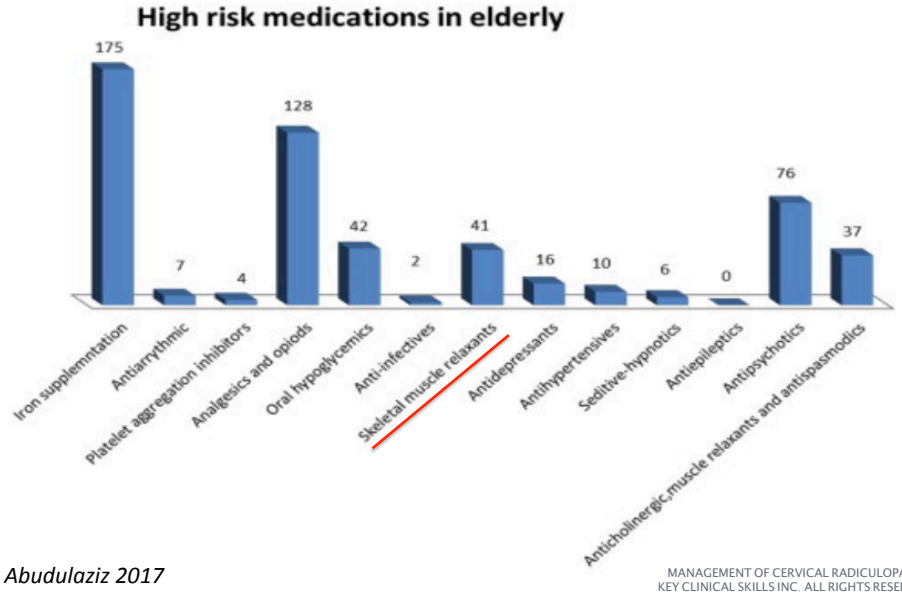
Benzodiazepames
- Depress spinal polysynaptic reflexes
- Primarily used in outpatient setting

Examples:
- Diazepam
- Baclophen
- Mephenesin

May reduce secondary muscle guarding & pain

Moreau 2014

Muscle relaxants and falls



Abudulaziz 2017

Gabapentinoids

Recommended as first line medication (NICE Pathway for neuropathic pain 2015)

Gabapentin
(Neurontin)

Pregabalin
(Lyrica)

- Anticonvulsant
- Analgesic

Used in treatment of:

- Neuropathic pain

Recommended dosage	
Gabapentin	1200-3600 mg TID
Gabapentin extended release	1200-3600 mg BID
Pregabalin	300-600 mg BID

Finnerup 2015, Gomes 2017

Gabapentinoids

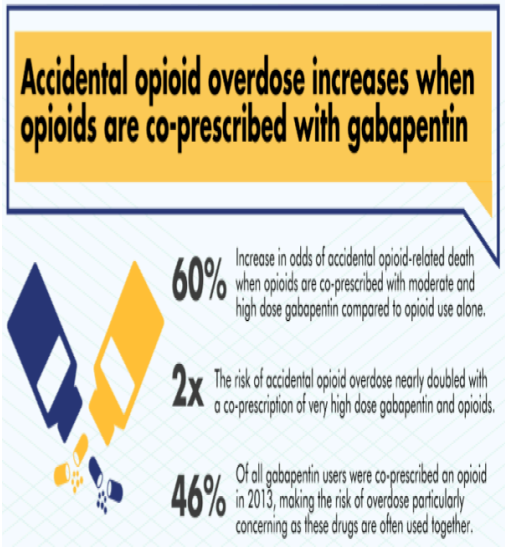
Adverse Effects:

- Drowsiness
- Visual disturbance
- Thirst
- GI upset
- Dementia
- Weight gain

Adverse withdrawal effects:

- Agitation
- Sweating
- Braddycardia
- Tremors
- Insomnia
- Seizures

Gomes 2017, Quintero 2017



Antidepressants

Recommended as first line medication (NICE Pathway for neuropathic pain 2015)

Tricyclics

- Work by blocking re-uptake of amine neurotransmitters

MAO inhibitors

- Reduce enzyme that removes amine neurotransmitters

Demonstrated to be effective in spinal pain with radicular component

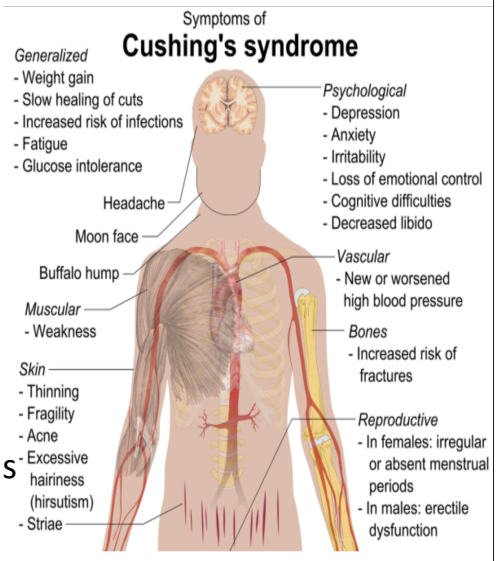
Schukro 2016

Class	Generic name	Trade name
Tricyclics	Amitriptyline	Elavil, Endep
	Amoxapine	Asendin
	Clomipramine	Norpramin
	Doxepin	Sinequan
	Imipamine	Norfranil, Tofranil
	Nortriptyline	Aventyl, Pamelor
	Protriptyline	Vivacil
	Trimipramine	Surmontil
Mono-Amine Oxidase (MAO) inhibitors	Isocarboxazid	Marplan
	Phenelzine	Nardil
	Tranylcypromine	Pamate

Gluco-corticosteroids

Mode of action:

- Inhibit expression of inflammatory proteins (cytokines)
- Limit the production of factors that attract leukocytes to site of inflammation
- Inhibit production of pro-inflammatory prostaglandins
- Reduce vascular permeability



CPS 2018, Phamwiki 2020

Common medications, doses & adverse effects

Drug	Dose	Adverse effects	Comments
Ibuprophen	600-800 mg bid	GI, Cardiovascular, Renal	Indicated for mid to moderate pain
Naproxen	250-500 mg bid	GI, Cardiovascular, Renal	Indicated for mid to moderate pain
Diclofenac	50 mg tid	GI, Cardiovascular, Renal	Indicated for mid to moderate pain
Celecoxib	200 mg tid	GI, Cardiovascular, Renal	Indicated for mid to moderate pain
Hydrocodone Acetominophen	2.5-10 mg PRN 325-500 mg PRN	Constipation, Drowsiness Liver, Dependence	Indicated for moderate to severe pain
Oxycodone	5-10 mg PRN	Constipation, Drowsiness Dependence	Indicated for moderate to severe pain
Tramadol	50-100 mg PRN	Dizziness, Nausea, Constipation Drowsiness	Indicated for moderate to severe pain
Cyclobenzaprine	5-10 mg tid	Drowsiness, Dry mouth, Fatigue	Indicated for secondary muscle pain
Carlsoprodol	350 mg qid	Drowsiness, CNS	Indicated for secondary muscle pain

Ishak 2015

Indications for medical intervention eferrals

Pain management referral

- The recommended non-pharmacological & pharmacological options have been trialed with reasonable compliance for minimum of 4 weeks

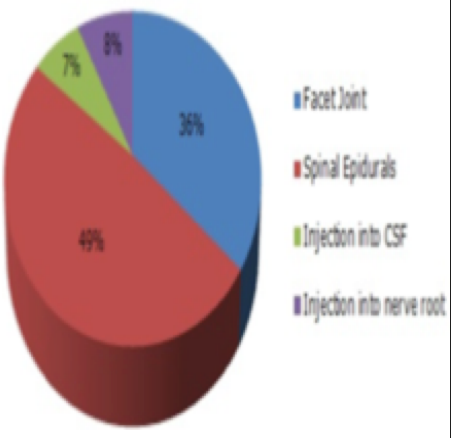
And one of:

- The patient has high constant pain levels interfering with their function despite care
- The patient requires escalating/high doses of opioids

Alleyne 2016

Medical interventions

- Epidural
- Facet joint
- Sympathetic block
- Prolotherapy
- Trigger point needling
- Stem cells



Safety Risk factors

Needle malposition
- Dural puncture
- Disc entry
- Intra-abdominal puncture
- Pneumothorax
- Intra-vascular injection
- Nerve trauma
- Spinal cord trauma

Radiation
- 0.38 mrems
- Pregnancy
- Medications

Infection
- 1-2% infection rate

Allergy
- Contrast media
- Anesthetics
- Cortico-steroid

Coagulopathy
- Anti-platelet medications
- Anti-coagulant

Cutrone 2019

Injection contraindications

Absolute
- Bleeding diathesis
- Currently taking anti-coagulants, anti-platelets, thrombolytic medications
- Active local or systemic infections
- Local anesthetic allergies
- Local malignancy

Relative
- Pregnancy
- Congestive heart failure
- Cognitive impairment
- Uncontrolled mental health diagnosis (depression, anxiety, schizophrenia)
- Obstructive sleep apnea
- Insulin dependent diabetes mellitus

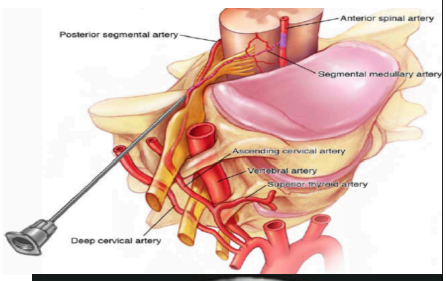
Cutrone 2019

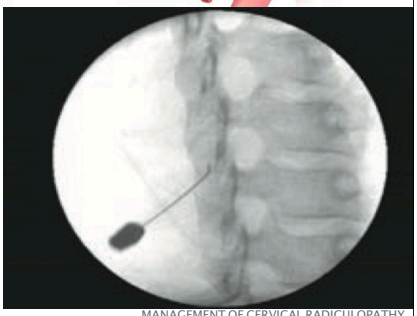
Selective nerve root block as a diagnostic tool

AKA "Transforaminal approach

- Injection of local anesthetic into nerve root sleeve
- If relief of typical pain
- Injection of corticosteroid performed 30% are not "selective" (media travels)

Yeon 2008, Furman 2008, Arun-Kumar 2015





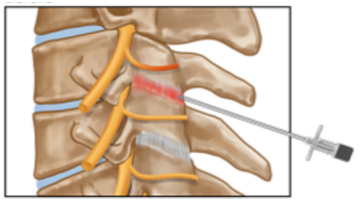
Intra-articular facet injection

Performed under fluoroscopy guidance

Injection of local anesthetic & corticosteroid

- Reduction in VAS pain score by 45.3%
- Improvement of NDI 24.3%

Bureau 2014



Intra-articular facet injection

Clinical decision rule cervical facet joint pain

Fluoroscopy guided intra-articular facet blocks as the reference standard

- Manual spinal examination
- Palpation for tenderness
- Extension/rotation test

Sens PST 94
MSE 92
-ve LR PST 0.8

Combined PST & MSE & ERT
Spec 84
+ve LR 4.94

Schneider 2014

Intra-articular facet injection

Segmental palpation for pain vs imaging

- Prospective study of 121 patients
- Outcome of pain relief when manual examination for segmental pain provocation is used to select spinal level to inject

Yann 2016

	Imaging alone	Palpation for pain
1 day improved	29.7%	44.8%
1 day worse	9.9%	6.9%
1 week improved	21.3%	37.9%
1 week worse	16.9%	10.3%
1 month improved	31.0%	50.0%
1 month worse	22.9%	10.0%

Cervical facet joint block

Therapeutic:

- Injection of anesthetic & cortico-steroid to suppress inflammation

https://www.youtube.com/watch?v=Nv2WJVkeJ1c

Adverse effects:

- Allergic reaction
- Bleeding
- Infection
- Increased pain
- Nerve or spinal cord damage
- Paralysis

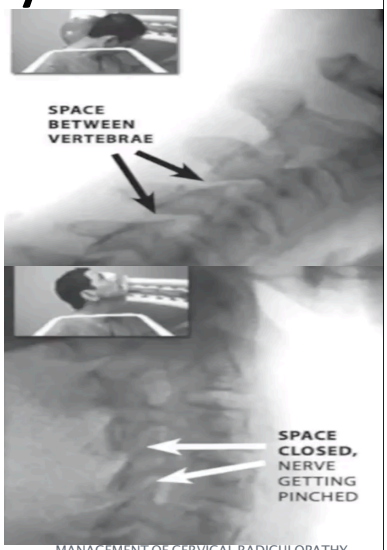
Baker 2013

Spinal prolotherapy

AKA "Regenerative therapy"

- Injection of local irritant (i.e. Phenol or Dextrose)
- Target of injections are various ligmentous structures
- Initiate primary inflammatory and secondary reparative reactions

Dagenais 2012



Spinal prolotherapy

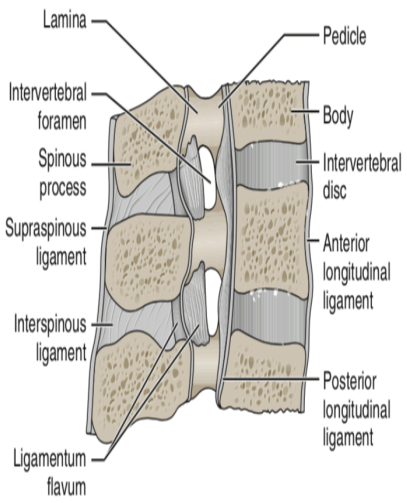
Indications:

- Neural entrapment secondary to local mechanical instability
- Corroborated on flexion/ extension views
- Non-specific local and referred pain from ligament or tendon injury due to trauma, repetitive strain injury or collagen deficiency

Adverse effects:

- Increased pain, stiffness, bruising
- Headache, nausea, diarrhea

Dagenais 2012



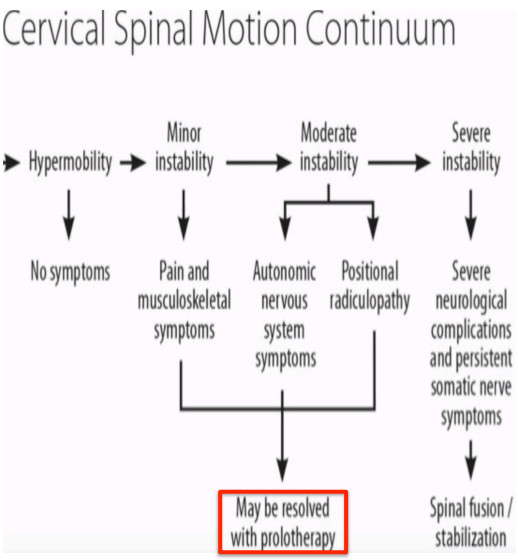
Spinal prolotherapy

Outcomes:

Systematic review of 33 studies (15 RCTs)

- Use in non-acute cases of persistent mechanical pain indicated

Steilen 2014, Hauser 2016



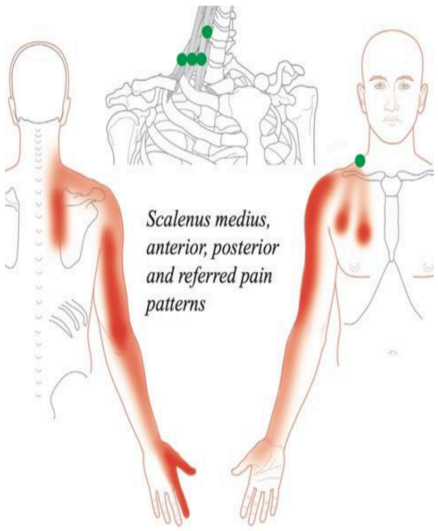
Trigger point injection

Indications:

- Patients who demonstrate local twitch response on palpation or dry needling

Poor response:

- Patients with a diagnosis of fibromyalgia



Dagenais 2012

Trigger point injection

Injection into hyperactive muscle bands

Procedure is outpatient

Injected drugs include:

- Local anesthetics
- Saline
- Sterile water
- Cortico-steroids
- Non-steroidal anti-inflammatories
- Botulinum toxin

Clinical practice guidelines	
Belgium	Insufficient evidence to recommend
Europe	Not recommended
USA	Poor evidence to support

www.spine-health.com/video/trigger-point-injections-video

Dagenais 2012

Trigger point injection/needling

Systematic review

13 studies, 422 subjects

- Local anesthetic (LA)
- Botlinum Toxin A (BTXa)
- Dry needling (DN)

Outcomes:

- All significantly reduced pre-treatment pain
- No significant difference between groups
- BTXa high expense
- DN higher intervention site pain

Adverse events

Event	LA %	BTXa %	DN %
Muscle pain	6.8	13.4	8.7
Vertigo	0.53	0.71	0
Fatigue	1.1	1.77	0
Headache	1.6	2.5	0
Flu-like symptoms	1.1	2.5	0
Weakness	0.5	1.4	0
Paresthesia	0	0.7	0
Pain at injection site	0	0	7.8

Walker 2020

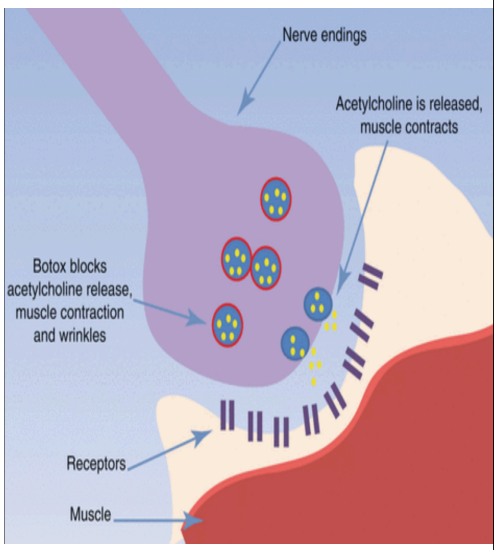
Trigger point injection

Botulinum Toxin

- Purified version of compound that causes Botulism
- Inhibits release of ACH from pre-synaptic terminals

Adverse Effects:

- Paralysis
- Death
- Limited number of injections



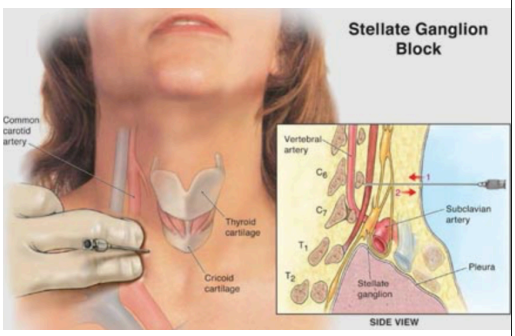
Dagenais 2012

Sympathetic block

Injection of local anesthetic +/- cortico-steroid into sympathetic chain

Indications:

- Persistent radicular pain
- CRPS (types 1 & 2)
- Phantom limb pain
- Painful neuropathy
  - Diabetic
  - Post herpetic



Evidence is limited, conflicting and of low quality *Cochran 2015, Alexander 2017*

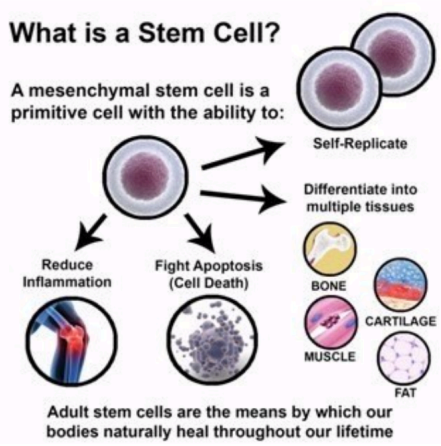
Stem cells

Stem cell therapy thought to:

1. Mitigate nociceptive pain
2. Slow or reverse catabolic mechanisms
3. Restoration of disc tissue

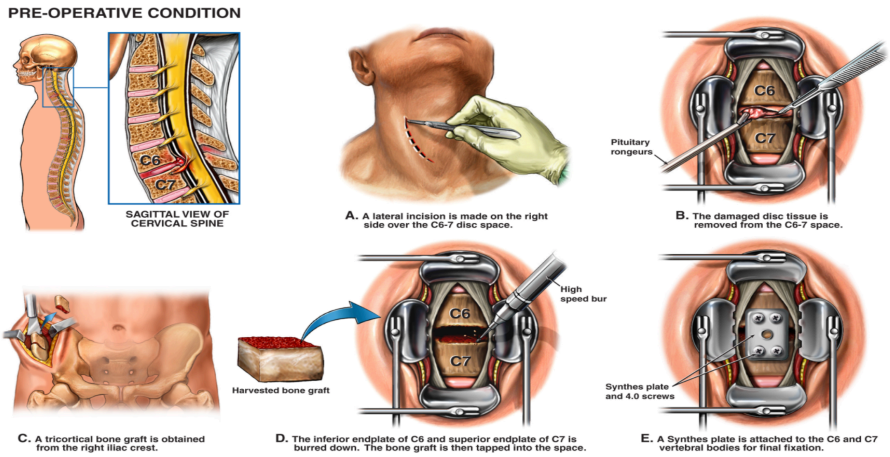
Limited evidence of efficacy

Constance 2020



Health Canada Warning
https://healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2019/69974a-eng.php

Cervical anterior discectomy & fusion



YouTube video available at: https://miro.medium.com/max/600/0*MNBy7P8oh_KDCcrW.jpg

Indications for surgical referral

Literature review

- 3 studies, 558 subjects
- 88% symptom resolution in first 4 weeks

Optimal period of conservative care 6-8 weeks

Rasanen 2006, Alentado 2014

- Few psychosocial risk factors
- Few medical co-morbidities
- Identifiable structural lesion
- Worsening neurological status
- Willing to accept surgical intervention risks
- **Failure to respond to conservative measures**

Indications for surgical referral

Radiculopathy Symptoms	% APP/ Surgeon agreement
Untreated constant spine related **arm pain** for 12 weeks	50%
Treated constant spine related **arm pain** for 4 weeks	52%
Treated intermittent spine related **arm pain** for 1 week	74%
Treated constant spine related **arm pain** for 12 weeks	98%

Rampersaud 2016

Indications for surgical referral

Radiculopathy Signs & symptoms	% APP/ surgeon agreement
Untreated constant **arm dominant** pain of 3 months duration with non-disabling biceps weakness	68%
Treated constant **arm dominant** pain of 4 weeks duration with non-disabling biceps weakness	72%
Constant **arm dominant** pain of 4 weeks duration with progressive biceps weakness	98%
Treated constant **arm dominant** pain of 3 months duration with non-disabling biceps weakness	100%
Constant **arm dominant** pain of 3 months duration with progressive biceps weakness	100%

Rampersaud 2016

Indications for cervical discectomy/fusion

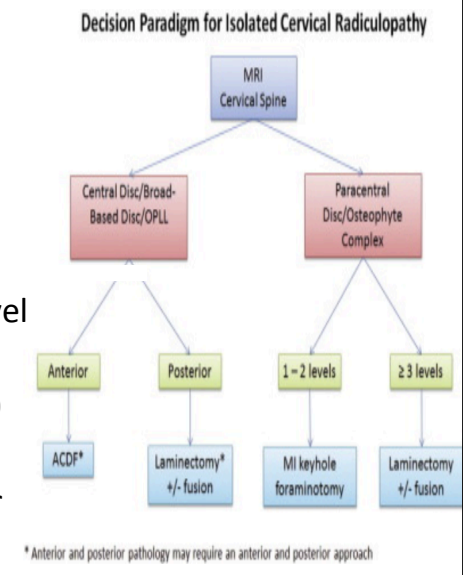
Laminectomy alone

- Rarely indicated
- 11-47% chance of post laminectomy kyphosis

Anterior Decompression and Fusion

- Patients with single or two level disease
- Fixed cervical kyphosis of > 10 degrees
- Compression arising from 2 or fewer disc segments

NASS 2011



Predictors of outcome of cervical surgery

Cervical radiculopathy (4988 subjects)

Negative predictors:

- Higher baseline NDI
- Longer duration symptoms
- Worker's compensation
- Ambulation assistance
- Posterior surgical approach

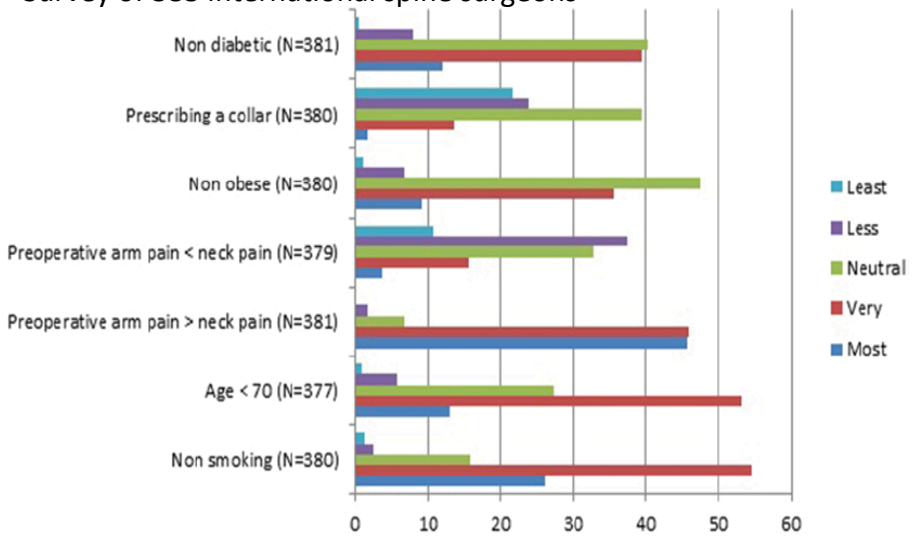
Positive predictors:

- Evidence of listhesis
- Older age
- Pre-operative employment
- Private insurance
- Greater arm pain
- Education > high school

Archer 2020

Predictors of outcome of cervical surgery

Survey of 383 international spine surgeons



Chin-See-Chong 2020

Surgical outcomes

Long term follow-up

- 122 pts with Cx radiculopathy
- Non-instrumented ACDF
- 2-15 yr follow-up
- 83% mild or no neck pain
- 85% no functional impairment deficits
- 19.6% pseudoarthrosis 1 level, 27% > 2 levels
- Pseudos did not preclude +ve outcome

Bohlman 1993

- Conflicting evidence exists as to its efficacy with success rates of 52-99% reported.
- Recurrent symptoms have been reported in as many as 30% of patients

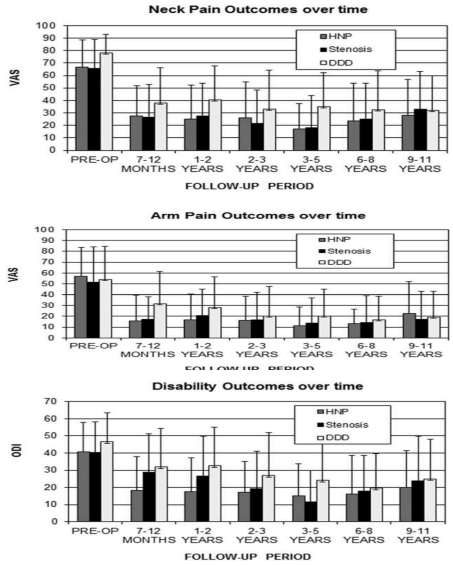
Matz 2009

Surgical outcomes

10 year follow-up of 159 anterior cervical discectom & fusion patients

Follow-up post -op	Do you consider your treatment to have been successful?	Would you undergo this treatment again under similar circumstances?
< 1 yr	95%	95%
1-2 yr	91%	91%
2-3 yr	94%	95%
3-5 yr	90%	92%
6-8 yr	88%	88%
9-11 yr	85%	85%

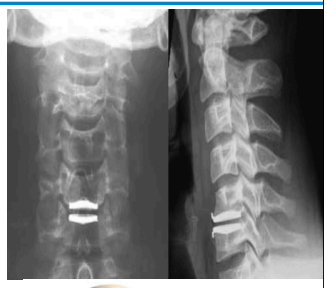
Butterman 2018

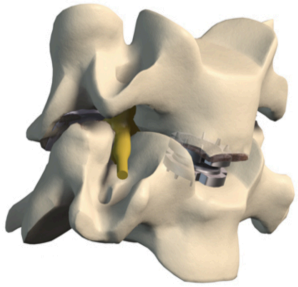


Artificial disc replacement

Indications:

Pathology	Discectomy & fusion	Artificial disc
Central or foraminal compression	+	+
Single level	+	+
Multi level	+	+/-
Retro-vertebral compression	+	-
Spondyloarthropathies	+	-
Underlying instability	+	-
Poor bone quality	+	-
Infection	+	-
Known malignancy	+	-
Allergy to device material	-	-

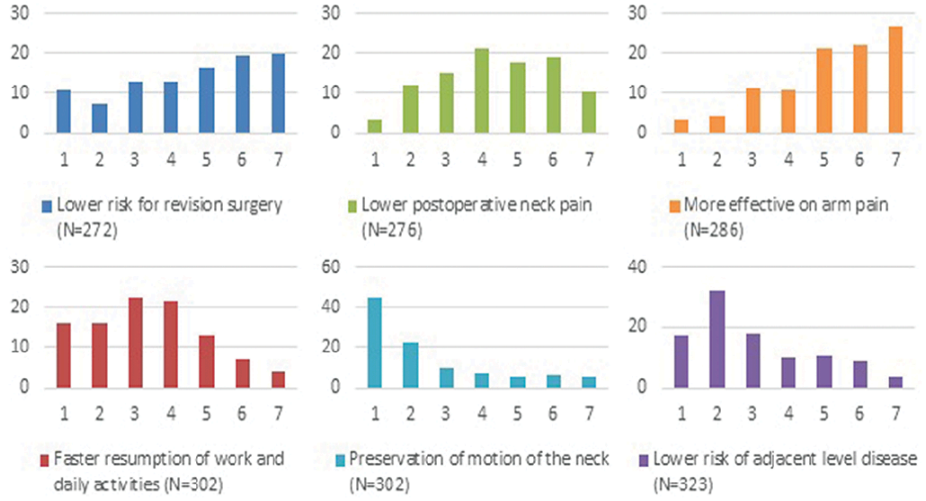




Leven 2017

Advantages of artificial disc replacement

Survey of 383 international spine surgeons



Chin-See-Chong 2020

Artificial disc replacement

Systematic review of 14 meta-analysis

Items	Hua Jiang	Si Yin	Yu Gao	Dan Xing	Chunpeng Ren	Minjie Rao	Jiaquan Luo	Fuqing Gao	Qiang Yao	Lei Kuang	Yan Hu	Shi hua Zou	Lei Shengguan	Hui Lu
year	2011	2013	2013	2012	2014	2014	2014	2015	2015	2016	2016	2016	2017	2017
NDI														
SF-36														
Neurologic status														
ROM														
Reoperation														
Complications														
VAS Neck Pain														
VAS Arm Pain														
Operative Time														
Blood Loss														
Length of Hospital Stay														
ASD														
Patient satisfaction														
JOA														

Favoring TDR | Favoring ACDF | No difference | No reporting

"Cervical disc arthroplasty was superior compared to anterior discetomy for the treatment of symptomatic cervical disc disease"

Zhai 2020

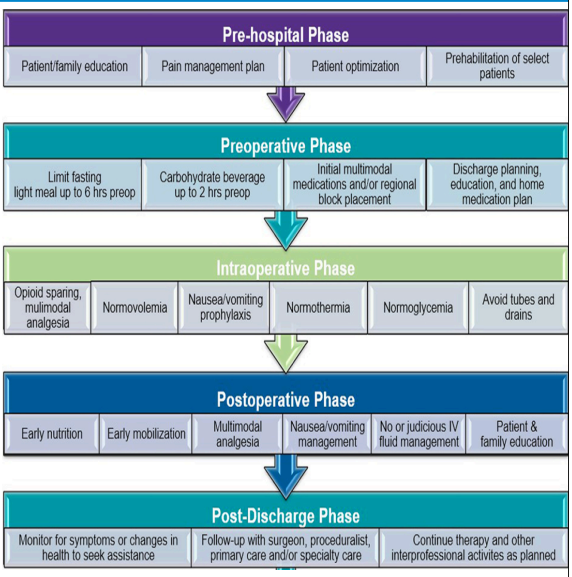
Pre & Post-surgical Physiotherapy

Prospective study of 1319 surgical cases

Pre-surgical Physiotherapy patients:

- Shorter hospitalization
- At 1 yr post SX
  - Higher SF-36
    - Physical functioning scores
    - Physical component scores
- At 2 yrs post Sx
  - Lower VAS arm & neck pain scales
  - Higher return to work

Gerling 2018, Elsarrang 2019



Management of cervical Radiculopathy

Physiotherapy vs Anterior surgery & Physiotherapy

- Prospective RCT
- 63 subjects
- 2 year follow-up
- Physiotherapy included:
  - Neck specific exercises
  - Thoracic mobilization
  - Cognitive behavioral education approach

Peolsson 2013

Outcomes:

- No differences between the 2 groups for:
  - Cervical ROM
  - Manual dexterity
  - Neck motor endurance
  - Arm elevation during neck extension

Prognosis with conservative management

Retrospective case series

- 88% of symptomatic patients (no neurological deficit) will recover within 4 weeks
- 80% of those with objective motor deficits will improve within 3 weeks

Childress 2016

Prognosis with conservative management

Predictors of short term outcome

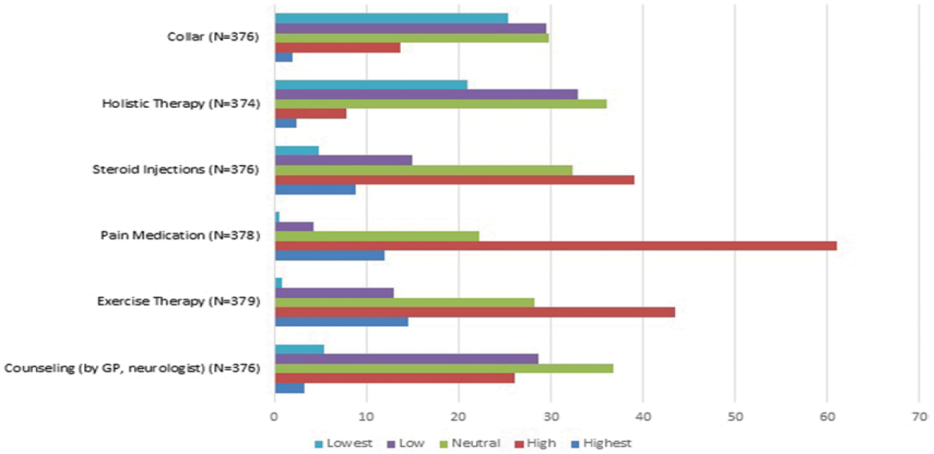
1. Age < 54 yrs.
2. Dominant arm not affected
3. Looking down does not worsen symptoms
4. Multimodal treatment of:
   - Manual therapy
   - Cervical traction
   - Deep neck flexor training
   - For at least 50% of visits

# variables	Sen	Spec	+ve LR	Probability of success
4+	0.18	0.98	8.3	90.4
3+	0.68	0.87	5.2	85.4
2+	0.94	0.37	1.5	62.9
1+	1.0	0.08	1.1	55.4

Cleland 2007

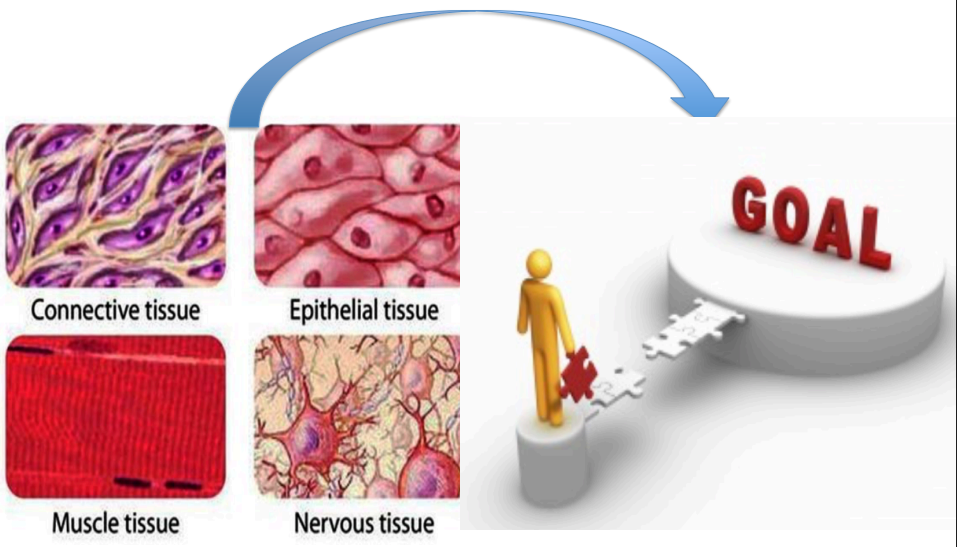
Expectations of spine surgeons

Survey of 383 international spine surgeons
Reported expectations of outcomes form non-surgical interventions



Chin-See 2017

How about we change our approach?



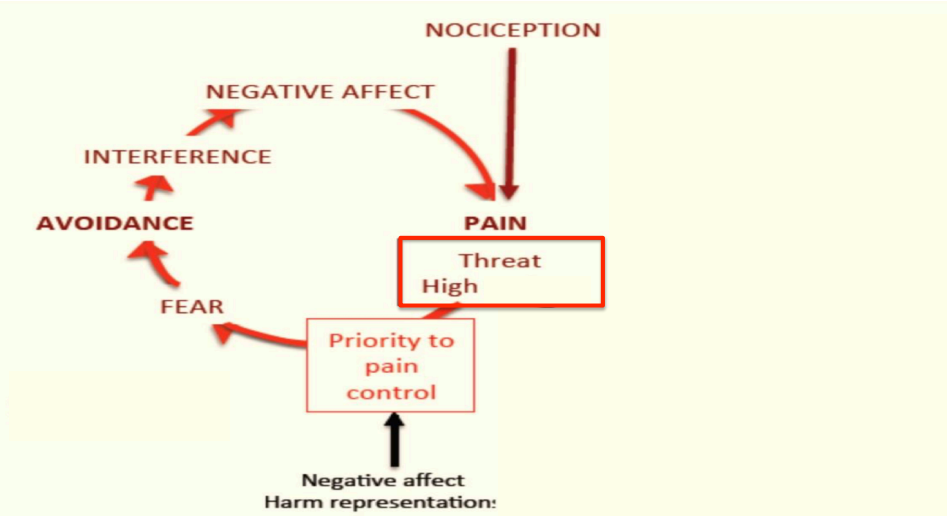
Goal oriented approach

Functional recovery goal
Deep neck flexor
Aerobic conditioning

Mobility recovery goal
Manual therapy
Neural mobilization

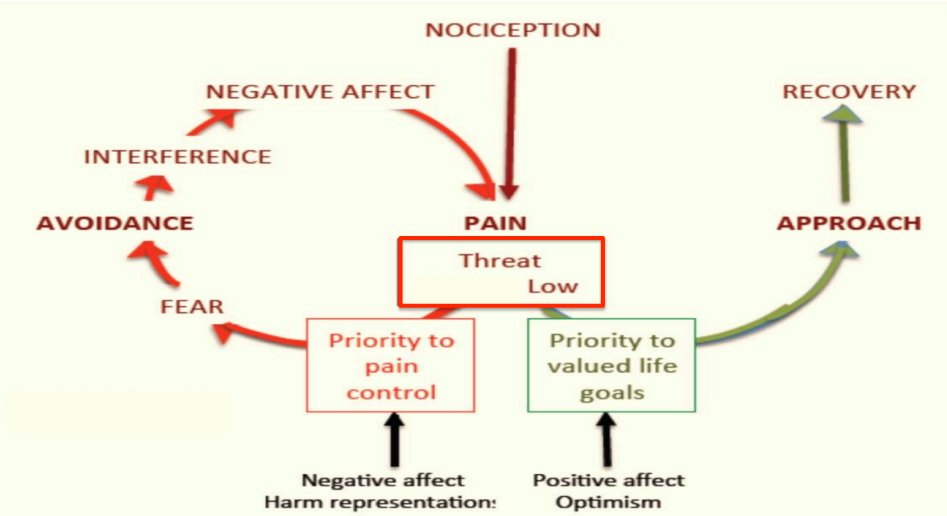
Pain control goal
Education
Immobilization
Traction
Directional preference
Pain modulation

Education
Fear – avoidance model



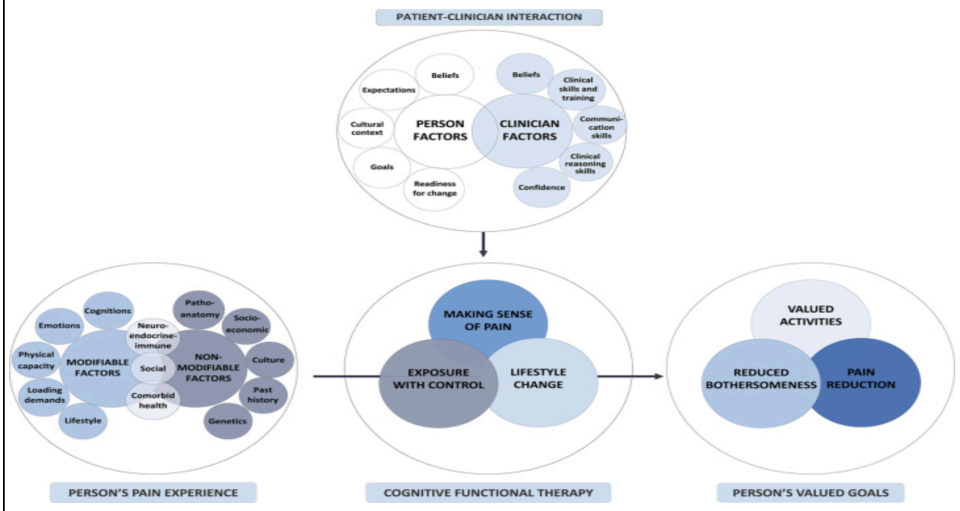
Vlaeyeb 2012

Education
Fear – avoidance model



Vlaeyeb 2012

Cognitive Functional Therapy



- https://europepmc.org/article/PMC/6037069

O'Sullivan 2018

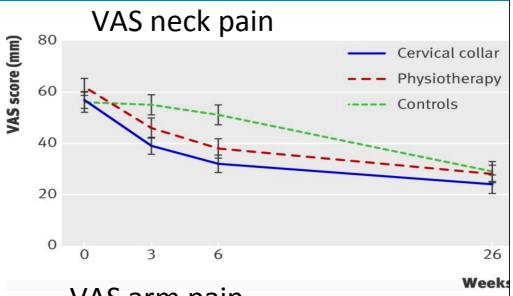
Immobilization

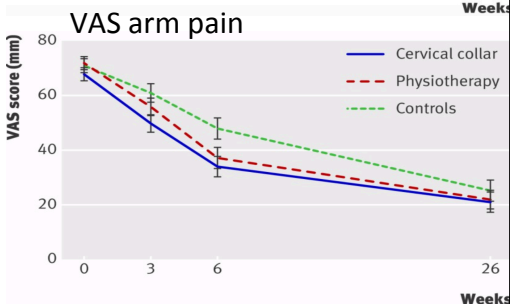
Randomized controlled trial

205 subjects

- Controls
  (Wait and see)
- Physiotherapy
  (12 sessions, 2/wk)
- Semi rigid collar
  (3 -6 wks.)

Kuijper 2009





Immobilization

Single blind randomized controlled trial

- 101 subjects
- Clinical and imaging findings of CR
- Randomly assigned to:
  - Soft collar
  (8 hrs./day for 2 wks.)
  - Semi-rigid collar
  (8 hrs./day for 2 wks.)
  - Controls

Aksoy 2018

Soft & semi-rigid collars vs controls

At 2 & 6 weeks

Significantly better improvement in:

- VAS
- NDI
- SF-36 pain perception
- SF-36 physical component

Immobilization

Type of collar

Significant difference in ROM limitation between between:

- Philadelphia
- Soft collar

No significant difference in ROM limitation between:

- Aspen
- Miami J

Sandler 1996, Gavin 2003

Immobilization

RCT of chronic radicular arm pain

- 81 subjects
- > 3 months symptoms

Surgical group

- Anterior discectomy & fusion
- 29% re-operation rate

Physiotherapy group

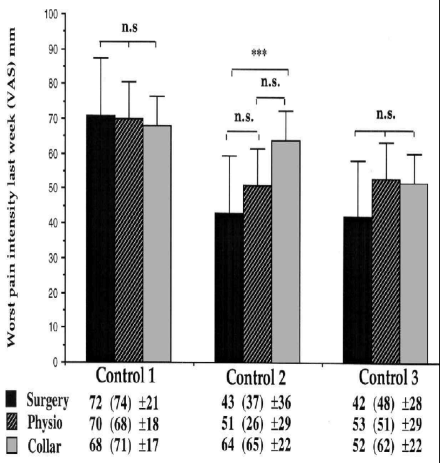
- Manual therapy
- ROM & motor control exercises

Immobilization group

- Semi-rigid collar during day soft collar at night
- 3 months

Persson 2001

Worst pain intensity past wk.



Immobilization

Effective Dosage

- 1-2 weeks to gain pain control
- Gradual reduction of duration of usage

Negative effects

- Loss of proprioception
- Deconditioning
- Soft tissue contracture
- Psychological dependence

Kuijper 2009, Jasper 2018, Cote 2016

APTA CPG for neck pain with radicular pain

"Because of the detrimental effects of prolonged use, collars should be restricted to a limited time in the acute phase only and only in individuals who do not obtain relief from other treatments."

Blanpied 2018

Identifying Possible Responders to Mechanical Cervical Traction

Variables:

1. Age > 55
2. + shoulder abduction test
3. + ULTT #1
4. Symptom peripheralization with lower cervical (C4-C7) P-A motion testing
5. + Neck distraction test

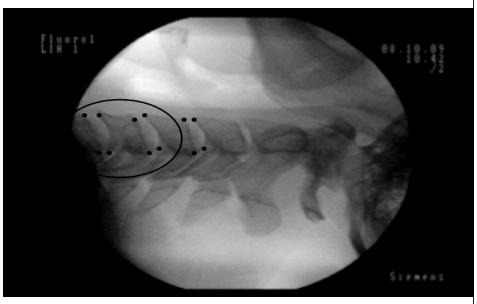
> 4 variables present:
+LR = 11.7

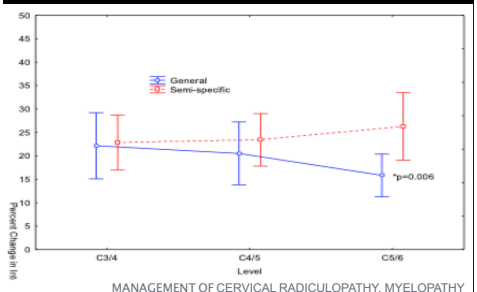
Raney 2009

Cervical Traction

Non-specific vs semi-specific manual traction

Mulligan 1999, Werstine 2018





Cervical Traction

Semi-specific manual cervical traction

Indications:

- Arm pain of cervical radicular origin

Procedure:

- Have 1-2 cm gap between finger tips (space for spinous process)
- Finger pads on articular pillard above target level
- Allow belt to do the work - do not "pull with hand/arms"
- Vary amount of anterior glide to spinal level - lower - less glide upper - more glide

Mulligan 1999

Cervical Traction

Mechanical Traction

- 15 degree angle of pull (adjust per pt comfort)
- Initial pull 12 lbs; adjust on pt tolerance/symptom reduction/centralization
- Intermittent: 60 sec pull/ 20 sec relax @50% force
- 15 min. with 2 min. rest after

Raney 2009, Fritz 2014

Cervical Traction

Home traction

- Seated
- Initial pull: 8-12 lbs, adjust per tolerance, symptom reduction, centralization
- Max pull 20 lbs
- 15 min with 2 min. rest after

Raney 2009, Fritz 2014

Cervical Traction

Amount of traction on cervical IVF height

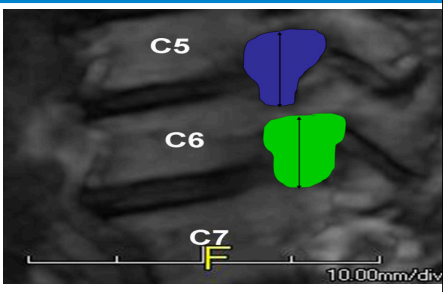
Significant changes:

- Neutral to 5kg
- 5 kg to 10 kg

No significant change

- 10kg to 15 kg

Liu 2008



Percent increased height IVF			
Level	5 kg	10 kg	15 kg
C2/3	5.08%	20.92%	21.2%
C3/4	5.48%	21.62%	23.30%
C4/5	8.76%	16.27%	21.80%
C5/6	4.65%	12.7%	13.85%
C6/7	5.08%	11.29%	14.40%

Cervical Traction

Systematic review & Meta-analysis

- 5 studies, 459 subjects

"the current literature lends support to the use of traction in addition to other physical therapy procedures for pain reduction with less impact on function and disability."

Romeo 2018

APTA Clinical Practice Guideline

Neck pain with radiating pain

Chronic

"Clinicians should provide mechanical intermittent cervical traction."

Planpied 2018

Directional preference

Systematic review

- 5 studies, 744 subjects

"The additional benefit of MDT compared with the wait-and-see or other therapeutic approaches may not be clinically important in terms of pain intensity and is not clinically important in terms of disability."

Takasaki 2014

Predictors of response

Retrospective study of 104 patients with cervical pain

1. Patient compliance to directional preference therapy
2. Patient age > 55
3. Condition chronicity
4. Immediate improvement of symptoms following initial session

Holmes 2017

Manual therapy

Systematic Review

- 4 studies, 317 subjects

"Using manual therapy techniques in conjunction with therapeutic exercise is effective in regard to increasing function as well as AROM, while decreasing levels of pain and disability"

Boyles 2011

Systematic Review

- 5 studies, 796 subjects

"Existing literature does provide support for the cautious application of HVLA procedures in cases of confirmed or suspected cervical radiculopathy"

Rodie 2012

Cervical mobilization

"Opening" side glide mobilization

- Patient supine head on pillow
- Therapist uses open palm cradle on postero lateral mid to lower cervical spine
- Lateral translation (not side bend) towards painful side
- Graded, slow oscillations mid-to end range

Cervical mobilization

Randomized controlled trial

- 8 treatment sessions over 4 weeks
- Home exercise program

Comparison group

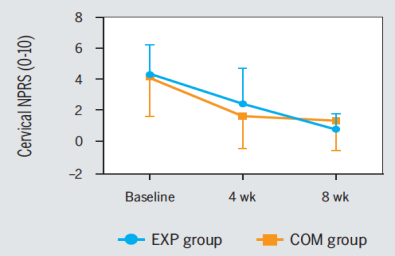
- Received 4 non-thrust manual therapy techniques
- No IVF opening techniques

Experimental group

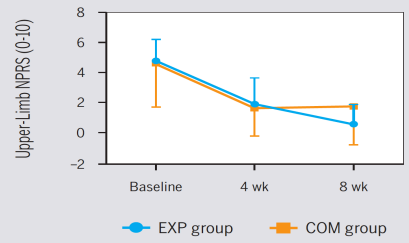
- Received 4 non-thrust manual therapy techniques
- Including 2 IVF opening techniques

Langevin 2015

Mean cervical NPRS



Mean upper limb NPRS



Thoracic manipulation

Randomized controlled trial

- 43 subjects
- +ve for Wainner CPR
- NDI > 10/50
- Data collected 48 – 72 hrs post intervention

Thoracic manipulation n=22

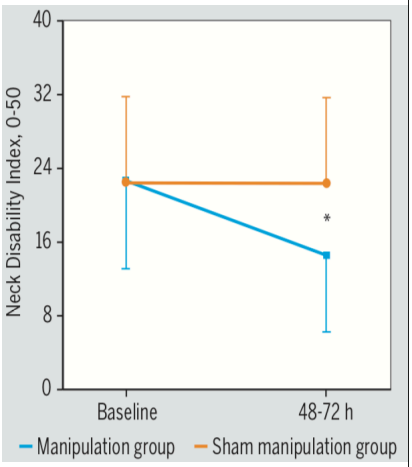
- Supine manipulation position
- HVLA thrust directed to upper thoracic region
- Audible cavitation required

Sham manipulation n=21

- Supine manipulation position
- No HVLA thrust
- No cavitation

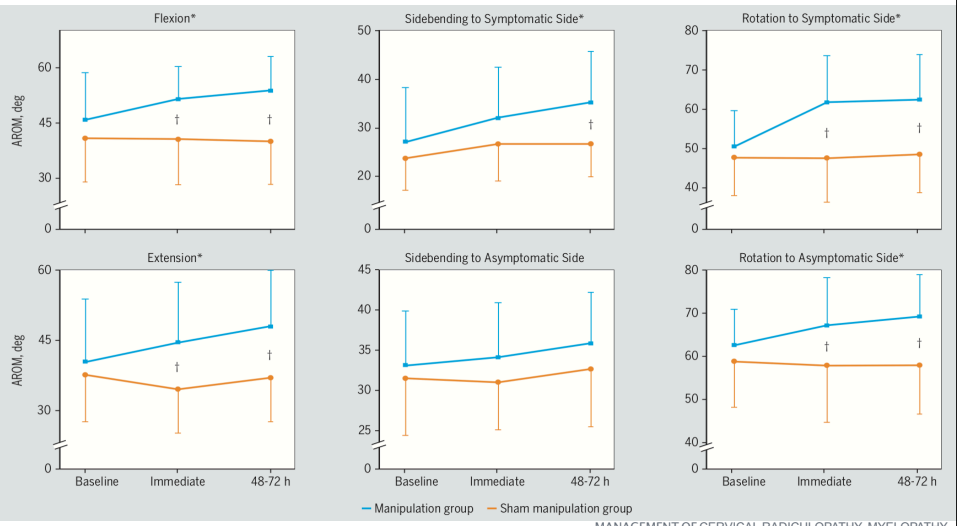
Young 2019

Mean NDI



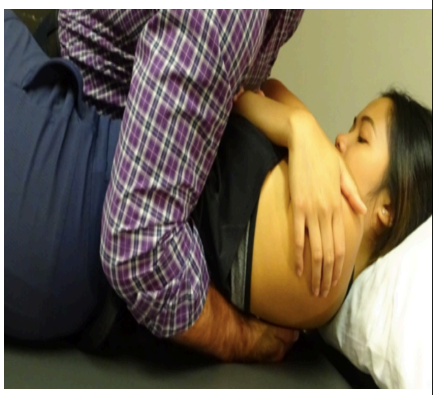
Thoracic manipulation

Mean active ROM



Thoracic manipulation

- Patient supine
- Therapist creates “pistol grip”
- Place lower hand just below target level
- Roll patient onto hand
- Patent lifts buttocks off bed
- Thrust is antero-postero through patient's elbows/ forearms



Thoracic manipulation

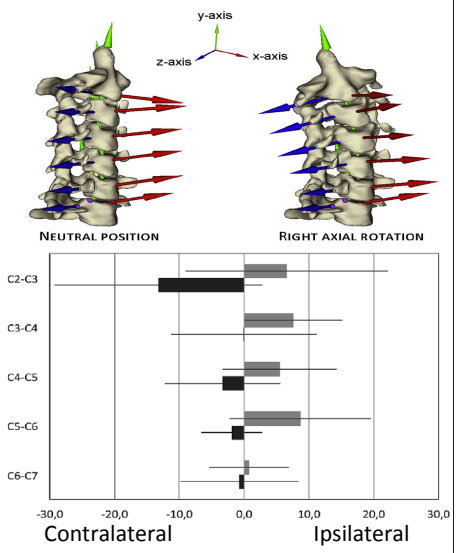
- Patient seated
- Arms crossed
- Therapist grasps elbows
- Rolled towel between
- Thrust is a postero-cephalic pull through elbows

Cervical manipulation

CT assessment of IVF dimensions

- 30 subjects
- Pre-manipulative position
- Contralateral IVF
  - Decreased area
- Ipsilateral IVF
  - Increased area

Digailly 2018



Cervical manipulation

Prospective observational study

- 31 subjects
- Diagnosis of cervical radiculopathy
  - Clinical (Wainner cluster)
  - Imaging (CT or MRI)
- Pragmatic approach
  - Cervical manipulation (18 cases)

Murphy *2006*

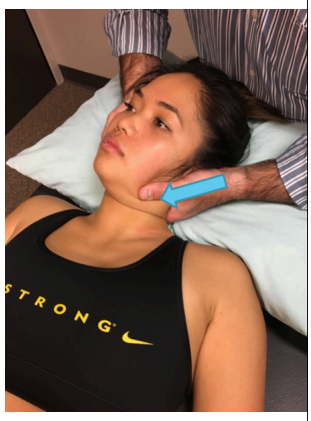
Those receiving HVLA cervical manipulation	
Variable	**Mean improvement**
BDQ baseline – follow-up	51.7 %
BDQ baseline long-term	80.5 %
NRS Baseline to last follow-up	63.9 %
NRS baseline to long-term	76.9 %

BDQ: Bournemouth Disability Questionnaire
NRS: Numeric Rating Scale

Cervical manipulation

"Downslope"manipulation

- Patient supine head on pillow
- Therapist uses open palm cradle on postero lateral mid to lower cervical spine
- Contralateral rotation, ipilateral infero-lateral translation
- Engage end-range barrier
- Pre-manipulative hold
- Infero-lateral small amplitude thrust towards shoulder



Neural mobilization

Predictors of responders to neural mobilization for nerve-related neck and arm pain

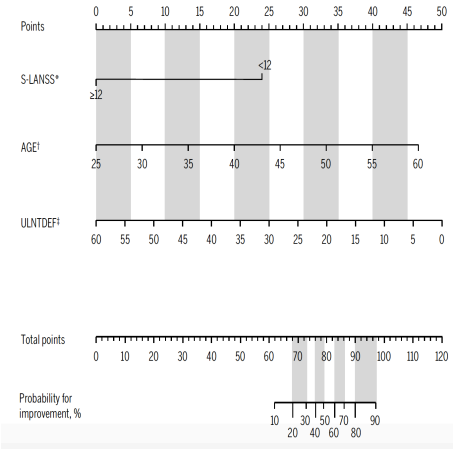
1. Absence of neuropathic pain qualities (S-LANSS)
2. Older age
3. Smaller deficits in elbow extension in median nerve neurodynamic test range

Increased likelihood of improvement from 53 to 90%

Absence of these

- Decreased likelihood of success to 9%

Nee 2013



Neural mobilization

Patient:

- Positioned with arm in ULTT #1
- Short of engagement of symptoms

Therapist:

- Stabilizes patient's shoulder
- Performs gentle, slow lateral translation glide away from painful side
- No symptoms should be reproduced and no lasting increase to baseline arm pain

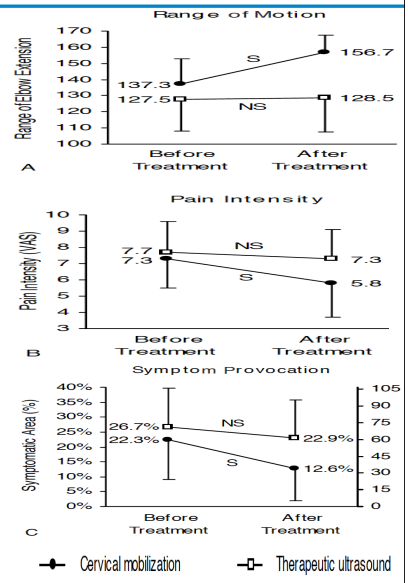
Nee 2013

Neural mobilization

Randomized controlled trial

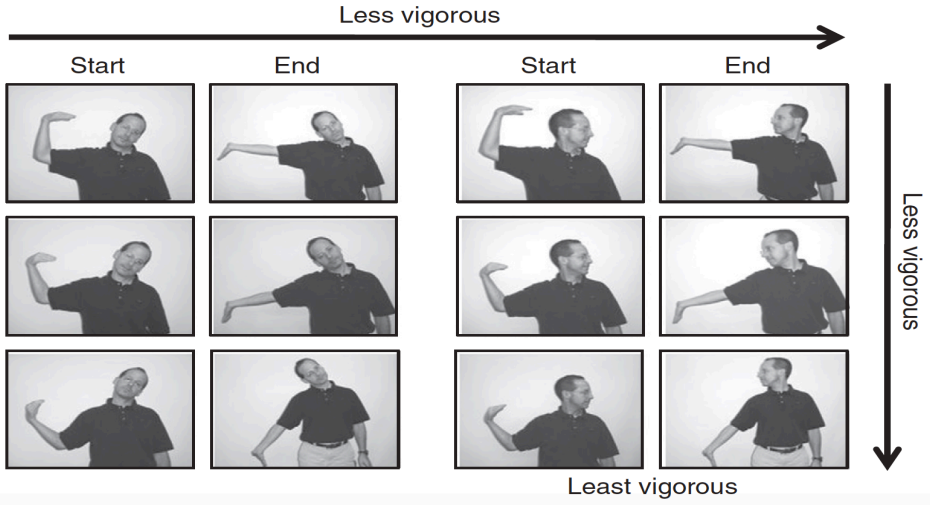
- 20 subjects
  - Sub-acute (2 wks – 6 mos. post acute onset)
  - Pain with median nerve palpation
  - +ve ULTT#1
- Control
  - 5 min therapeutic dose ultrasound to most painful region
- Mobilization
  - Involved arm placed in position as close to but still did not provoke symptoms during mobilization
  - Contralateral cervical side glide

Coppieters 2003



Neural mobilization

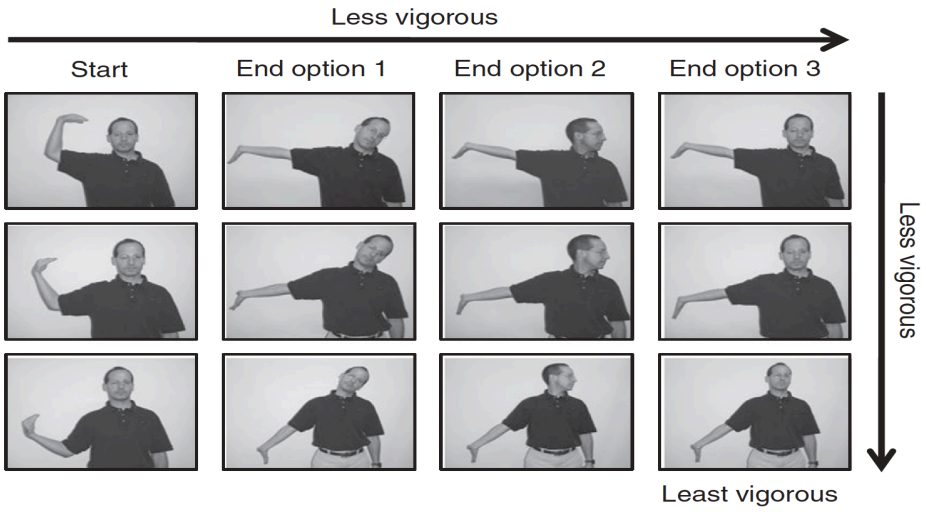
"Sliding" self-mobilization



Nee 2011

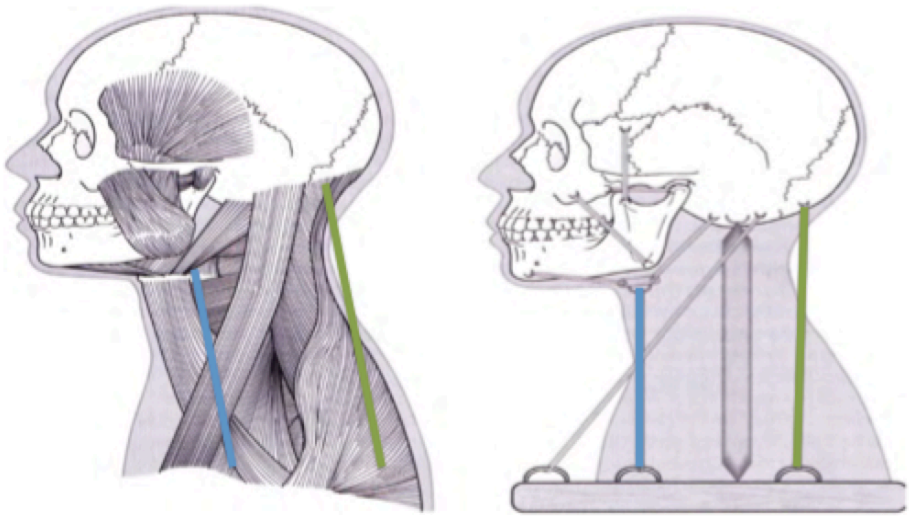
Neural mobilization

"Tensioning" self-mobilization

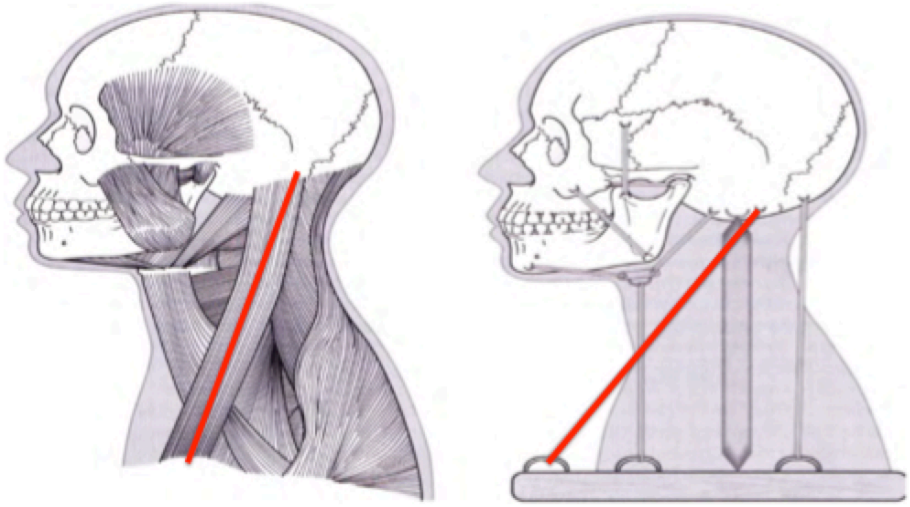


Nee 2011

Cervical motor control

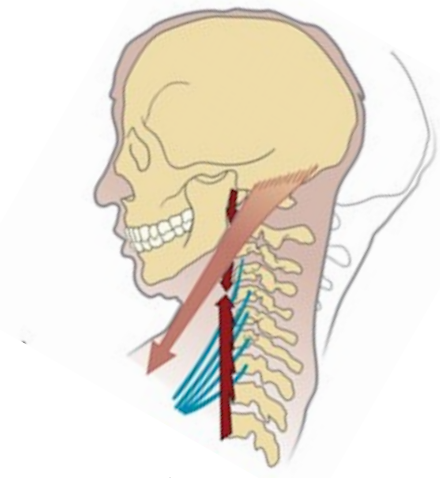


Cervical motor control

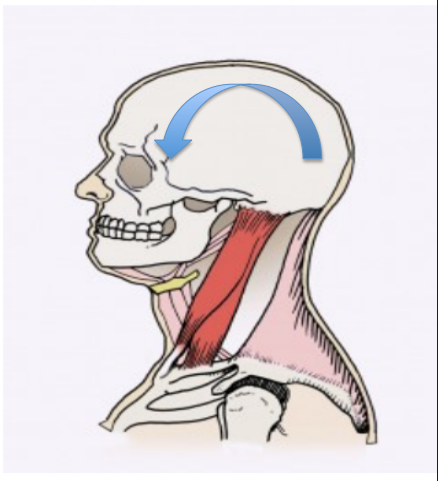


Cervical motor control

Longus coli activated

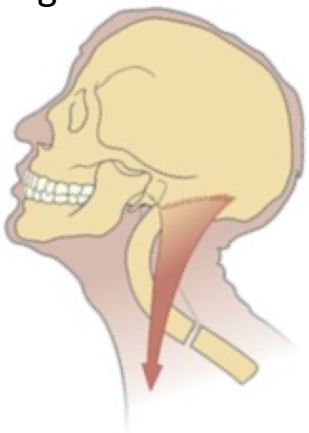


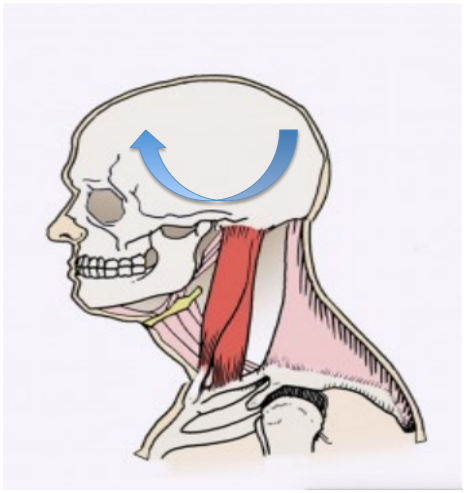
Kapandji 2010



Cervical motor control

Longus coli inactive

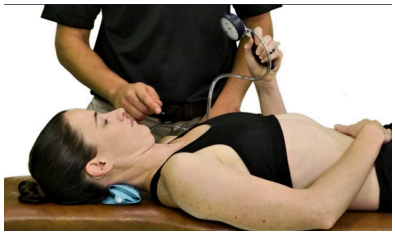


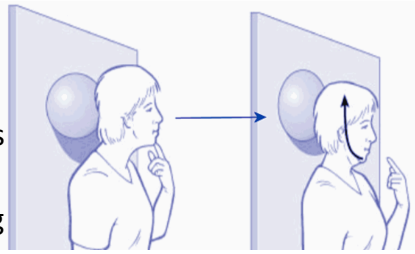


Kapandji 2010

Cervical motor control

- Cuff placed behind neck & inflated to 20mmHg
- Patient instructed to slowly flex neck with nodding motion
- Progression by increasing cuff pressure in 2 mmHg increments held for 2 sec.
- Goal of 30 mmHg
- <u>Without activating SCM</u>
- Home program using a rolled towel as patient gains skill
- Further progression to weight bearing





Jull 2008

Active exercise

Upper quarter strengthening including resistance targeted to:

- Shoulder abduction
- Shoulder retraction
- Lat. pull down
- Push-up
- Chest press
- Shrug
- Arm curl
- Bent-over row
- Chest flies

Ylinen 2007, Gross 2009, Ylinen 2010, Andersen 2011,

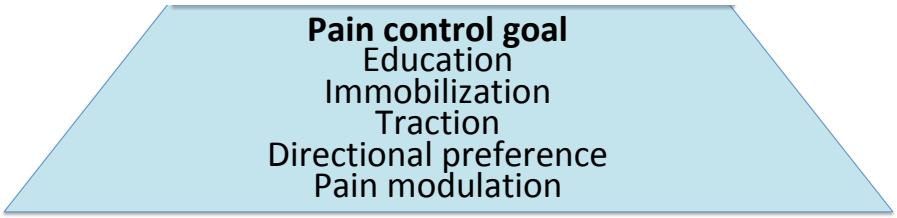
Exercise in treatment of cervical radiculopathy

Systematic Review

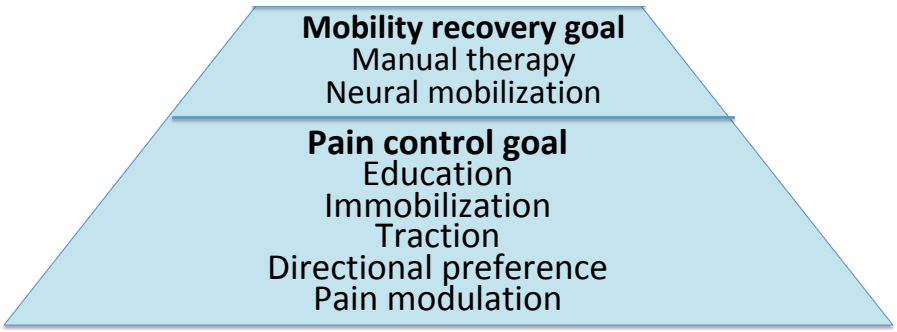
- 10 studies, 871 subjects
- "Exercise alone or exercise plus other treatments may be helpful to patients with cervical radiculopathy.
- However exercise option should be carefully considered for each patient with CR in accordance with their different situations"

Liang 2019

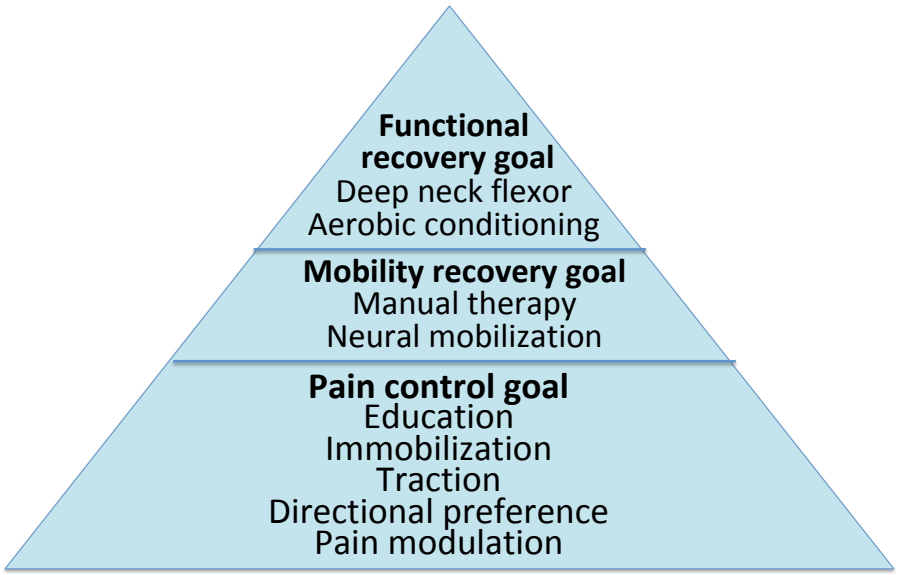
Goal oriented approach



Goal oriented approach



Goal oriented approach



Thank you