

CHRONIC PAIN: TRAUMA, REHABILITATION & TREATMENT

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OVERVIEW

Trauma, pain and rehabilitation

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graph TD; A[Trauma, pain and rehabilitation] --> B[Types of pain]; B --> C[Rehabilitation]; C --> D[Treatment]; D --> E[Case studies];
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Types of pain

Rehabilitation

Treatment

Case studies

SHEPHERD CENTER

Long-term acute care (LTAC) facility

Spinal cord injury

Acquired brain injury

Multi-trauma

- Fractures, amputations
- Infectious amputation – 4 limb

Skin

- Plastic surgery flaps for skin ulcers in chronic population

SHEPHERD SPINE & PAIN INSTITUTE

Primarily outpatient treatment

In-Patient consultation

Community as well as shepherd patients treated

18 years experience

In house psychology and physical therapy within the pain center

Balanced, multimodal treatment including medication management, and physical therapy, spinal cord stimulation, peripheral nerve stimulation, typical injections as well as psychological care

TRAUMATIC INJURY

Motor vehicle

- Vs barrier
- Vs pedestrian
- Vs motor vehicle
- Vs tree

Work comp, PI

- Secondary gain
- malingering

HOSPITAL STAY AND RECOVERY

Critical illness and
bed status

Causes multiple
deleterious effects

Muscle wasting

Pulmonary
compromise

Neuropathy

Myopathy

Cardiac
compromise

$VO_{2peak} = CRF$
• Vital sign

FVC, FEV1, FEV1/FVC

Ventilatory efficiency

Lung diffusion capacity

HR, SV, CO

VO_2 /work rate slope

Hb

Ventilatory threshold 1

avO_2 -diff

Muscle strength and mass

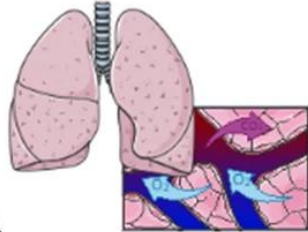
Pulmonary

Cardiovascular

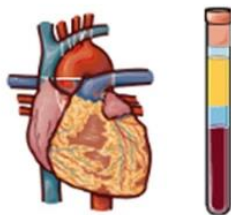
Periphery

COVID-19- and inactivity-induced alterations

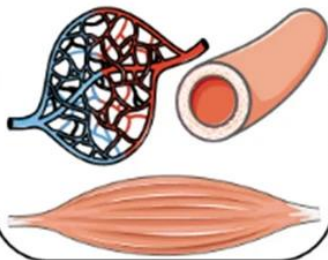
Lung function & gas exchange



Cardiac function, O_2 -carrying capacity



Vasculature & oxidative capacity



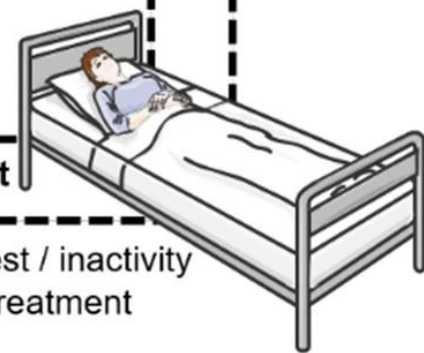
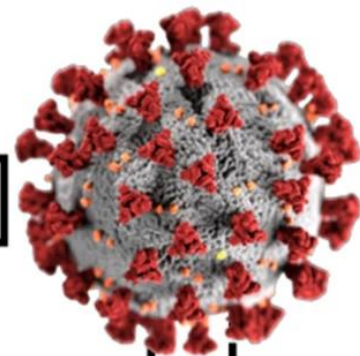
Short- to long-term sequelae




direct

indirect

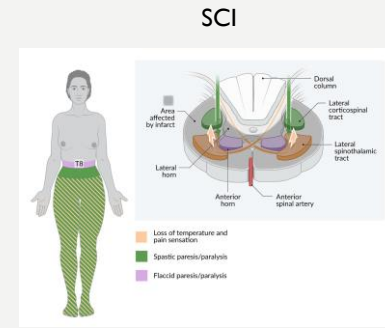
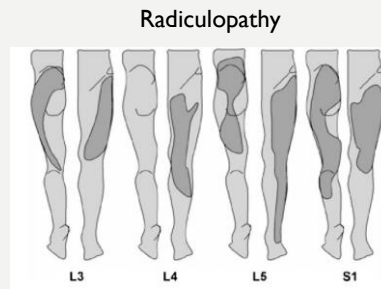
- Bed rest / inactivity
- Drug treatment



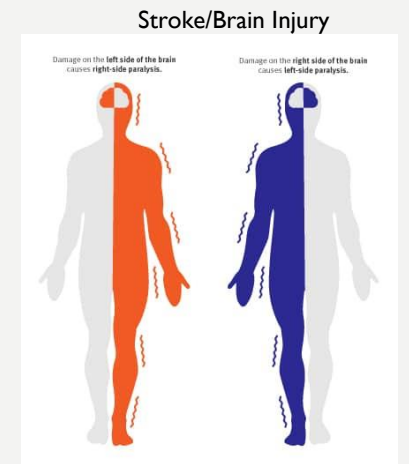
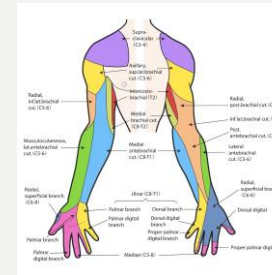
REFERRAL PATTERNS FOR PAIN

- Neuropathic
 - Stabbing, shooting, aching
 - Radiculopathy
 - Any level of spine
 - Plexopathy
 - Spinal cord injury
 - Brain injury and stroke
- 

REFERRAL PATTERNS OF NEUROPATHIC PAIN



Plexopathy



REHAB

- Dependent on patient needs
- PT
- OT
- Speech
- We can do some interventions to speed recovery and ability to participate in rehab

WHEN WE GET CALLED: INPATIENT

Patient is having difficulty tolerating therapy, weaning off opiates

Moderate to high dose opiates are correlated with poor outcomes in spinal cord injury rehabilitation including poor functional gains, increase risk for pressure ulcers, as well as poor adjustment to community life

Procedural help

Nerve injections, joint injections, IT baclofen bolus trials in challenging anatomical situations

KRAUSE, J ET AL. EXPLORATORY STUDY OF PRESSURE ULCERS AFTER SPINAL CORD INJURY:RELATIONSHIP TO PROTECTIVE BEHAVIORS AND RISK FACTORS. Archives of PM&R, JAN 2001; 82(1): 107-113.

PRIMARY PROCEDURES FOR INPATIENT

Trigger point injections

Shoulder and joint injections

Suprascapular nerve block, pulsed radiofrequency when appropriate

- primary shoulder pain or shoulder hand syndrome
- Stroke, brain injury or tetraplegia

Sphenopalatine ganglion block

- Headaches of various etiologies

Baclofen Bolus trial

- SCI, ABI, storming
- Patients with stenosis, ankylosing spondylitis or previous surgery
- This can be done when it is clear that spasticity is interfering with recovery, hygiene will be a long-term need for the patient despite the fact that it is early in the course of their injury

OUTPATIENT CARE

Multimodal pain care

Best practices

Psychological care

Physical therapy

- In-house or close to the patient

Medication management

- Limiting doses of opiates
 - Using atypical medications
 - ziconotide
 - Intrathecal medications
 - Morphine, hydromorphone, bupivacaine, clonidine
 - Micro dosing

TREATMENT OPTIONS

SUPRASCAPULAR NERVE (SHOULDER PAIN)

- Derived from upper trunk of brachial plexus
 - C5,6
 - Mixed nerve, sensory and motor fibers
 - sensory branches to both the gleno-humeral and acromioclavicular joints.
 - Innervates supraspinatus and infraspinatus mm
 - Can be entrapped at suprascapular notch or spinoglenoid notch
 - Blockade for pain

SUPRASCAPULAR NERVE BLOCK

For acute or chronic pain related to

Paralysis

Stroke, ABI, SCI, brachial plexopathy

Both sci (para) and plexopathy called ...

Arthritis

After replacement

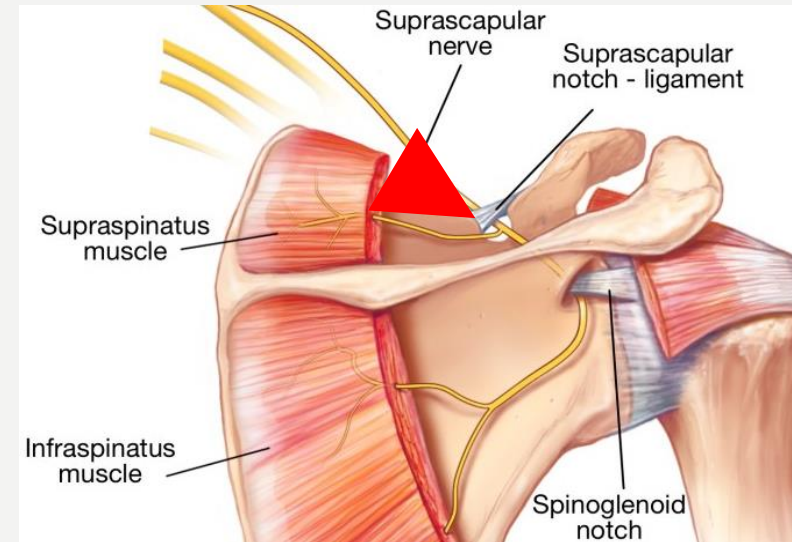
Easy to block

Anatomic palpation

Fluoroscopically guided

Ultrasound

lidocaine./ropivacaine (steroid maybe)



Shanahan, E et al. Suprascapular nerve block (using bupivacaine and methylprednisolone acetate) in chronic shoulder pain, Ann Rheum Dis, 2003 May; 62(5): 400–406.

SHOULDER HAND SYNDROME

Sympathetic syndrome after paralysis

- Stroke

- Brachial plexus injury

- Tetraplegia

Thought to be related to glenohumeral subluxation

Management

- PT

- Taping

- Multidisciplinary

- Blocks

- Neuromodulation

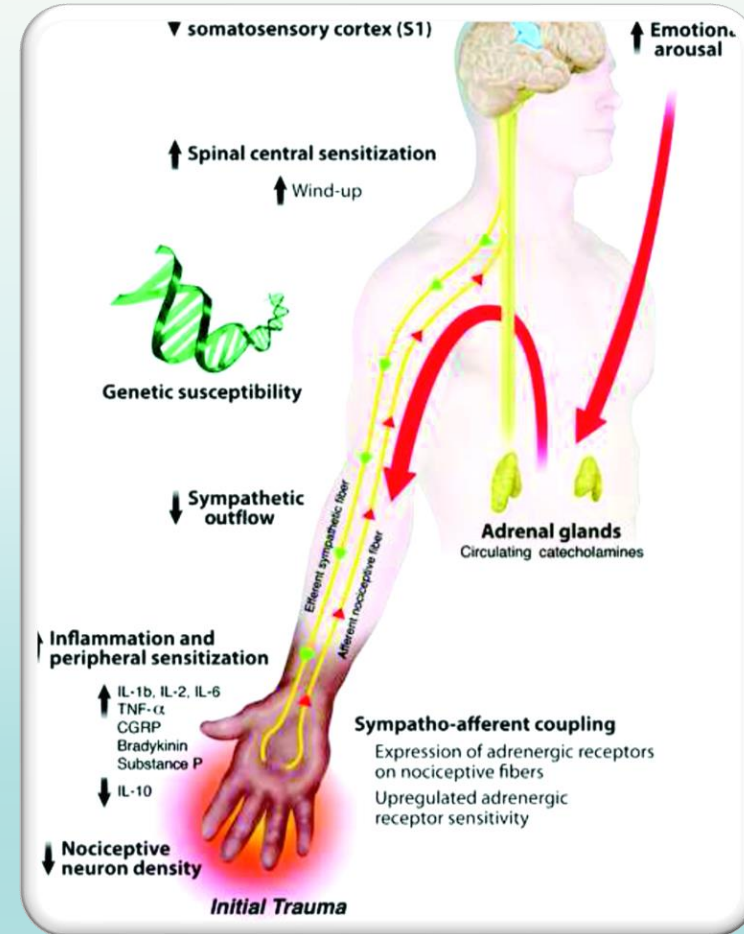
Not great evidence for typical treatment for crps

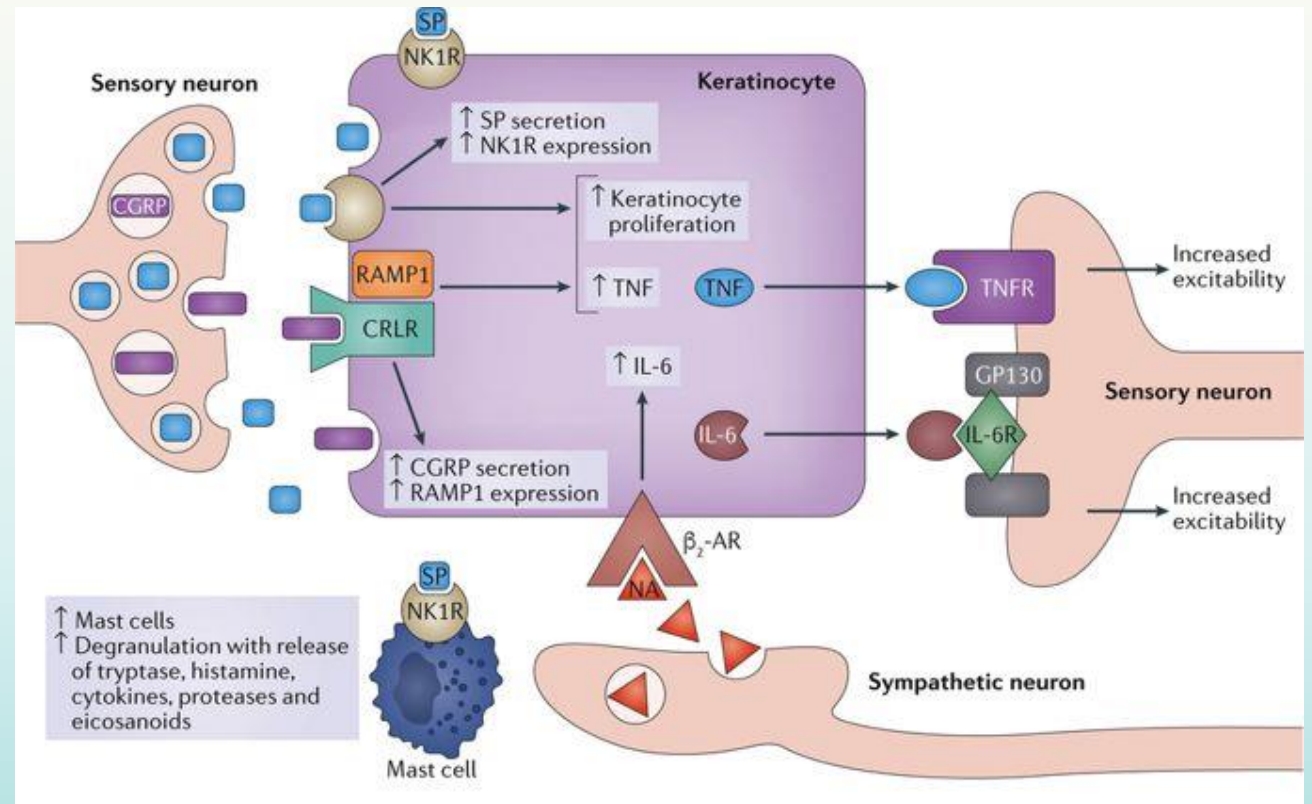
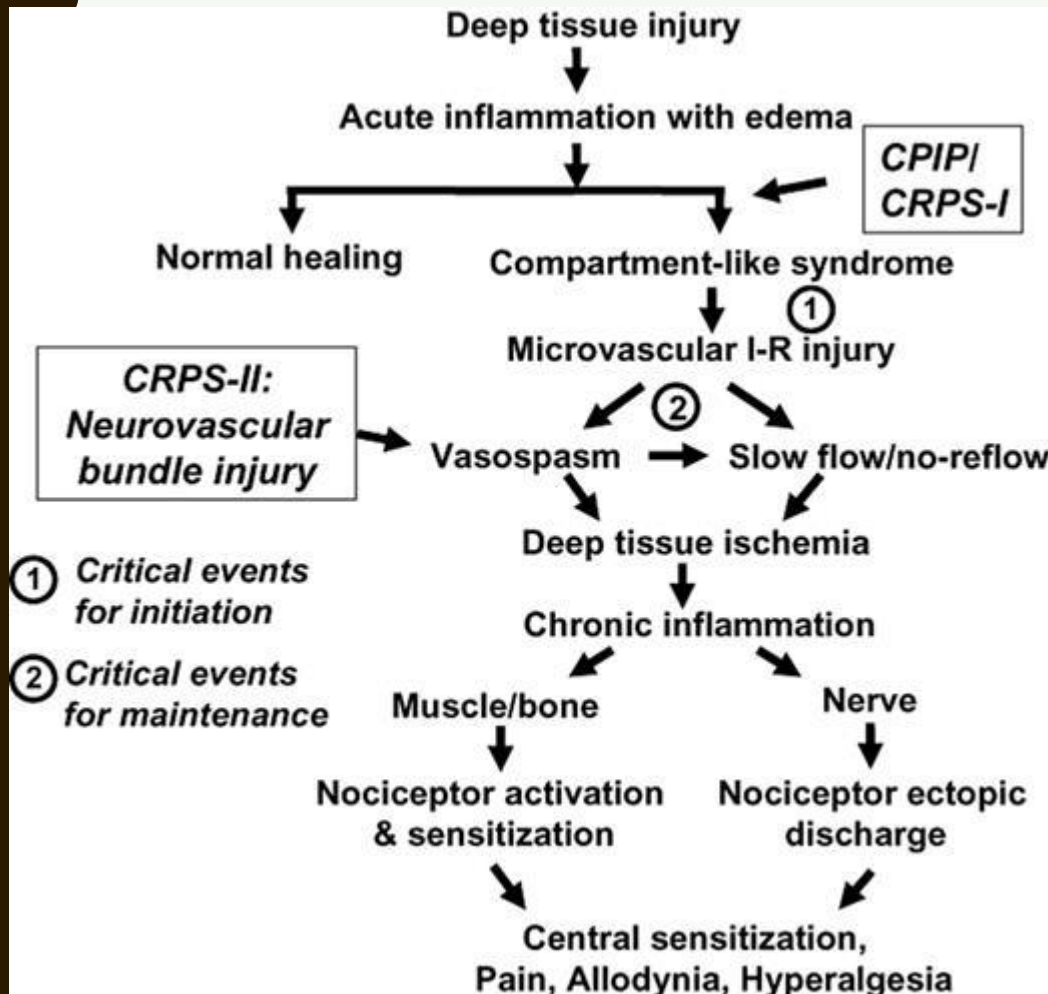
Pertoldi et al. Shoulder-hand syndrome after stroke. A complex regional pain syndrome. [Eura Medicophys](#). 2005 Dec;41(4):283-92

Johnson, E et al. Management of Shoulder-hand Syndrome. JAMA, January 10, 1966; 195(2):108-10.

PHYSIOLOGY OF SHS/CRPS

- Exaggerated inflammatory response
- Chemical mediation within the spinal cord with hyperexcitability
- peripheral sensitization
- C fiber discharge centralization through the medulla
 - Sympathetic or non-sympathetic mediated
- Budapest criteria for clinical diagnosis

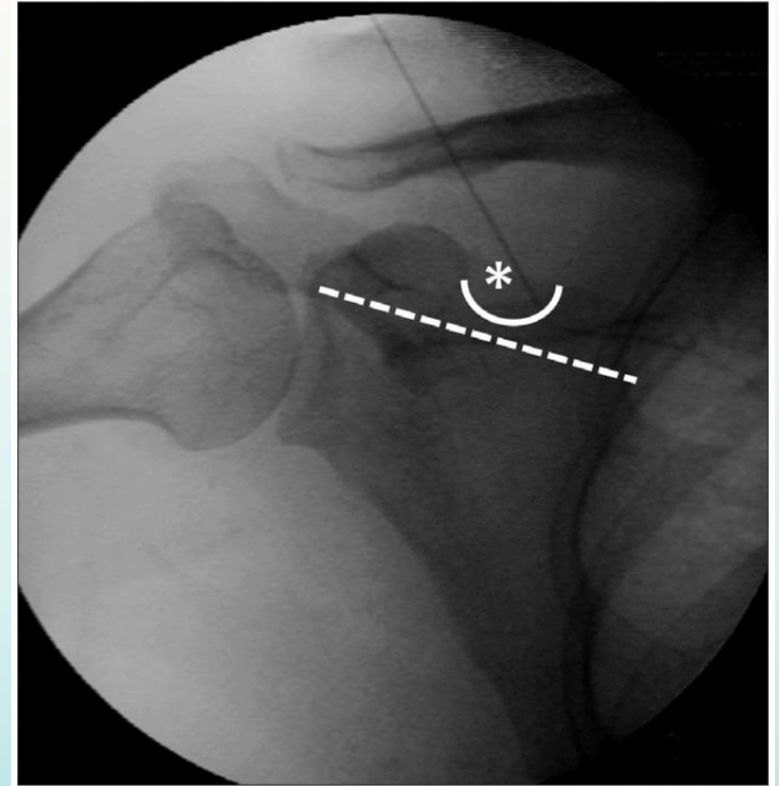




Dubuis, E et al. Longstanding complex regional pain syndrome is associated with activating autoantibodies against alpha-1a adrenoceptors. *Pain*, November 2014, 155(11):2408-2417.

PULSED RF

- Non destructive lesioning
- Placement critical for having intended effect
- 42 C, 120 sec, Hz and PW vary



- Liliang, PC et al. Pulsed radiofrequency lesioning of the suprascapular nerve for chronic shoulder pain: a preliminary report. *Pain Medicine*, 2009 Jan; 10(1): 70-5.
- Gofeld, M et al. Pulsed Radiofrequency of Suprascapular Nerve for Chronic Shoulder Pain: A Randomized Double-Blind Active Placebo-Controlled Study, *Pain Practice*, February 2013; 13(2): 96-103.

PERIPHERAL NERVE STIMULATION

- Sprint (SPR therapeutics)

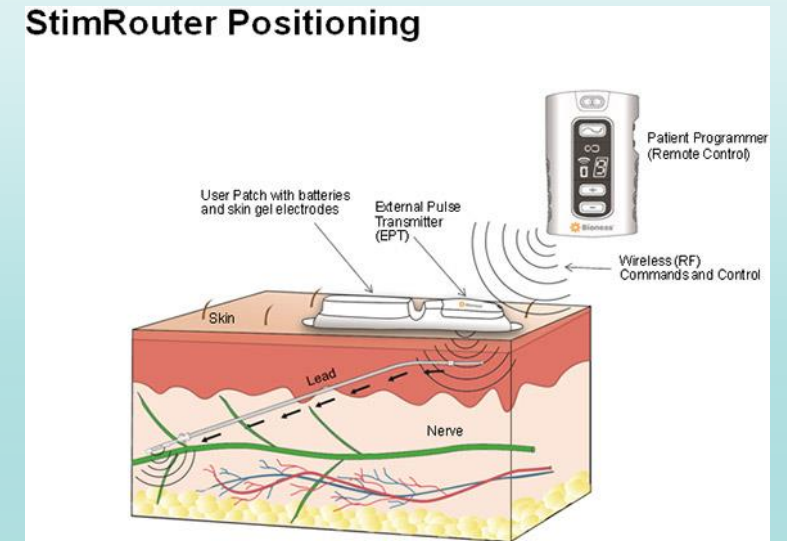


Nalu



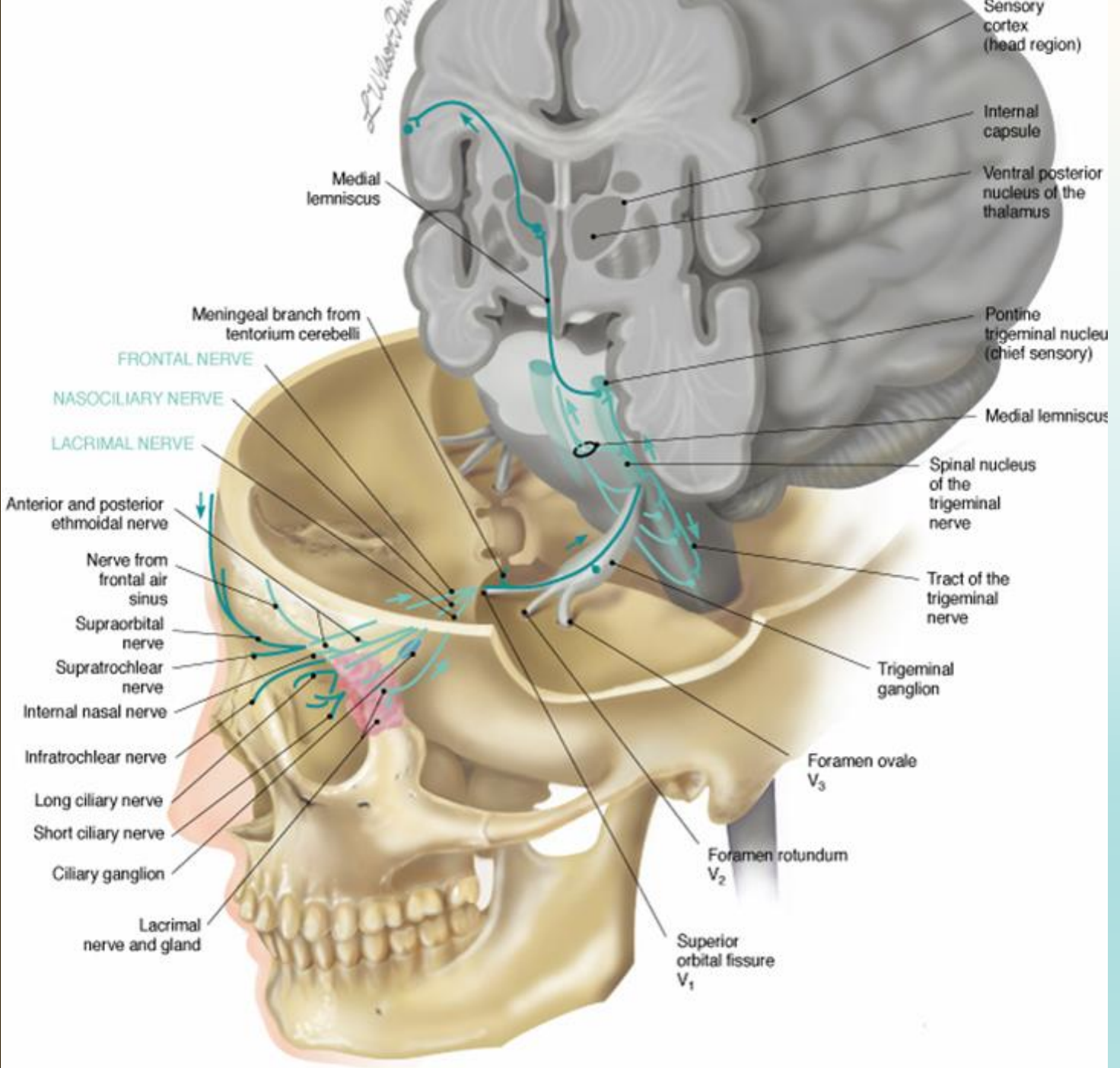
Bioness

StimRouter Positioning

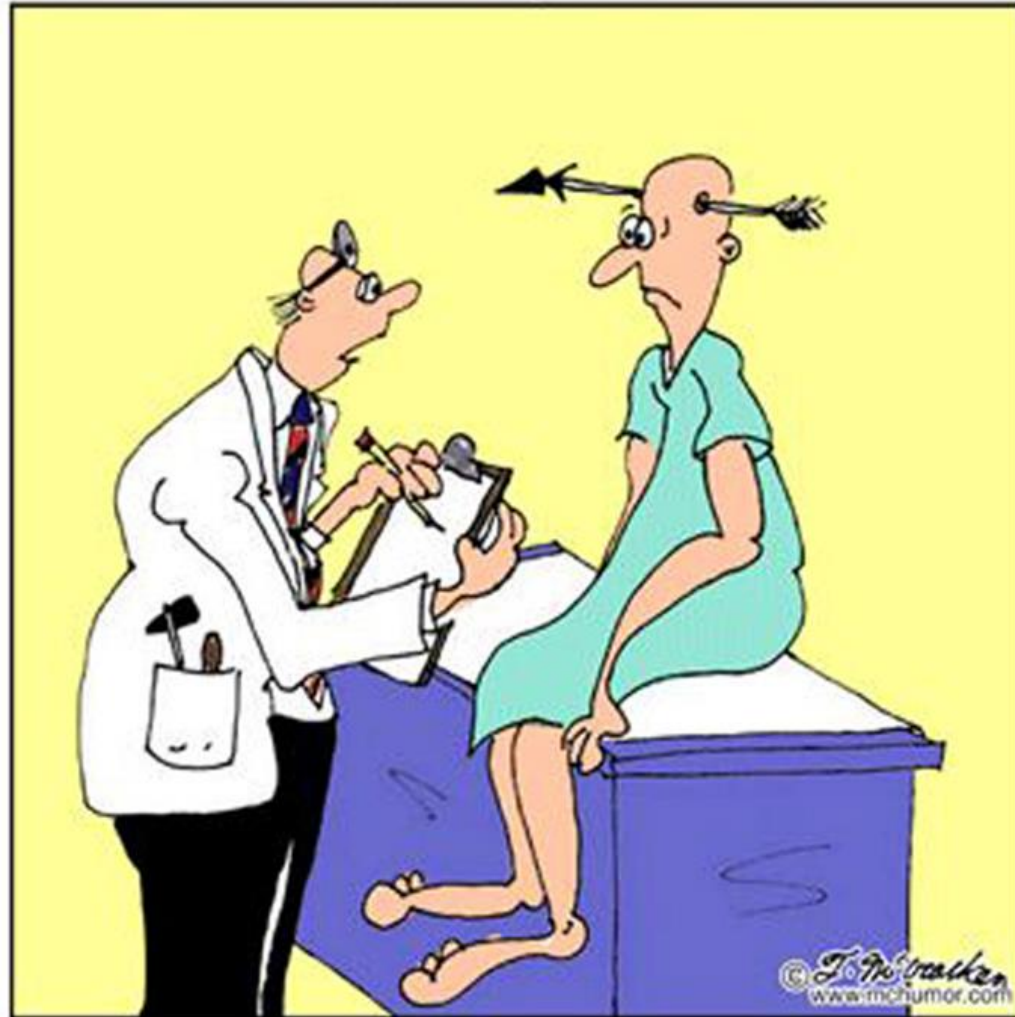


FACIAL PAIN, AND POST BRAIN INJURY, HEADACHE

- Common
- Craniectomy/cranioplasty
- Low level can't particularly communicate what the issue is
- Medications
 - Gabapentin, pregabalin, TCAs, oxcarbazepine and carbamazepine, levetiracetam
- **Sphenopalatine ganglion block!!**

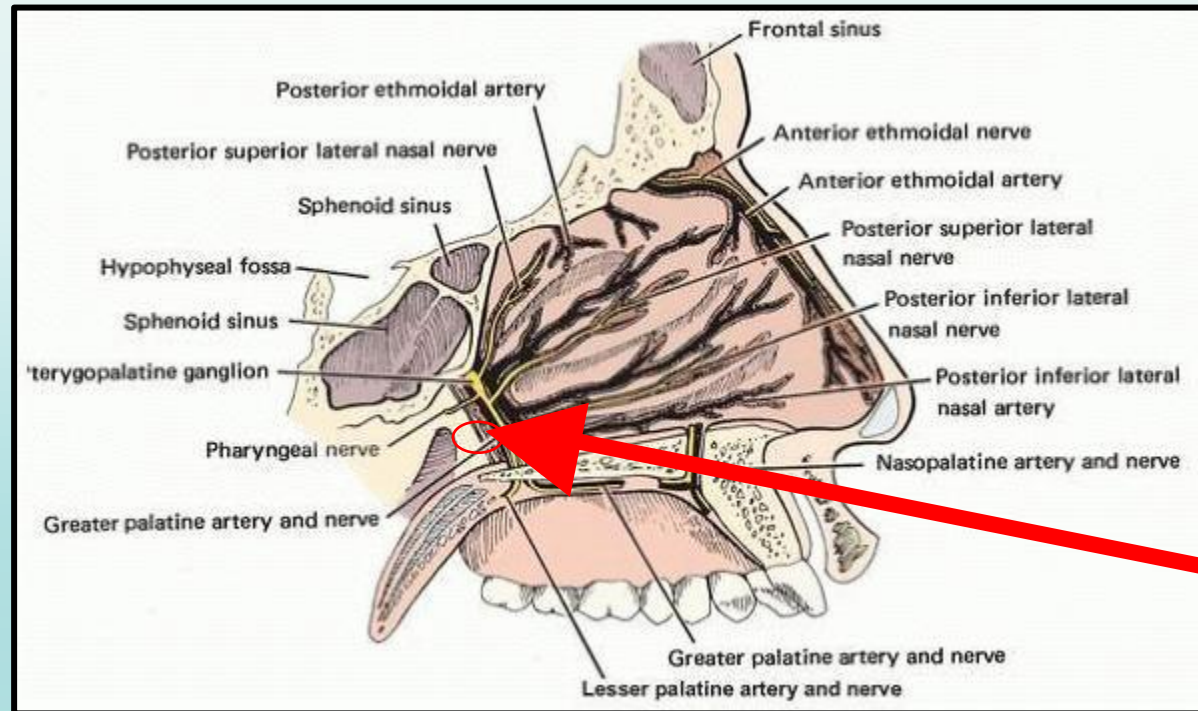


SPHENOPALATINE GANGLION “BRAIN FREEZE BUTTON”



“Off hand, I'd say you're suffering from an arrow through your head, but just to play it safe, I'm ordering a bunch of tests.”

PTERYGOPALATINE GANGLION/SPHENOPALATINE GANGLION



SPG BACKGROUND:

- The sphenopalatine ganglion (SPG)
 - located in the cranial section of the autonomic nervous system
 - unique characteristics favorable for the treatment of many painful syndromes involving the face and head.
 - located near important neuroanatomic structures for pain perception.
 - may be involved in persistent idiopathic facial pain (PIFP) and unilateral headaches.
 - A few motor nerves accompany the SPG sensory trunks.



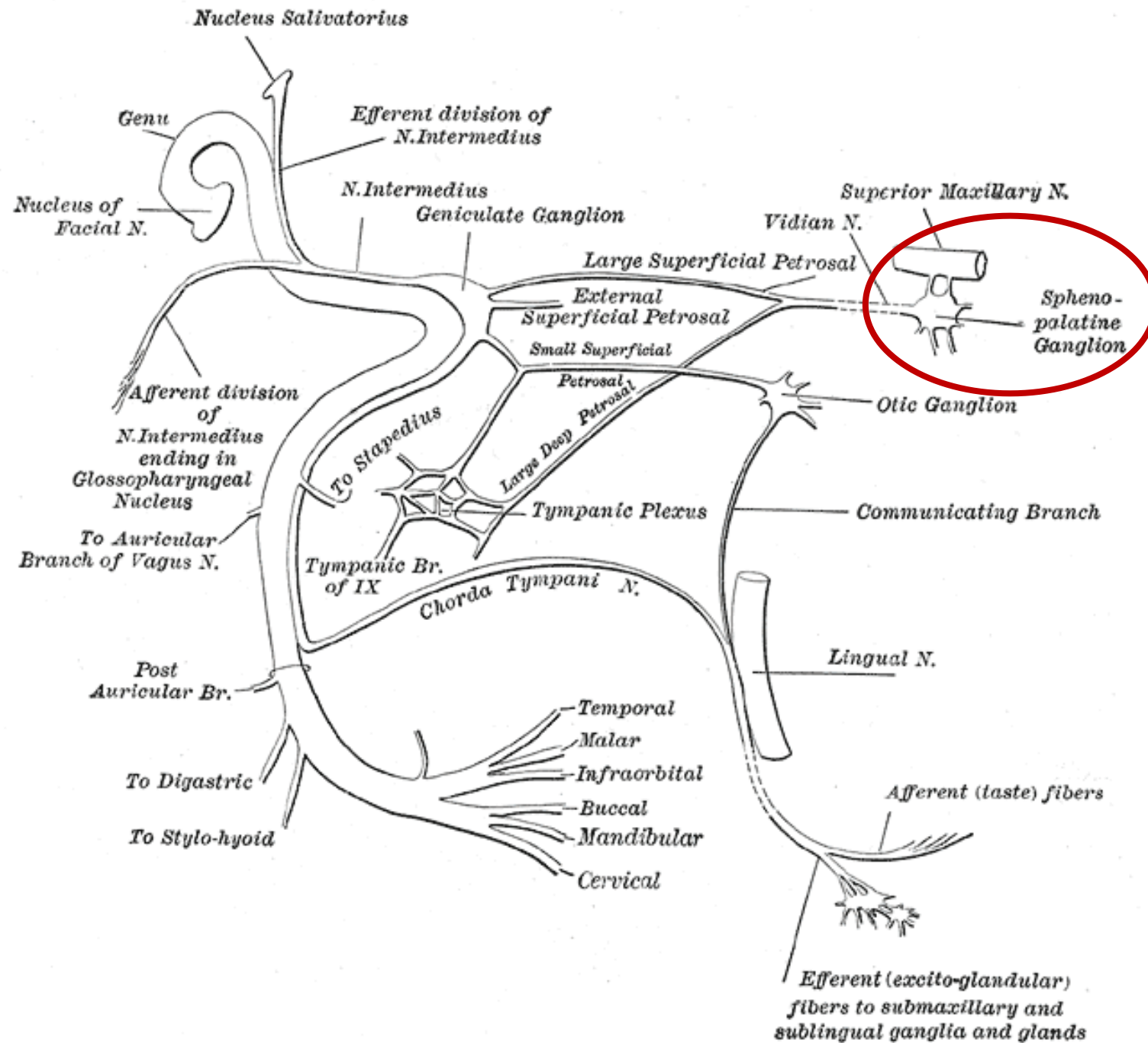
IRRITATION OF THE SPG MOTOR ROOT:

- Produces face and neck neuralgias
 - facial and occipital and cervical nerves
- Accounts for disturbances in the eye and mandible
 - connections with the ciliary and otic ganglions and a variety of visceral symptoms
 - vagus nerve
- Causes reflex otalgia by its connection
 - tympanic plexus

GENERAL SPG FACTOIDS:

- SPG
 - Relay station for parasympathetic fibers from the pons
 - Vasodilator for cerebral blood flow to prevent ischemia (i.e. migraine)
- postganglionic parasympathetic for vessels of the brain
 - SPG's communicates with
 - superior cervical ganglion (SCG) (through the internal carotid plexus)
 - intracranial portion of the internal carotid artery (through its fibers from SPG)
- SPG's superficial location in the pharynx may explain its sensitivity to odors, chemicals, and air particles.
- intraocular pressure balance and cerebral vasodilatation associated with vascular originated headaches.
- important role for cerebrovascular autonomic physiology, in pathophysiology of cluster and migraine headaches, and in conditions of stroke and cerebral vasospasm.

Piagkou, M. et al. The Pterygopalatine Ganglion and its Role in Various Pain Syndromes: From Anatomy to Clinical Practice. Pain Practice. 2012 November;12(8): 673.



INDICATIONS FOR SPGB:

Diagnostic and therapeutic head and neck blocks can assist with the diagnosis and management of many chronic pain conditions (pain of musculoskeletal, vascular, and neurogenic origin).




Currently widely accepted indications for the SPGB include:

Sphenopalatine neuralgia (SPN)	Trigeminal neuralgia (TGN)	Atypical facial pain	Acute and chronic migraine	Acute and chronic Cluster headache	Post-traumatic headaches	Herpes zoster involving the ophthalmic nerve	Other atypical facial neuralgias
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THE INTRANASAL APPROACH

- The intranasal application of topical anesthetic is the simplest and most tolerable technique.
- lidocaine is placed on the nasopharyngeal mucosa posterior to the middle turbinate, using a cotton-tipped applicator.
- topical anesthetic diffusion to the SPG is unpredictable, and the SPGB is not durable.
- Anatomic abnormalities can make it difficult and dangerous
 - Facial fractures and deviated septum
- Several modifications of the traditional intranasal technique have been described.
 - intratracheal cannula
 - control the medication amount reaching the posterior nasopharynx as well as provide better needle guidance.
 - The increased danger to the nasal mucosa during needle insertion led to the development of the transnasal endoscopic technique, where the needle is inserted under direct vision, using rigid sinuscope.
 - Felisati et al. described an endoscopic SPGB technique that approaches the PPF via the lateral nasal wall.
- First line due to safety

INTRANASAL APPROACH

- The intranasal topical application of local anesthetic is relatively easy to perform.
 - 6-inch hollow-shaft cotton tip applicator in the anesthetic solution (lidocaine 2% jelly and liquid 0.75% ropivacaine or 0.5% bupivacaine).
 - patient in slight Trendelenburg Position with Chin Lift
 - Insert the applicator through the one nare toward tragus
 - The arch corresponds to the level of the middle turbinate. Advance slowly, pushing the applicator laterally towards the back of the nasal pharynx, then Inject 2-3cc of anesthetic mixture into the q-tip shaft slowly.
 - Leave the applicators in for approximately 15-25 min. You may repeat the local anesthetic solution 5-10 minutes into the procedure.
 - Due to the connections with the lacrimal gland, blockade of the SPG will result in ipsilateral tearing due to unopposed parasympathetic activity.
 - If the block is effective, it can be repeated as needed.
- 

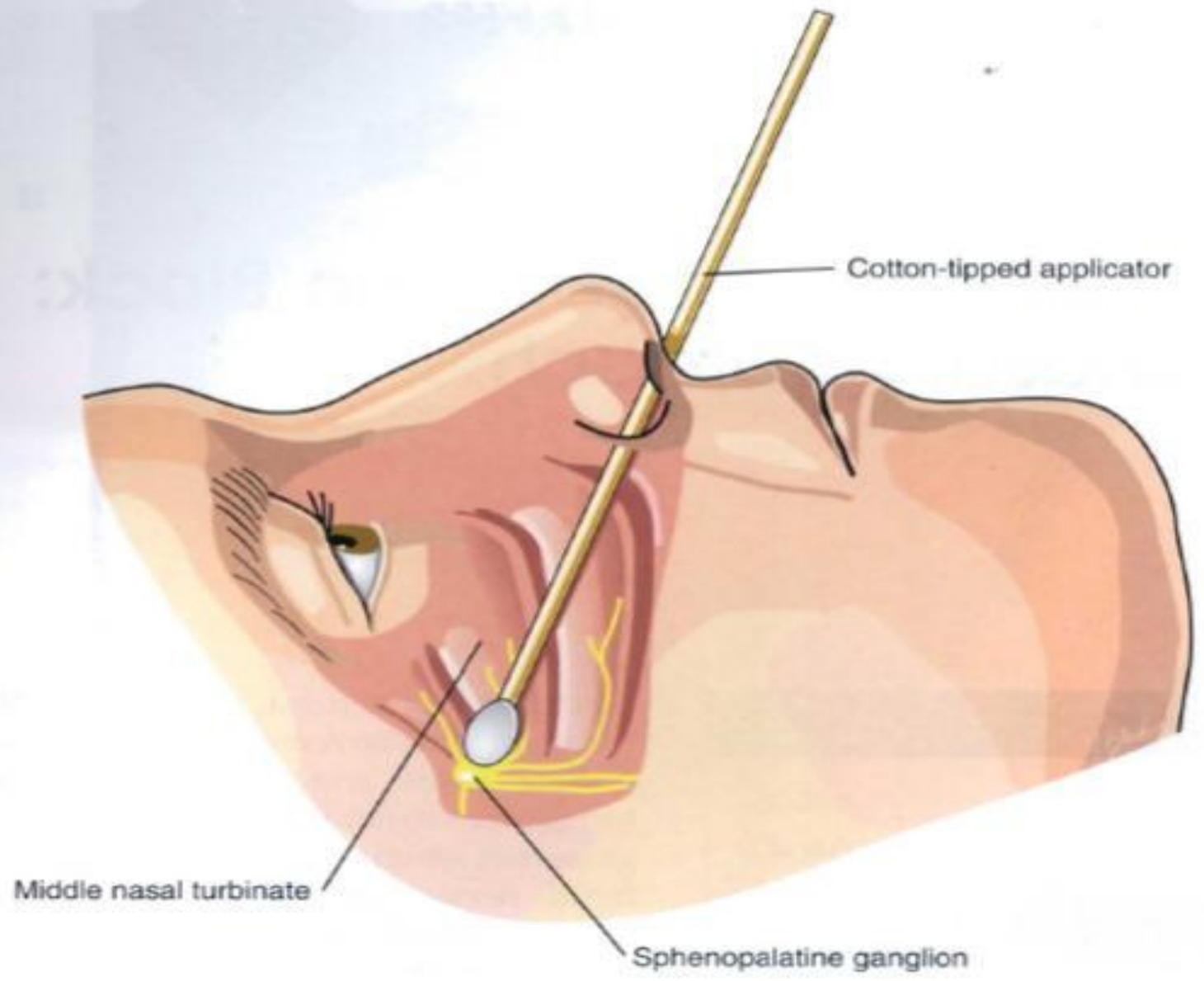


Figure 3-1

FREQUENCY



GUIDELINES APPLY TO
MOST OF THE BLOCKS



EVERY 2-3 MONTHS AT
MOST



NEED TO PROVIDE 50% OR
GREATER EFFICACY AND
REDUCED MEDICATION
USE



INCREASED FUNCTION
AND ACTIVI

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“We could try a larger monitor with an ergonomic glare filter...but you’re still going to get headaches if you keep banging your head against the screen.”

SPASTICITY

“ a motor disorder characterized by a velocity-dependent increase in

tonic stretch reflexes (muscle tone) with exaggerated tendon jerks,

resulting from hyperexcitability of the stretch reflex, as one component of the upper motor neuron syndrome.”

- J.W. Lance, 1980

- i.e., the increase in muscle response to phasic stretch, in a **velocity-**

dependent manner

- at the bedside, the two ways of assessing spasticity by phasic stretch

are passive mobilization at different speeds and tendon taps.

UPPER MOTOR NEURON SYNDROME (UMN)

- **POSITIVE SYMPTOMS**

- Spasticity
- increased muscle tone
- exaggerated tendon jerks
- repetitive stretch reflex discharges; clonus
- released flexor reflexes
- Babinski response

- **NEGATIVE SYMPTOMS**

- Loss of finger dexterity
- Weakness
- Loss of selective control of muscles and limb segments
- fatigue

SPASTIC CONDITIONS

- **Congenital**
 - cerebral palsy
 - Some genetic
- **Acquired**
 - Stroke
 - multiple sclerosis
 - traumatic brain injury
 - spinal cord injury
 - Anoxia (brain injury)
 - neurodegenerative

SPASTICITY

Symptoms

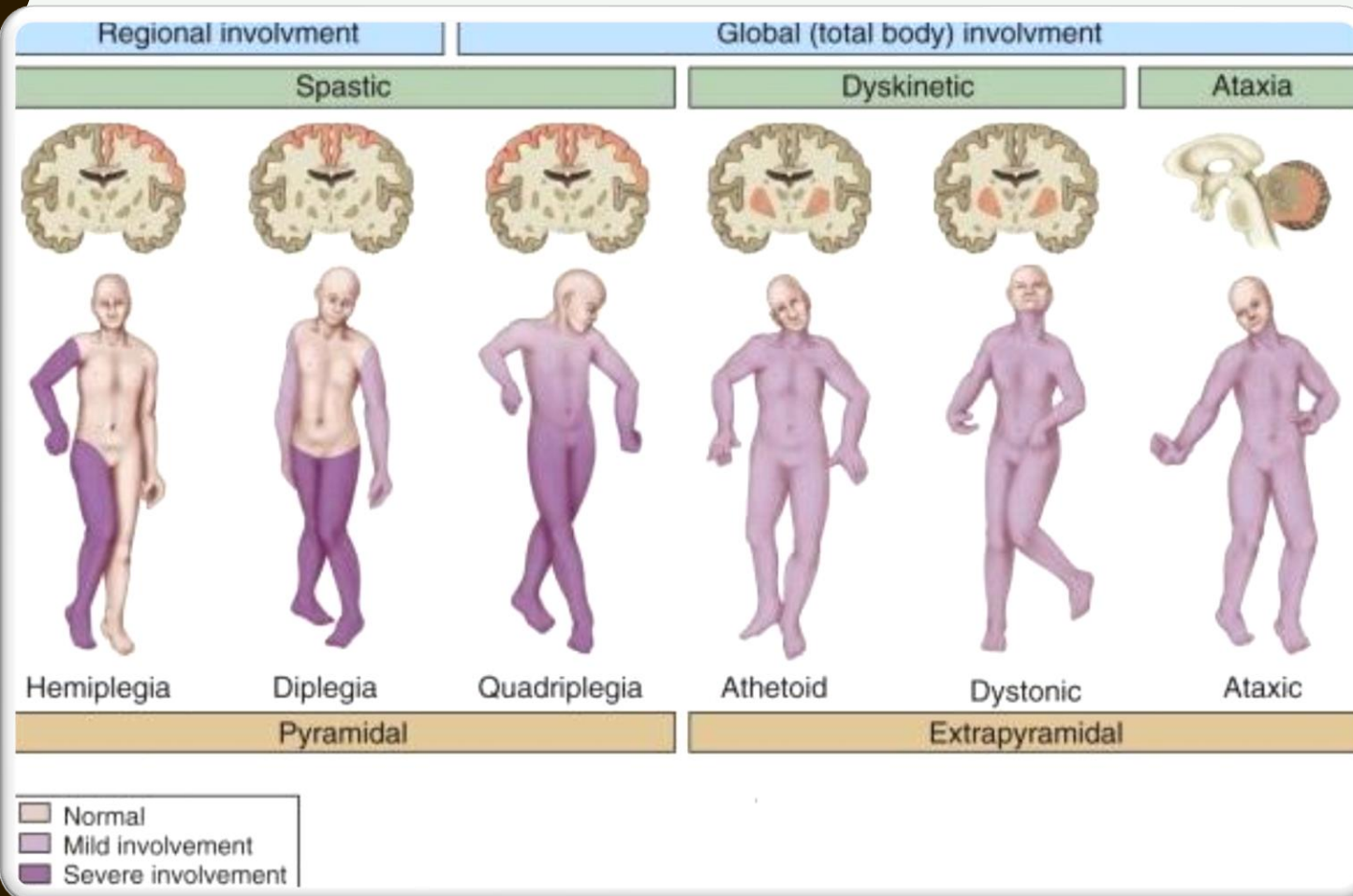
- Clonus
- Increased DTR

• Decq suggested modified definition

- Symptom of UMN with exaggerated stretch reflex secondary to hyperexcitability of spinal reflexes
- Intrinsic tonic spasticity
- Intrinsic phasic spasticity – increased DTR and clonus
- Extrinsic spasticity – increased flexor/extensor tone

Adams, MM et al. Spasticity. Spinal Cord, 2005(43):577-586.

MECHANISM OF SPASTICITY



- - EXACT MECHANISM IN HUMANS IS NOT CLEAR

- - POSSIBLE FACTORS INCLUDE:

1. ALPHA MOTONEURON HYPEREXCITABILITY

- - IMBALANCE IN SUPRASPINAL EXCITATORY VS. INHIBITORY INPUTS TO THE ALPHA MN

2. FUSIMOTOR HYPERACTIVITY

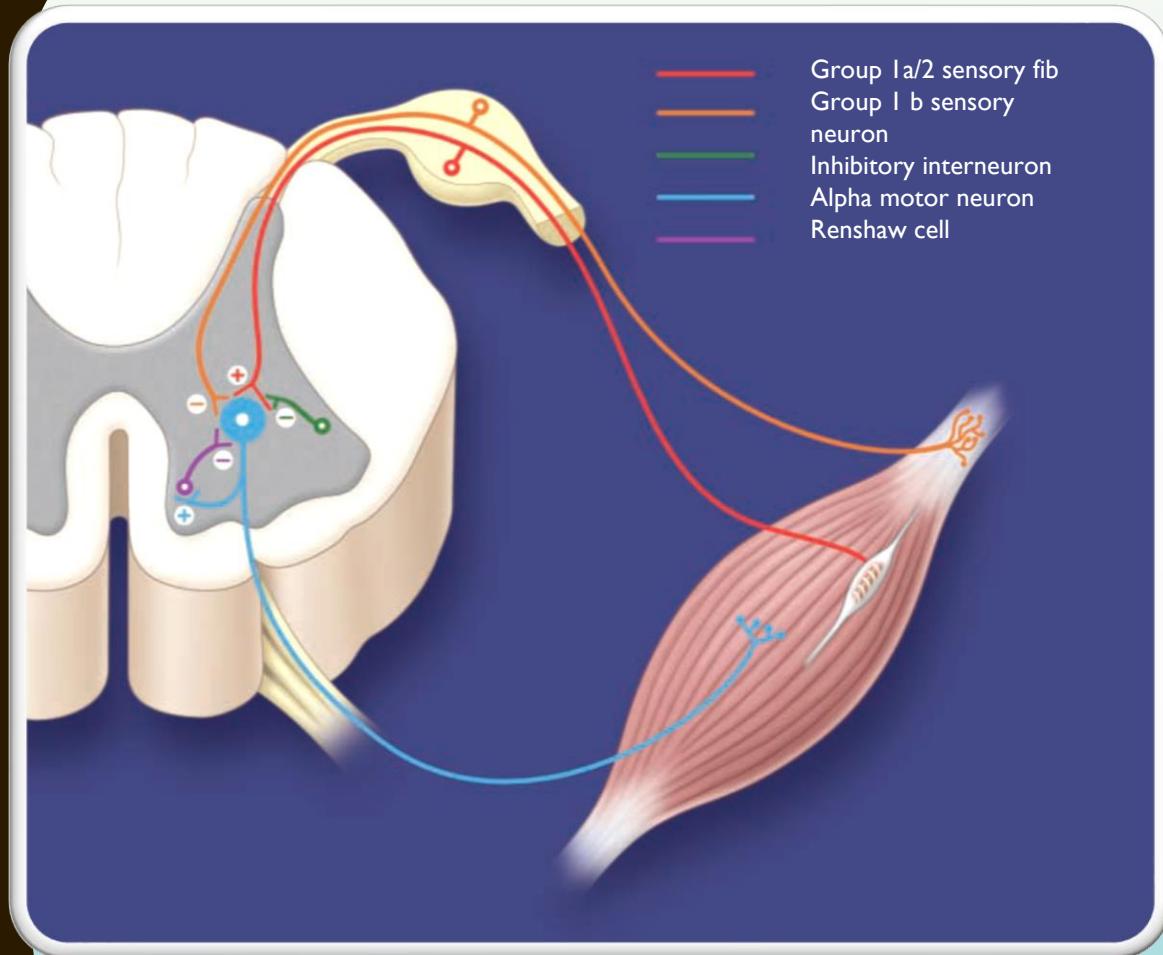
- - HYPERACTIVITY OF GAMMA MN CAN LEAD TO INCREASE SENSITIVITY OF MUSCLE SPINDLE TO STRETCH

- - LIKELY NOT ENOUGH TO SOLELY EXPLAIN THE CLINICAL PICTURE

SPASTICITY

- SCI
 - Not immediate, delayed due to spinal shock
 - Affects 65-78% after first year
 - Decreases QOL and ADLs
 - Pain and fatigue
 - Disturbs sleep
 - Pressure ulcers
 - Flaps, prolonged bedrest, osteomyelitis and death

MANAGEMENT OF SPASTICITY



- Stretching, exercise, splinting, positioning
 - Daily, may require and aide
- Medication
 - Baclofen – gaba b pre/post synaptic, blocks ca, reduces alpha motor activity
 - Diazepam – gaba a post synaptic cl channels causing hyperpolarization
 - Tizanidine – alpha I antagonist (mild BP effect)
 - Dantrolene (sarcomere) – liver enzymes need to be checked regularly
- Botulinum toxin
- IT pump
 - Baclofen in combination with pain medication

SPASTICITY MEASUREMENT

Modified Ashworth scale

0-4

Measures resistance to passive movement, not velocity of movement

Used regularly in clinical practice

Modified Tardieu Scale

Takes into account low, medium, high velocity and angle of snap

Not validated, though seems more accurate

King's Hypertonicity Scale

4 assessments, total score 4-20, 1-5 per area

presence of increased tone

active range of motion

Alternating movements

resistance to passive movement

BOTOX FOR SPASTICITY

- Product of clostridium botulinum
- Multiple subtypes identified
- Botox (A)
- Effects within 3-7 days, peak within 2-4 weeks
- For focal upper and lower extremity spasticity
 - Does improve function
 - Last about 10-11 weeks
 - Repeat every 90 days



INTRATHECAL BACLOFEN

Intrathecal bolus trial

25-100 mcg

1-2 hours to see maximal response

Medtronic is only pump currently approved for baclofen

Several pharma companies make drug

Al-Shaar, H. et al. Intrathecal baclofen therapy for spasticity: A compliance-based study to indicate effectiveness. *Surgical Neurology International*. 2016; 7(Suppl 19): S539–S541.

MORE INTRATHECAL THERAPY

PACC guidelines 2012,
2016, 2020, 2024

Morphine,
hydromorphone

- Primary afferents presynaptically and within dorsal horn
- Inhibits release of substance p and CGRP

ziconotide

- Blocks N-type calcium channels presynaptically

bupivacaine

- Amide local anesthetic, blocks membrane permeability to sodium
- Off label for chronic pain

Clonidine

Fentanyl, others

IT PHILOSOPHY

- Generally start with ziconotide
 - Layer in opioid, clonidine, bupivacaine as needed
- Trial
 - Bolus
 - If patient has pump, may add ziconotide to baclofen
 - Or other opioid if ziconotide not indicated
 - Refill every 90 days if for pain or compounded medication
 - 6 months if baclofen only

LITHIUM

Chronic neuropathic pain in SCI

6-12 week dosing

Dose range goal 0.6 – 1.2 mmol

Measure every 2-3 weeks of treatment

Adjust dose based on blood level

Studied in ASIA a-c

Stimulates proliferation (activation of phosphoinositol-3-kinase, Akt-1, low k induced phosphatase, yada

Mesenchymal stem cells

Hematopoietic stem cells

Embryonic stem cells

Enhances survival Of neural stem cells

No change in motor, sensory, functional or specificity scores

Side effects include gastrointestinal discomfort, diarrhea, tremor, polyuria, maternal urination

Yang, ML et al. Efficacy and safety of lithium carbonate treatment of chronic spinal cord injuries: a double-blind, randomized, placebo-controlled clinical trial. Spinal Cord, 2012, 50: pp141-146.

CONVENTIONAL PAIN TREATMENTS

Psychology

- Catastrophization

- Can lead to poor outcomes

Biopsychosocial model for pain applies to all pain states

- Cognitive reframing

- Biofeedback

- Coping strategies

- Improve overall QOL

Perry, K et al. Comparison of a Pain Management Program with Usual care in a pain management center for people with spinal cord injury-related chronic pain. *Clinical Journal of Pain*. 2010 March/April 26(3): pp.206-216.

LETS DO SOME EXAMPLES

- 56 year old man injured at work
 - C5 ASIA D
 - SPASTICITY
 - PAIN
 - NEUROGENIC BOWEL AND BLADDER
 - NEEDS?

C5 INCOMPLETE SCI

Neuropathic pain is more frequent in incomplete injuries

Meds, lithium

Spasticity is common

SCS?

- Not great evidence overall, but it works
- Meds
 - Opioids, gabapentoidoids, antispasmodics
- Depends on severity, coping mechanisms, education and psychosocial support

IT pump probably makes the most sense long term

- Compound baclofen with pain medication (ziconotide > opioids)

LOW BACK PAIN AND HERNIATED DISCS

- Please don't send for surgical consult first
 - Many competing incentives that will lead to surgery, which many times isn't indicated or makes the issue worse
- Physiatry (PM&R) or PT first
- MRI if radicular component
- Urgent if bowel and bladder involvement





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66 YO FEMALE, INJURED BACK AT WORK LIFTING WHILE BENT OVER AND LEANING TO THE RIGHT

Pain down the leg

No change in sensation

Smoker

Not in good physical condition

TREATMENT

Physical therapy

Probably not a good candidate for mobilization therapy

- Older female, may have some osteopenia
 - Smoking accelerates this
- If question of active radiculopathy, mobilization not indicated

PT fails, pain persists

- Advanced imaging MRI
- Multiple degenerative changes

WHICH IS CAUSING PAIN FORM THE WORK RELATED INCIDENT



- Examine the patient
 - Is this even an radiculopathy?
 - Changes in sensation, reflexes, and strength
 - If not, its radiculitis (pain resembling a nerve entrapment)
 - This is **sacroiliac joint dysfunction**
 - Injection (once or twice, should help for at least 6 weeks)
 - RF (should help 6 months, 50%)
 - PRP (can be very helpful, once yearly or less)

45 YEAR OLD HIT ON THE HEAD AT WORK, BLEED AND SKULL FRACTURE

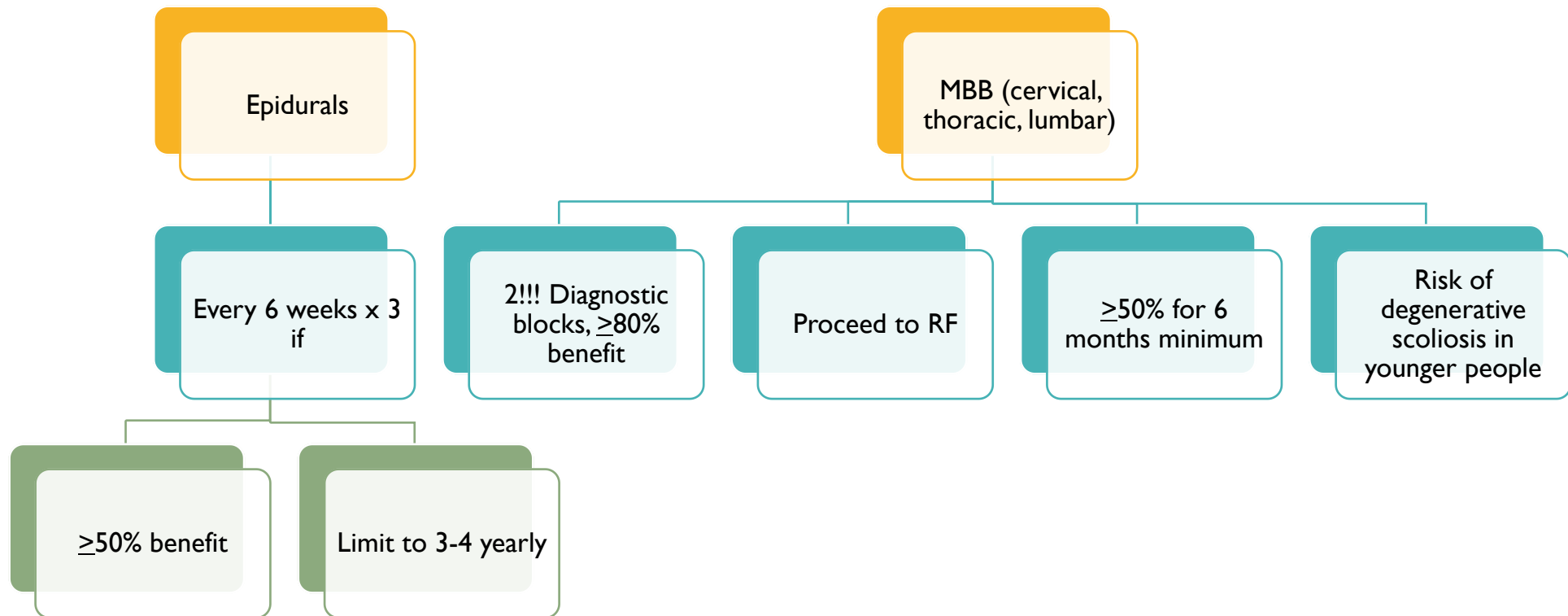
- Brain injury
 - Pain, acute or chronic
 - Rehab potential?
 - Support system?
 - Lots of if's



LET'S SAY HE HAS

- Headache
 - Sphenopalatine ganglion block
 - 1-2 , can be truly effective, repeat every 2-6 months as needed
 - Botox for persistent headaches, every 90 days
 - PNS if refractory and severe, occipital nerve (off label)
- Hemiplegia
 - Gait aid
 - Assistance
 - Spasticity
 - Meds, pump

INTERVALS FOR “REGULAR PAIN TREATMENT”

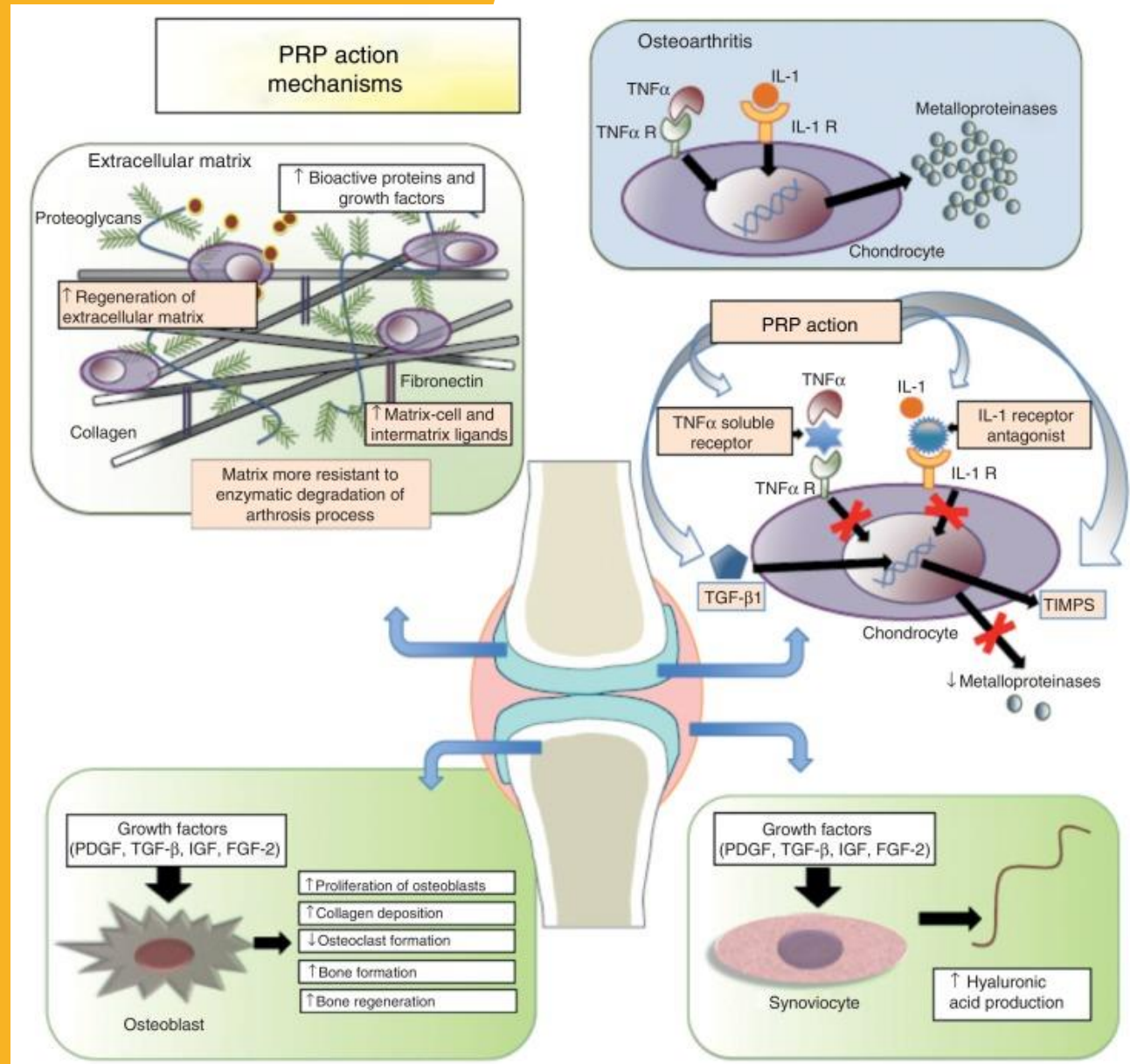




JOINTS, TENDONS, LIGAMENTS

- If sprain or partial
 - Consider PRP
 - Derived from patients own blood
 - Needs to be sufficiently concentrated to have effect (4-12x baseline)
 - Yearly or less, much cheaper than surgery

PRP MECHANISMS



SO MUCH MORE

- Happy to answer any questions

DR ERIK SHAW DO PC

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- Medicolegal consulting