Complex Regional Pain Syndrome: Interventional Pain Care

Benjamin W. Johnson, Jr., MD, MBA, DABPM, FIPP
Medical Director, PainMD
Associate Clinical Professor of Anesthesiology (Volunteer)
Vanderbilt University School of Medicine

Objectives

- To become aware of current perspectives of well-known Interventional therapies for CRPS
- To become familiar with new and emerging interventional therapies for CRPS

Outline

- Definition of CRPS
- Treatment plan
- Current therapies
- Emerging therapies
- Summary
- Conclusion

Definition of CRPS

CRPS is a syndrome characterized by a continuing (spontaneous and/or evoked) regional pain that is seemingly disproportionate in time or degree to the usual course of pain after trauma or other lesion.

The pain is regional (not in a specific nerve territory or dermatome) and usually has a distal predominance of abnormal sensory, motor, sudomotor, vasomotor edema, and/or trophic findings.

The syndrome shows variable progression over time.

CRPS type I develops after any type of trauma, especially fracture, soft tissue lesion (see below).

CRPS type II occurs after major nerve damage.

International Association for the Study of Pain.
Classification of chronic pain. 2nd edition (revised).

Definition of CRPS

“Unfortunately CRPS I has become a catch all phase and there are serious questions on whether it exists at all…”

Borschers AT, Gershwin ME: The clinical relevance of complex regional pain syndrome type I: The Emperor's New Clothes. Autoimmunity Reviews 16:22-33 (2017)

Definition

“at least 80 different names are found in the English literature alone, more than 100 terms can be encountered in other languages.”

Borschers AT, Gershwin ME: The clinical relevance of complex regional pain syndrome type I: The Emperor's New Clothes. Autoimmunity Reviews 16:22-33 (2017)

Summary of treatments for complex regional pain syndrome (CRPS)

Treatment	Category	RCT
Multi disc	Standard	None
PT / OT	Standard	+
Steroids	Standard	+
Anticonvulsants	Standard	+ / -
Analg Antidep	Standard	None
Trans lido	Standard	None
Opioids	Standard	None
SNS blocks	Standard	-
SCS	Standard	+
Beh Tx	Standard	None
Mirror/Motor	Uncommon	+

Treatment	Category	RCT
Calcitonin	Uncommon	+
Vita C pre	Uncommon	+
DMSO	Uncommon	+ (warm)
N-Ac	Uncommon	+ (cold)
Biphosphonates	Uncommon	+
IV ketamine	Uncommon	+
IV IG	Uncommon	+
Tadalafil	Uncommon	+
IT baclofen	Uncommon	+
LD naltrexone	Uncommon	+

Bruehl S: Complex Regional Pain Syndrome. BMJ 2015; 350;h2730

CRPS Treatment Challenges

"The lack of adequate treatments for CRPS is the result of an incomplete understanding of its pathophysiology that involves inflammatory, vascular, sympathetic nervous system, cortical, and spinal mechanisms."

Raucci U, Tomasello C, et al: Scrambler Therapy MC-5A for Complex Regional Pain Syndrome: Case Reports. Pain Practice 16(7): E103-E109, 2016.

Therapeutic Modalities

- Medications
- Interventions
  - Procedural
- Regenerative Medicine
- Physical therapies
- Behavioral therapies

Therapeutic Modalities

- Physical Therapy
  - Fluidotherapy
  - Graded tactile sensitizing
  - Flexibility
  - Range of motion

Medications
Oral

- Antidepressants
- Anticonvulsants
- Mixed modality medications
  - Tramadol
  - Tapentadol
- Opioids

Medications

Infusions

- Lidocaine
- Ketamine
- Mannitol
- Biphosphonates
- Calcitonin
- Magnesium

Emerging Therapeutic Modalities

- Intravenous Immunoglobulin therapy
- Plasma Exchange Therapy
- Low-dose naltrexone
- Control of gut permeability

Procedural Interventions

- Injections
  - IV regional blocks
  - Stellate ganglion blocks
  - Lumbar sympathetic ganglion blocks
- Scrambler Therapy
- Spinal Cord Stimulation
- DRG stimulation
- Intrathecal Drug Administration

IV regional blockade

- Invented by August Bier in 1908
- Tourniquet was placed on exsanguinated extremity
  - Guanethidine
  - Labetalol
  - Lidocaine + steroids
- No longer done widely for RSD, due to lack of insurance coverage

Varitimidis SE, Papatheodorou LK: Predictors of Pain Relieving Response to Sympathetic Blockade in Complex Regional Pain Syndrome Type 1. J Hand Surg Eur 36(9):771-7, 2011

IV Regional Block

Bier Block

Source: New York School of Regional Anesthesia

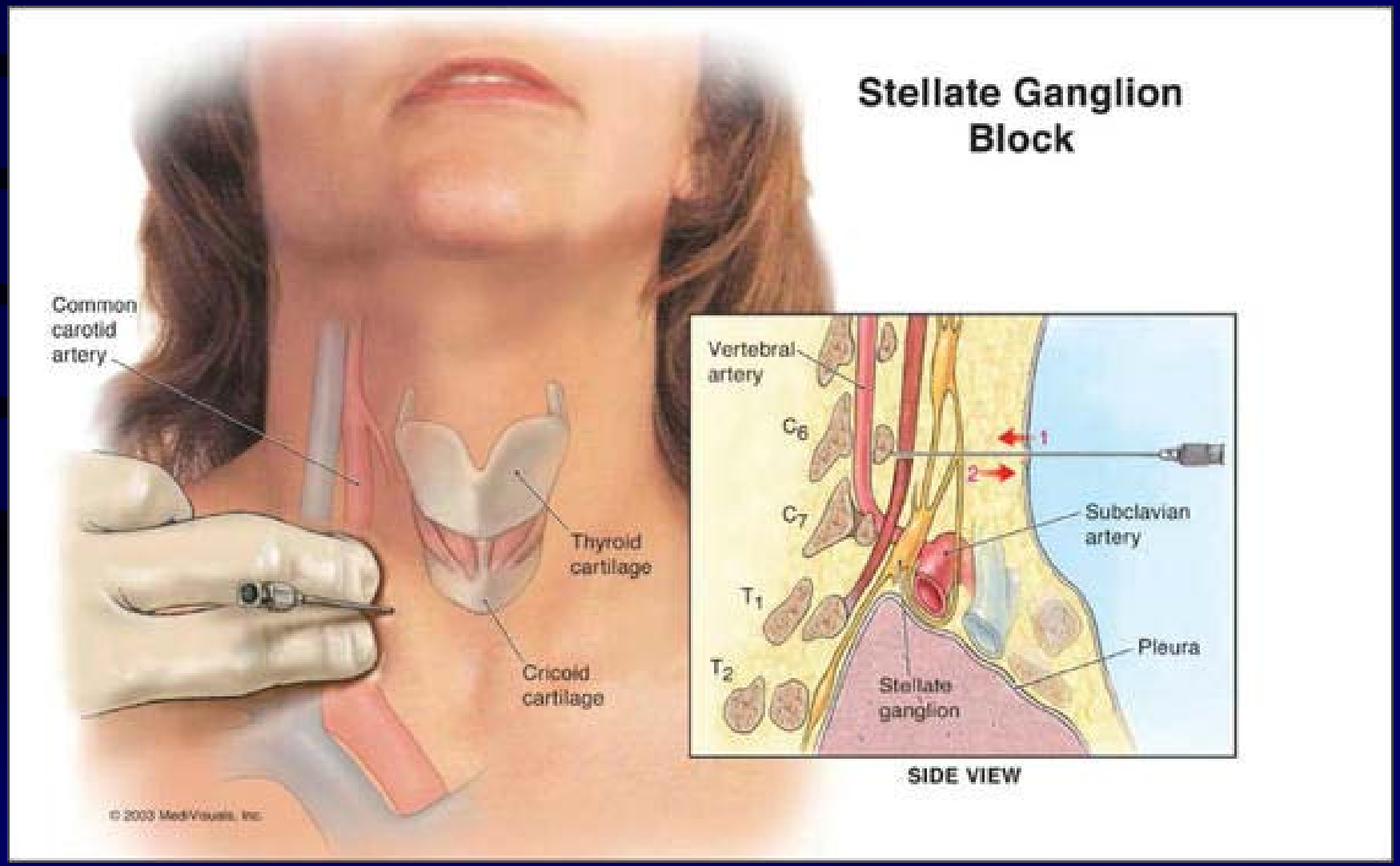
Sympathetic Blockade

- Upper limb
  - Stellate ganglion blockade
- Lower limb
  - Lumbar sympathetic ganglion blockade

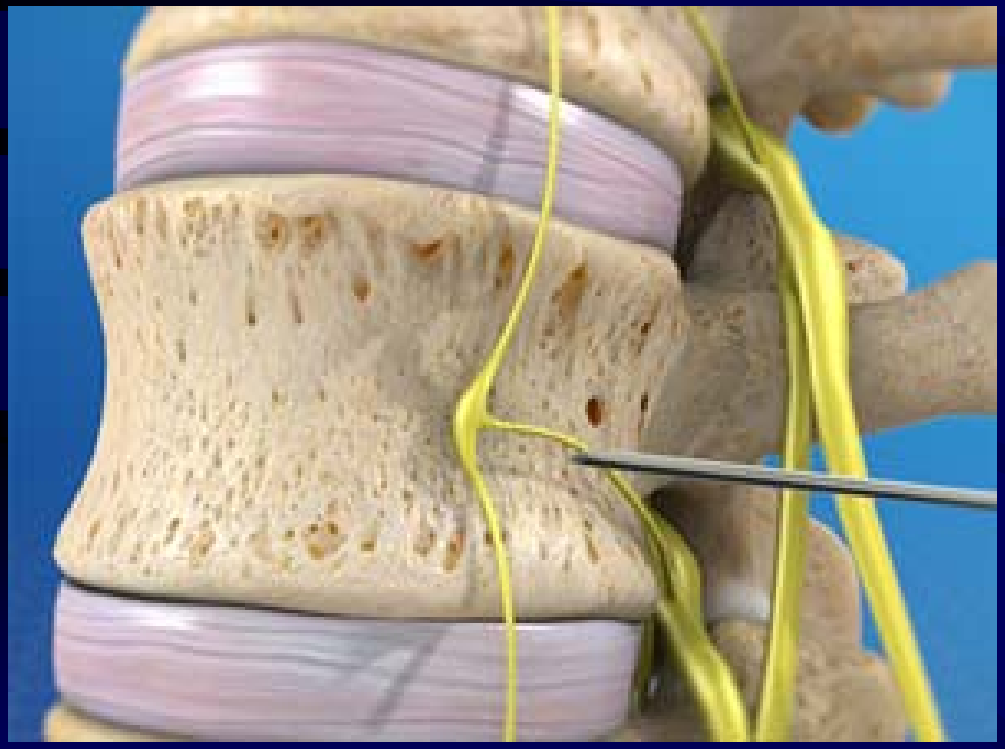
- Success rate = 30%
  - Still worth trying
  - Probably more helpful in early stages

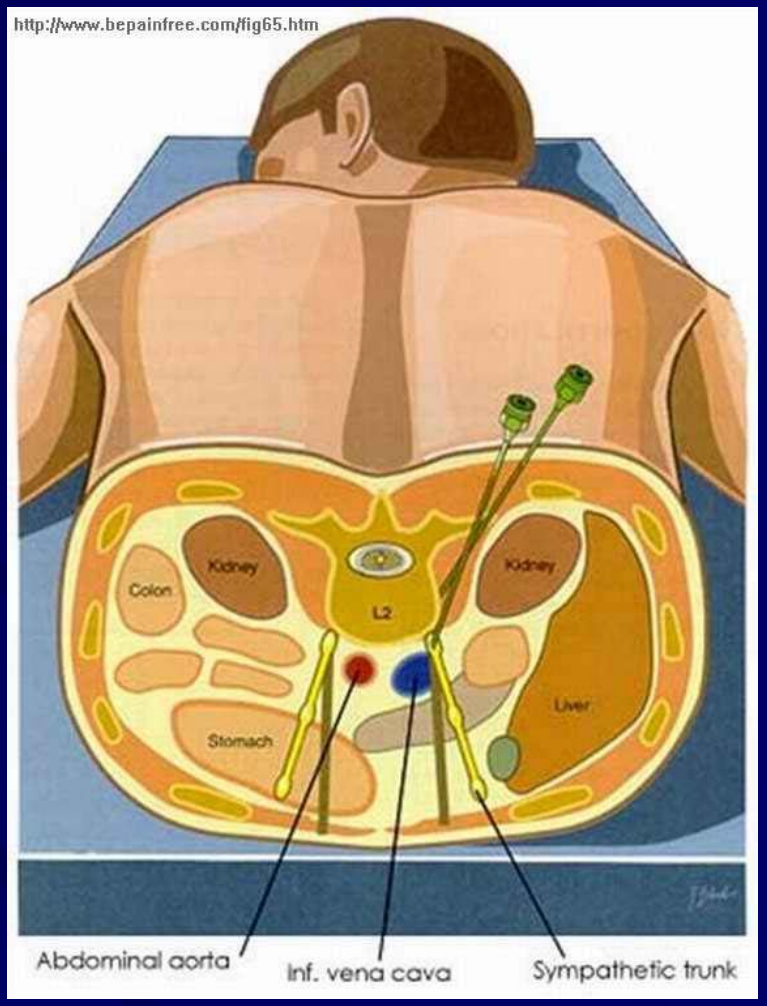
Van Eijs F, Geurts J, et al: Predictors of Pain Relieving Response to Sympathetic Blockade in Complex Regional Pain Syndrome Type 1. Anesthesiology 116(1): 113-121, 2012

Stellate Ganglion Block



Lumbar Sympathetic Ganglion Block





Plasma Exchange Therapy for RSD/CRPS

- This study shows that PE is effective in a subset of patients with severe long-standing CRPS
- The reduction in pain following the initial series of PE treatments can be maintained on a weekly PE schedule, IVIG, or with other immune modulating drugs.

Aradillas E, Schwartzman RD, et al: Plasma Exchange Therapy in Patients with Complex Regional Pain Syndrome. Pain Physician 18:383-394, 2015

Plasma Exchange Therapy for RSD/CRPS

- All PEs were performed with 1.5 plasma exchange volumes.
- An isotonic solution containing
  - 5% albumin with a
  - sodium content of 145 ± 15 mEq/L was used as the replacement fluid.

Aradillas E, Schwartzman RD, et al: Plasma Exchange Therapy in Patients with Complex Regional Pain Syndrome. Pain Physician 18:383-394, 2015

IV Immunoglobulin Therapy for CRPS

- "…we found that low-dose IVIG reduced pain intensity by 30% or more in approximately 50% of patients."
- Dosage
  - 0.25 g/kg in NS for each of 2 days

Goebel A, Baranowski A: Intravenous Immunoglobulin Treatment of the Complex Regional Pain Syndrome: A Randomized Trial.
Ann Int Med 152(3): 152-158, 2010

IV Immunoglobulin Therapy for CRPS

"Our results suggest that immune mechanisms play an important role in sustaining long-standing CRPS…Patients may be predisposed to CRPS after trauma because of the presence of serum autoantibodies, and IVIG may neutralize these antibodies"

Goebel A, Baranowski A: Intravenous Immunoglobulin Treatment of the Complex Regional Pain Syndrome: A Randomized Trial.
Ann Int Med 152(3): 152-158, 2010

Therapeutic Modalities

- **New Stimulation Strategies**
  - **Scrambler technology**
    - **attempts to relieve pain by providing "no pain" information via cutaneous nerves to block the effect of pain information.**
    - **ST synthesizes 16 different types of nerve action potentials similar to endogenous ones, assembles them into sequences, and uses algorithms to determine a patient-specific cutaneous electrostimulation to reduce pain.**

Raucci U, Tomasello C, et al: Scrambler Therapy MC-5A for Complex Regional Pain Syndrome: Case Reports. Pain Practice 16(7): E103-E109, 2016.

Scrambler Technology

Therapeutic Modalities

- Scrambler Therapy
  - "benign pain" protocol
    - 10-12 daily treatments
      - 30-60 min each
    - Booster treatments can be added if needed

Scrambler Therapy Official Website

Therapeutic Modalities

- **Scrambler Therapy**
  - **Different than TENS**
    - **TENS provides an on-off biphasic current without variation**
      - **PW 200 microseconds**
      - **Frequency 80 Hz**
    - **Scrambler therapy provides continuously changing variable nonlinear waveforms.**
      - **PW 6.8-10.9 microseconds**
      - **Frequency 43-52 Hz**

Marineo G, Iorno V: Scrambler Therapy May Relieve Chronic Neuropathic Pain More Effectively Than Guideline-Based Drug Management: Results of a Pilot, Randomized, Controlled Trial. J Pain Symptom Manag 43(1):87-95, 2012

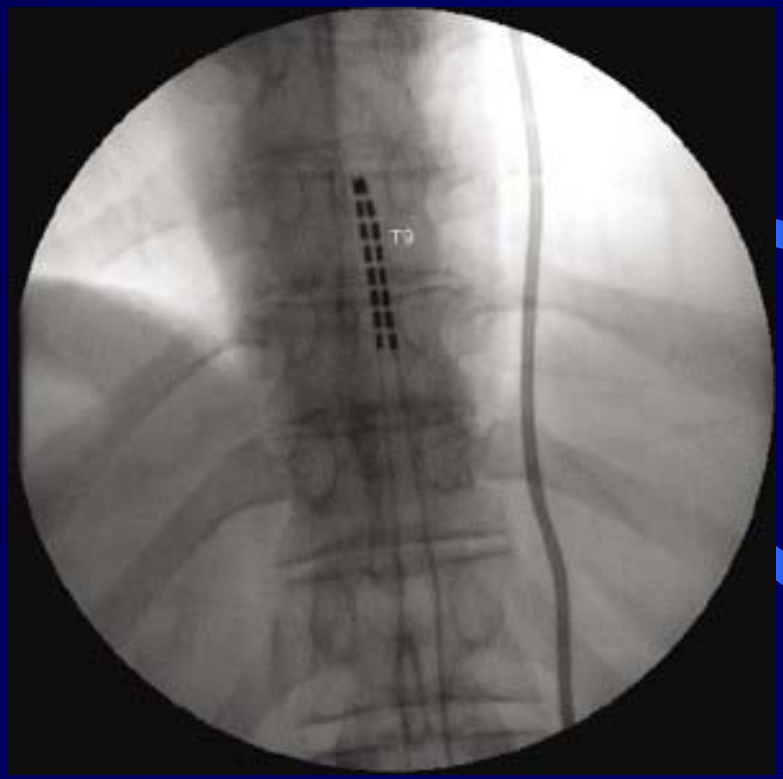
Therapeutic Modalities

- Scrambler Therapy
  - Indications
    - Chronic benign pain
      - Neuropathic pain
    - Cancer pain
  - Variables
    - Patients on anticonvulsants may not benefit as much

Majithia N, Smith TJ, et al: Scrambler Therapy for the management of chronic pain. Support Care Cancer 24(6): 2807-14, 2016

Neuraxial Stimulation

Spinal Cord Stimulation



Spinal Cord Stimulation

- RSD/CRPS is one of the main indications for Spinal Cord Stimulation
- Previously considered a procedure of late resort
  - Now considered much earlier
- Two phase process
  - Trial phase
    - 7-10 days
      - >50% improvement = success
  - Implant phase

Spinal Cord Stimulation
Trial

Therapeutic Modalities

- Spinal Cord Stimulation
  - Low frequency (conventional)
    - 50% of patients preferred
  - Higher frequency (conventional)
    - 50% of patients preferred

Kriek N, Groeneweg JG, et al: Preferred frequencies and waveforms for spinal cord stimulation in patients with complex regional pain syndrome: A multicentre, double-blind, randomized and placebo-controlled crossover trial. European Journal of Pain: (21) 507-519, 2017

Therapeutic Modalities

- Spinal Cord Stimulation
  - Conventional
    - Patient feels paresthesias
      - Buzzing / tingling sensation
        - » Some patients don't like the sensation
    - Patient's cooperation needed for accurate placement
    - Lead migration can cause lack of satisfactory stimulation

Therapeutic Modalities

- Spinal Cord Stimulation (conventional)
  - Best results
    - Perception of pain relief
    - Reduction in pain scores
    - Patient satisfaction
  - Good results
    - Functional improvement
    - Psychological improvements

Visnjevak O, Costandi S, et al: A Comprehensive Outcome-Specific Review of the Use of Spinal Cord Stimulation for Complex Regional Pain Syndrome. Pain Practice 2016

Therapeutic Modalities

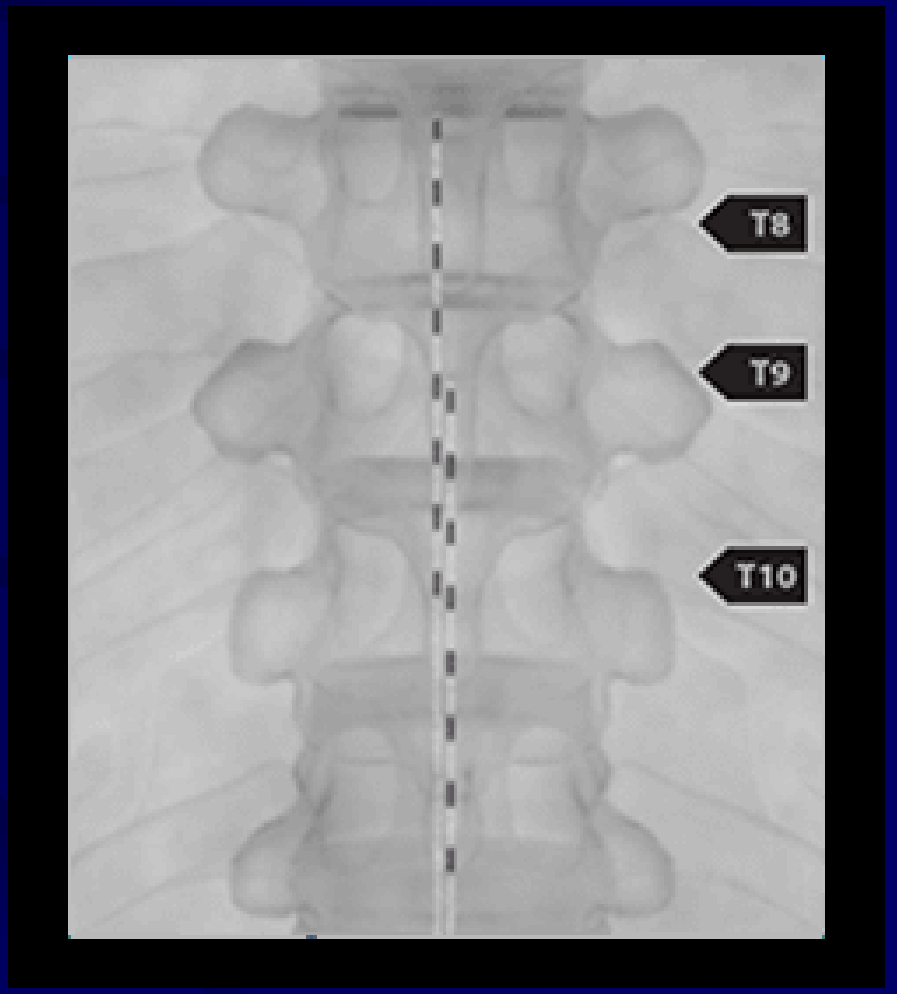
- **Spinal Cord Stimulation (conventional)**
  - **Less predictable**
    - **Analgesic sparing effects**
      - Patients may want to stay on their current medications
    - **Resolution of signs / symptoms**
      - Pain often returns when the unit is turned off

Visnjevak O, Costandi S, et al: A Comprehensive Outcome-Specific Review of the Use of Spinal Cord Stimulation for Complex Regional Pain Syndrome. Pain Practice 2016

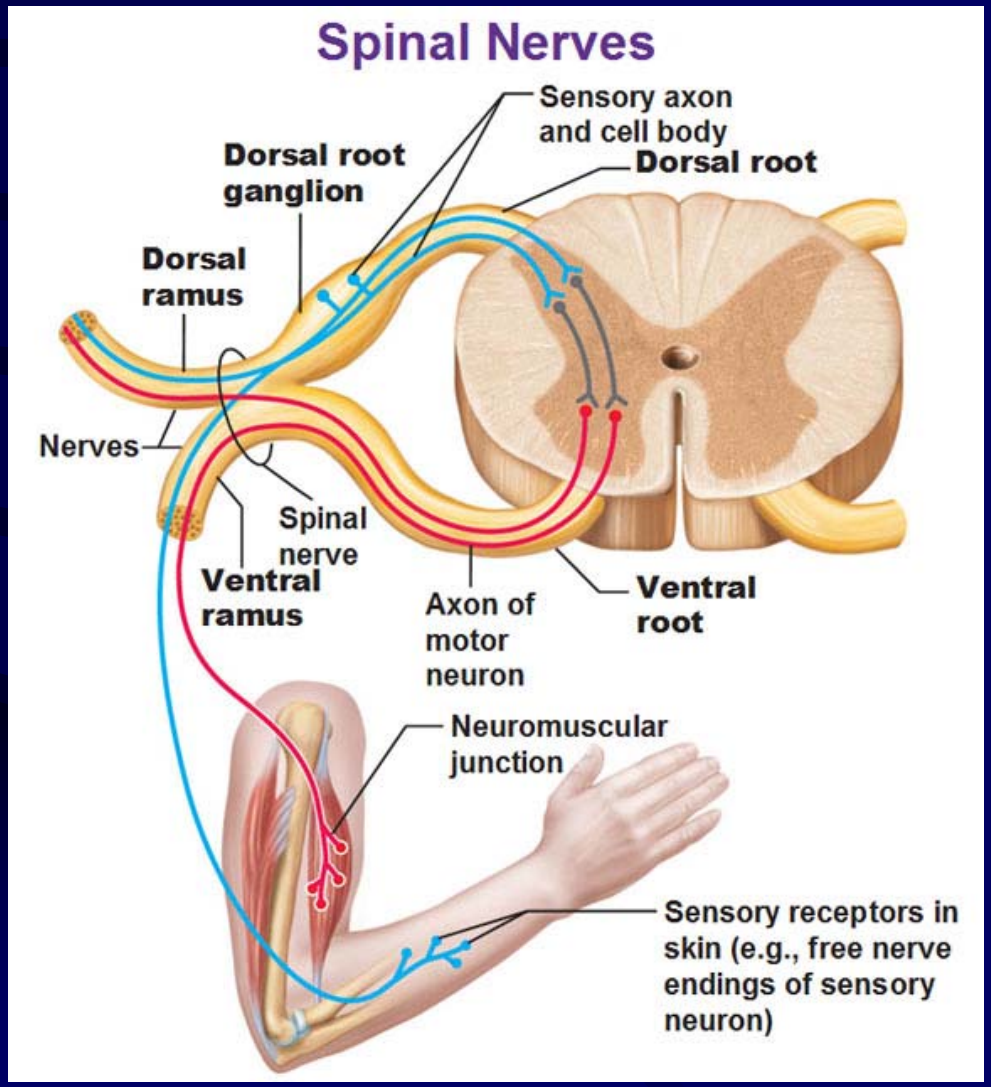
Therapeutic Modalities

- Spinal Cord Stimulation
  - High frequency
    - Patient does not feel the stimulation
    - Patient only feels pain relief
    - Strictly anatomic placement
      - Patient feedback not needed
        - » Good for patients with aphasia
        - » good for patients with cognitive deficits

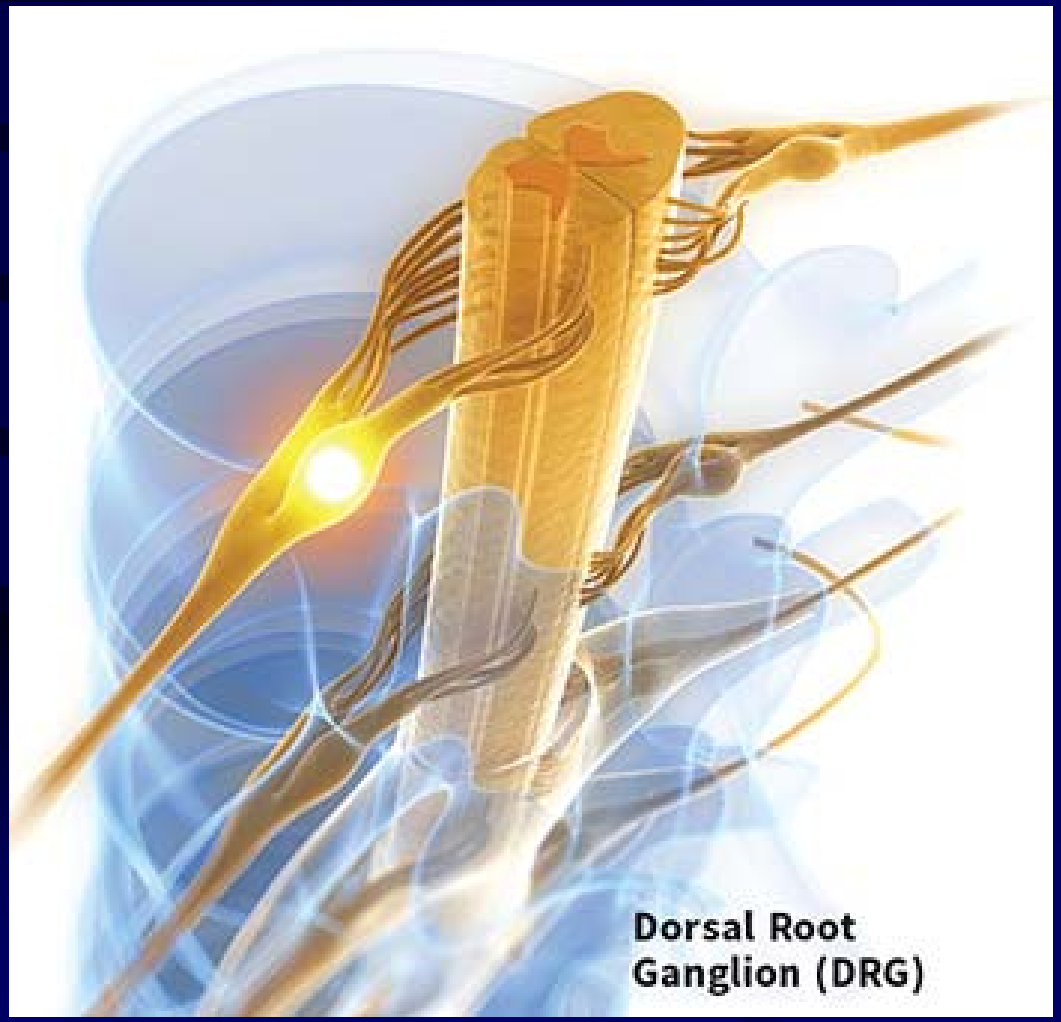
Spinal Cord Stimulation
High Frequency



Dorsal Root Ganglion Stimulation



Dorsal Root Ganglion Stimulation



Dorsal Root Ganglion Stimulation

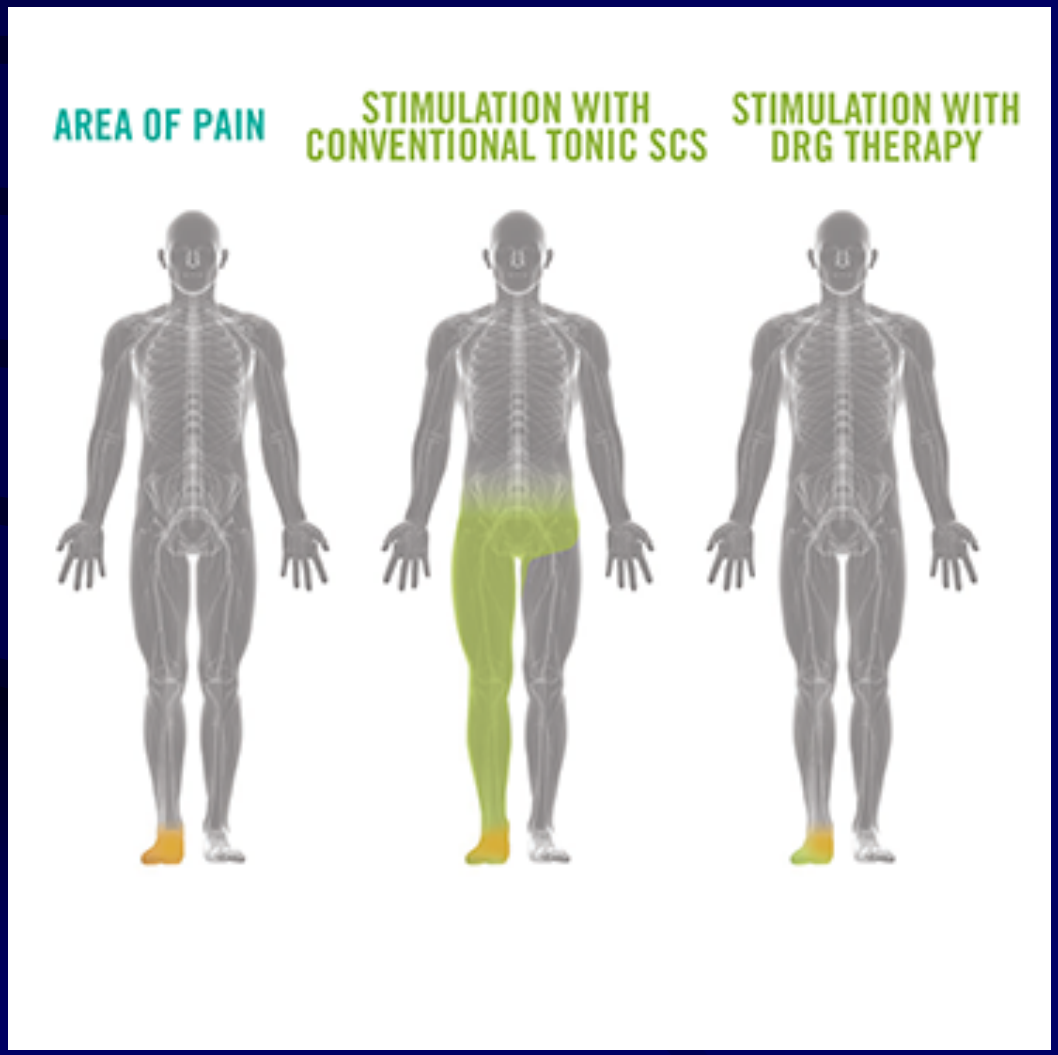
Dorsal Root Ganglion Stimulation (DRG)

New FDA Approved stimulation for chronic regional pain syndromes with a custom fit, targeted approach

- Lower Abdominal and Visceral Pain
- Chronic, Refractory and Post-Surgical Pain *(i.e hip, knee, foot, etc.)*
- Groin and Testicular Pain
- Phantom and Stump Pain (Post Amputation)
- CRPS I / RSD *(localized foot, knee, ankle)*
- Peripheral Causalgia, CRPS II *(Specific nerve injury)*

Focal stimulation of the DRG offers patients a **superior** pain relief than traditional Spinal Cord Stimulation for Complex Regional Pain Syndrome (CRPS) and other focal chronic pain syndromes.

Dorsal Root Ganglion Stimulation



Dorsal Root Ganglion Stimulation for RSD/CRPS

In this comparative study of 12 patients, the majority of patients chose DRG stimulation for their preferred treatment

Van Bussel CM, Stronks DL, et al: Dorsal Column Stimulation versus Dorsal Root Ganglion Stimulation for Complex Regional Pain Syndrome Confined to the Knee; Patients' Preference Following the Trial Period.
Pain Practice: accepted Feb 7, 2017

Dorsal Root Ganglion Stimulation for RSD/CRPS

All 8 subjects implanted with a DRG neurostimulator for CRPS reported some pain relief.

Good results (greater than or equal to 50% pain relief in the foot) were reported after 12 months of treatment for 6 of the 8 subjects.

This responder rate is similar to or better than reported outcomes with SCS for CRPS and confirms DRG stimulation as a viable and effective intervention for this difficult pain condition.

Van Buyten JP, Smet I, et al: Stimulation of Dorsal Root Ganglia for the Management of Complex Regional Pain Syndrome: A Prospective Case Series. Pain Practice (15) 208-216, 2015

Dorsal Root Ganglion Stimulation for RSD/CRPS

- Recently analyzed data from the ACCURATE trial…showed that DRG stimulation produced statistically significant improvements in both back and leg pain compared with traditional stimulation.

- In addition, patients with chronic lower limb pain due to CRPS or peripheral causalgia showed that patients with DRG stimulation experienced greater pain relief than with traditional stimulation.

Roy LA, Gunasingha RMKD, et al: New modalities of neurostimulation: high frequency and dorsal root ganglion.
Current Opinion in Anesthesiology 29:590-595, 2016

Spinal Cord Stimulation

- Is it safe?
  - It is safe in the hands of experienced providers
    - "…The patient's pre-existing medical condition and the experience and skill of the implanting physician may contribute to or influence the likelihood of some complications."
- Complications
  - Lead migration
  - Spinal cord injury
  - Infection

Deer TR, Lamer TJ, et al: The Neurostimulation Appropriateness Consensus Committee (NACC) Safety Guidelines for the Reduction of Severe Neurological Injury. Neuromodulation 20(1):15-30, 2017

Spinal Cord Stimulation

Complication Rates

Table 4.
Neurological Complication Rates for Percutaneous and Surgical Dorsal Column Stimulation Leads.

	Percutaneous leads	Paddle leads
Serious neurological complications	0–2.35%	0.54–1.71%
Paralysis/spinal cord injury	0.03*–2.35%	0.022–0.067%
Infection	3–6%	3–6%
Spinal/epidural hematoma	0.75%	0.19–0.63%
Cerebrospinal fluid leak	0.3%	0.05–0.001%

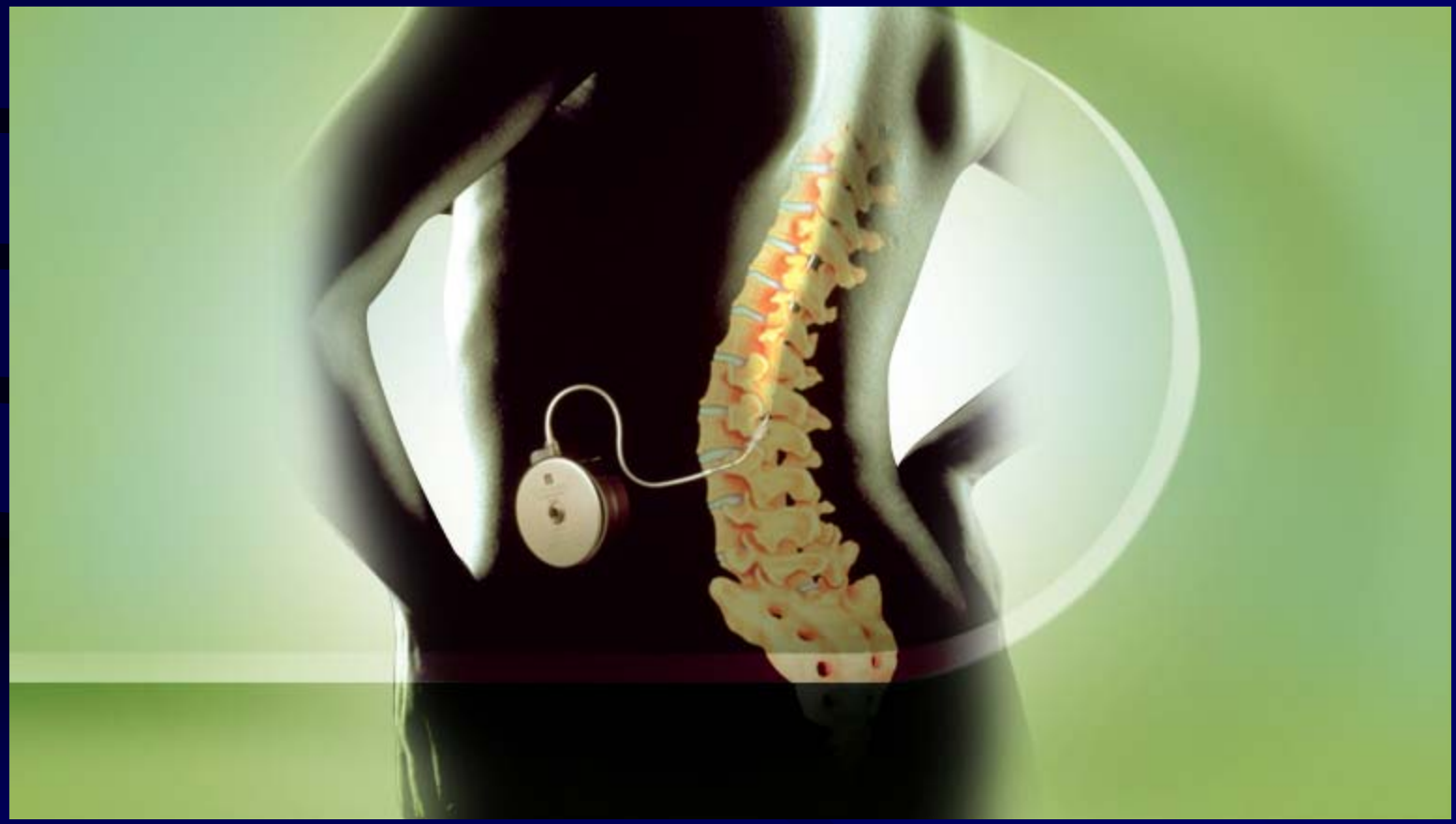
*Based upon on large series (1) of combined percutaneous/paddle leads with one case of paralysis (lead type not specified).

**Deer TR, Lamer TJ, et al: The Neurostimulation Appropriateness Consensus Committee (NACC) Safety Guidelines for the Reduction of Severe Neurological Injury.
Neuromodulation 20(1):15-30, 2017**

Spinal Cord Stimulation

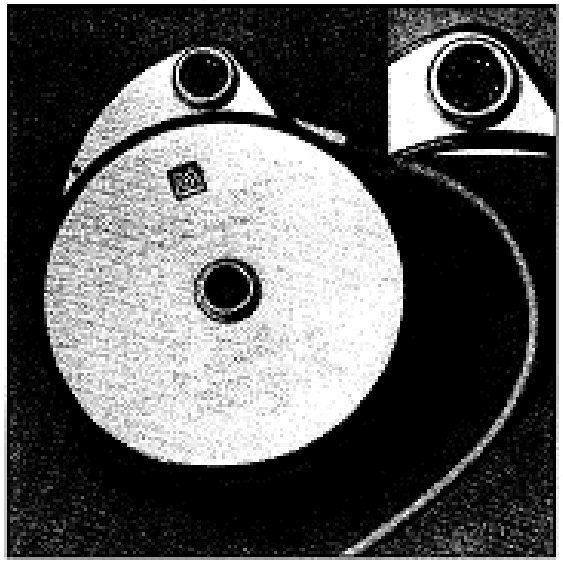
- When should it be considered?
  - When all reasonable treatments have been ineffective
    - Medications
    - Physical therapy
    - Behavioral therapy
  - When functionality has continued to deteriorate

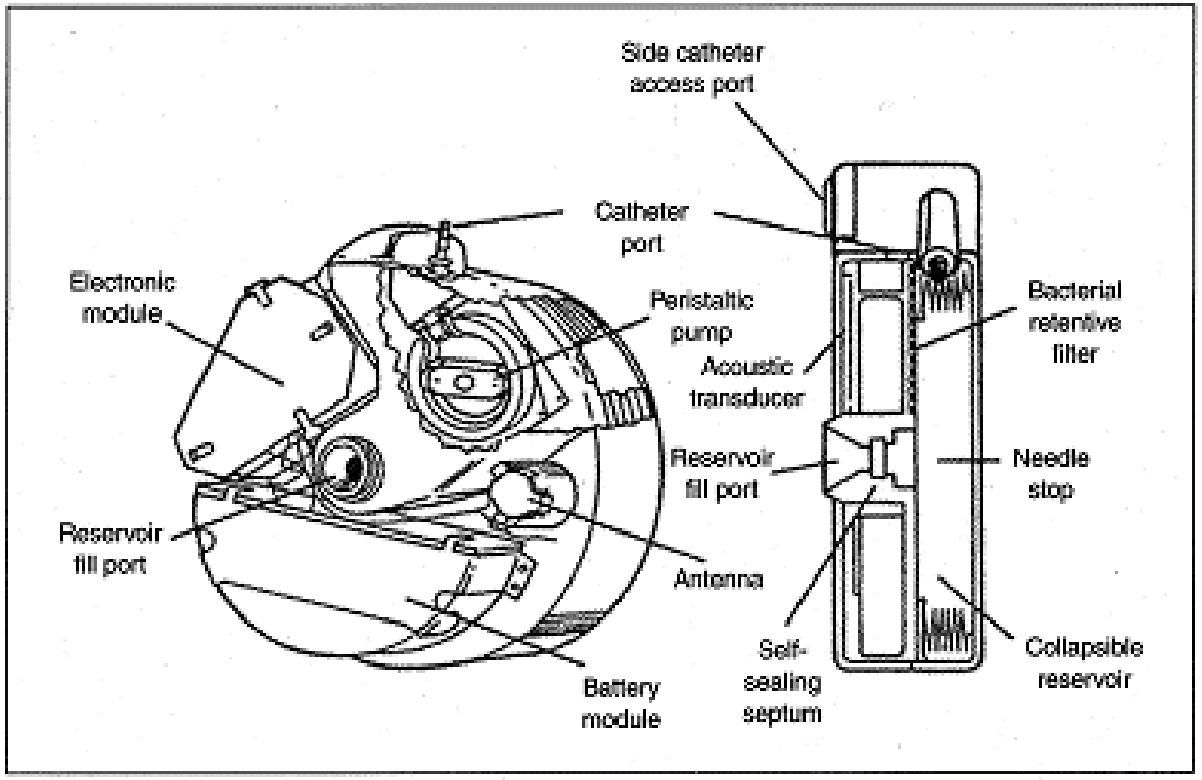
Implantable Drug Infusion System



Implantable Drug Infusion System

Figure 6: The Medtronic SynchroMed Programmable Implantable Infusion Pump. Courtesy of Medtronic Neurological Division.





Implantable Drug Infusion System

- **Medications available**
  - **Local anesthetics**
  - **Opioids**
  - **Other Analgesic Agents**
    - **Ziconitide**
    - **Baclofen**
    - **Clonidine**

Deer TR, Pope JE, et al: The Polyanalgesic Consensus Conference (PACC): Recommendations on Intrathecal Drug Infusion Systems Best Practices and Guidelines. Neuromodulation 2017; 20: 96–132

Indications for Drug Infusion System

- Patient experiences inadequate pain relief and/or intolerable side effects from systemic opioid therapy
- Patient has objective evidence of pathology
- Patient obtains psychological clearance
- Patient has no untreated substance abuse
- Patient has sufficient body size to accept the bulk and weight of the pump
- Clear therapy goals and realistic expectations have been established
- No contraindications to surgery or the therapy exist
- Patient has a favorable response to the screening test

Source: Medtronics 2017

Intrathecal Ziconitide

- "Ziconotide is a nonopioid analgesic currently …for the management of severe chronic pain in patients …who are intolerant of, or whose pain is, refractory to other treatments."
- "Each patient in this series who had marked improvements after ziconotide therapy had previously experienced inadequate symptom relief with numerous other therapies."

Kapural L, Lokey K: Intrathecal Ziconotide for Complex Regional Pain Syndrome: Seven Case Reports. Pain Practice 9(4): 296-303, 2009

Conus Magus

Intrathecal Ziconitide

- Non-opioid
- No withdrawal symptoms
  - Return of pain may occur if stopped
- Narrow therapeutic window
  - Small difference between dose for relief and dose causing side effects

Intrathecal Ziconitide

- **Most Common Side Effects:**
  - Nausea
  - Memory alterations
  - Mood disorders
  - Urinary retention
  - Confusion
  - Low blood pressure

Pope JE, Deer TR: Ziconotide: a clinical update and pharmacologic review.
Expert Opinion on Pharmacotherapy 14(7) 957-966 , 2013

Intrathecal Baclofen Infusion

- Reduction of global pain scores
  - Reduced, deep, sharp pain
    - Dull pain was relieved less
- Reduced dystonia / tremors

Van der plas AA, van Rijn MA, et al: Efficacy of intrathecal baclofen on different pain qualities in complex regional pain syndrome. Anes Analg 2013 Jan;116(1):211-5

SCS + Intrathecal Therapy

- Combined therapy
  - Reduced pain
  - Improved movement disorders
    - Dystonia / tremors
  - Reduced pain fluctuations

Goto S, Taira T: Spinal cord stimulation and intrathecal baclofen therapy: combined neuromodulation for treatment of advanced complex regional pain syndrome.
Stereotact Funct Neurosurg 2013;91(6):386-91

Contraindications to Drug Infusion Systems

- Infection;
- implant depth greater than 2.5 cm below skin;
- insufficient body size;
- spinal anomalies;
- drugs with preservatives,
- drug contraindications,
- drug formulations with pH ≤3,
- use of catheter access port (CAP) kit for refills or of refill kit for catheter access,
- blood sampling through CAP in vascular applications,
- use of Personal Therapy Manager
  - to administer opioid to opioid-naïve patients
  - or to administer ziconotide.

Source: Medtronics 2017

Intrathecal Drug Administration Complications

- Infections
- Catheter problems
  - Occlusion
  - Kinking
  - Migration
  - Breakage
- Medication adverse effects
- Programming errors
- Seroma
- Pump trauma

Intrathecal Drug Administration Systems

Statement	Evidence level	Recommendation grade	Consensus strength
Intrathecal therapy should be utilized for active cancer-related pain.	I for opioids; I for ziconotide	A	Strong
Intrathecal therapy should be utilized for noncancer-related pain.	III-2 for opioids; II-3 for opioids in combination with bupivacaine; I for ziconotide	B	Strong

Deer TR, Pope JE: The Polyanalgesic Consensus Conference (PACC): Recommendations for Intrathecal Drug Delivery: Guidance for Improving Safety and Mitigating Risks. Neuromodulation 2017; 20: 155–176

EMERGING THERAPIES

Regenerative Medicine

"Stem Cell" therapy

Regenerative Medicine Therapy

- What is it?
- Is it safe?
- What options are available?
- What options work best for CRPS?

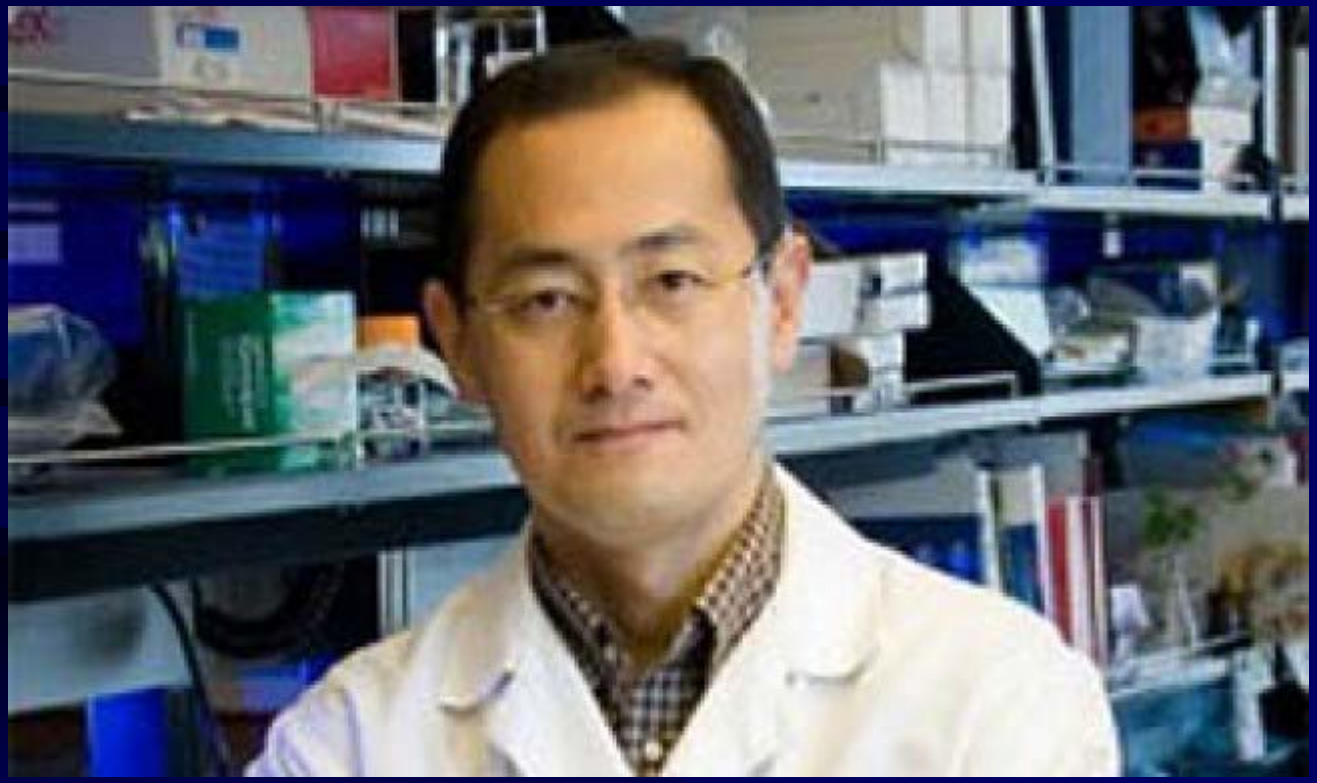
Regenerative Medicine Therapy

- What is it?
  - Regenerative Medicine Therapy is designed to help the body repair itself by
    - Activating repair cells in our bodies
    - Supplying our own repair cells to the site of injury
    - Supplying repair cells from other sources

Regenerative Medicine Therapy
"Stem Cell Therapy"

- Before 2006, stem cell therapy was highly controversial
  - It was associated with living tissue taken from developing babies
    - Ethical and moral concerns

Shinya Yamanaka
Stem Cell Pioneer



Takahashi K, Yamanaka S: Induction of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors.
Cell 126(4) 663-676, 2006

Shinya Yamanaka
Stem Cell Pioneer

- Co-winner of 2012 Nobel Prize
  - Physiology / Medicine
- "These cells, which we designated iPS (induced pluripotent stem) cells, exhibit the morphology and growth properties of ES cells…These data demonstrate that pluripotent stem cells can be directly generated from fibroblast cultures by the addition of only a few defined factors."

Takahashi K, Yamanaka S: Induction of Pluripotent Stem Cells from Mouse Embryonic and Adult Fibroblast Cultures by Defined Factors.
Cell 126(4) 663-676, 2006

Sources of Regenerative Options

- Autologous Sources
  - Pediatric post-partum options
    - Tissue Banks
  - Adult options
    - Bone marrow harvest
    - Adipose tissue harvest
    - Dental pulp tissue harvest

Sources of Regenerative Options

- Allographic Sources
  - Postpartum options
    - Tissue Banks
  - Adult options
    - Induced Pluripotential Cells
      - Bone marrow harvest
      - Adipose tissue harvest
      - Dental Pulp harvest

Strategies for Regenerative Therapy

- Risk
  - Correlate therapy risk level with disease severity
- Regulation
  - Correlate therapy choice with regulatory environment

Risk-Based Regenerative Therapy

- Low-Level Disease
  - Wellness
  - Graceful Aging
  - Orthopedic Pathology
- Low-Risk Therapy
  - Autologous Therapies
    - Alpha 2 Macroglobulin
    - Platelet-rich plasma
  - Allogenic Therapies
    - Amniotic fluid
      - Local application
        - » Orthopedic pathology

Jason M. Cuéllar, MD, PhD, Vanessa Gabrovsky Cuéllar, MD, Gaetano J. Scuderi, MD:
a2-Macroglobulin Autologous Protease Inhibition Technology.
Phys Med Rehabil Clin N Am 27 (2016) 909–918
Vines JB, et al: Cryopreserved Amniotic Suspension for the Treatment of Knee Osteoarthritis.
J Knee Surg 2016;29:443–450

Platelet-Rich Plasma

- An autologous WBC-poor, platelet rich tissue with numerous platelet-derived growth factors and bioactive compounds
  - Currently used for orthopedic indications
    - Tendinopathies
    - Plantar fasciitis
    - Joint osteoarthritis
      - Superior to Supartz, etc.

Kuffler DP: Platelet-rich plasma and the elimination of neuropathic pain. Mol Neurobiol 48(2):315-32, 2013

Amniotic Fluid

- An allographic product of conception which initially contains neonatal stem cells, which are typically filtered out
  - Amniocentesis: 2nd trimester
  - Amnioreduction: 3rd trimester
  - Elective Caesarean section
- Cell origins
  - Skin
  - GI
  - GU
  - Respiratory

LOUKOGEORGAKIS, et al: AMNIOTIC FLUID STEM CELLS: THE KNOWN, THE UNKNOWN AND POTENTIAL REGENERATIVE MEDICINE APPLICATIONS. Stem Cell 2016 Dec 23

Amniotic Fluid

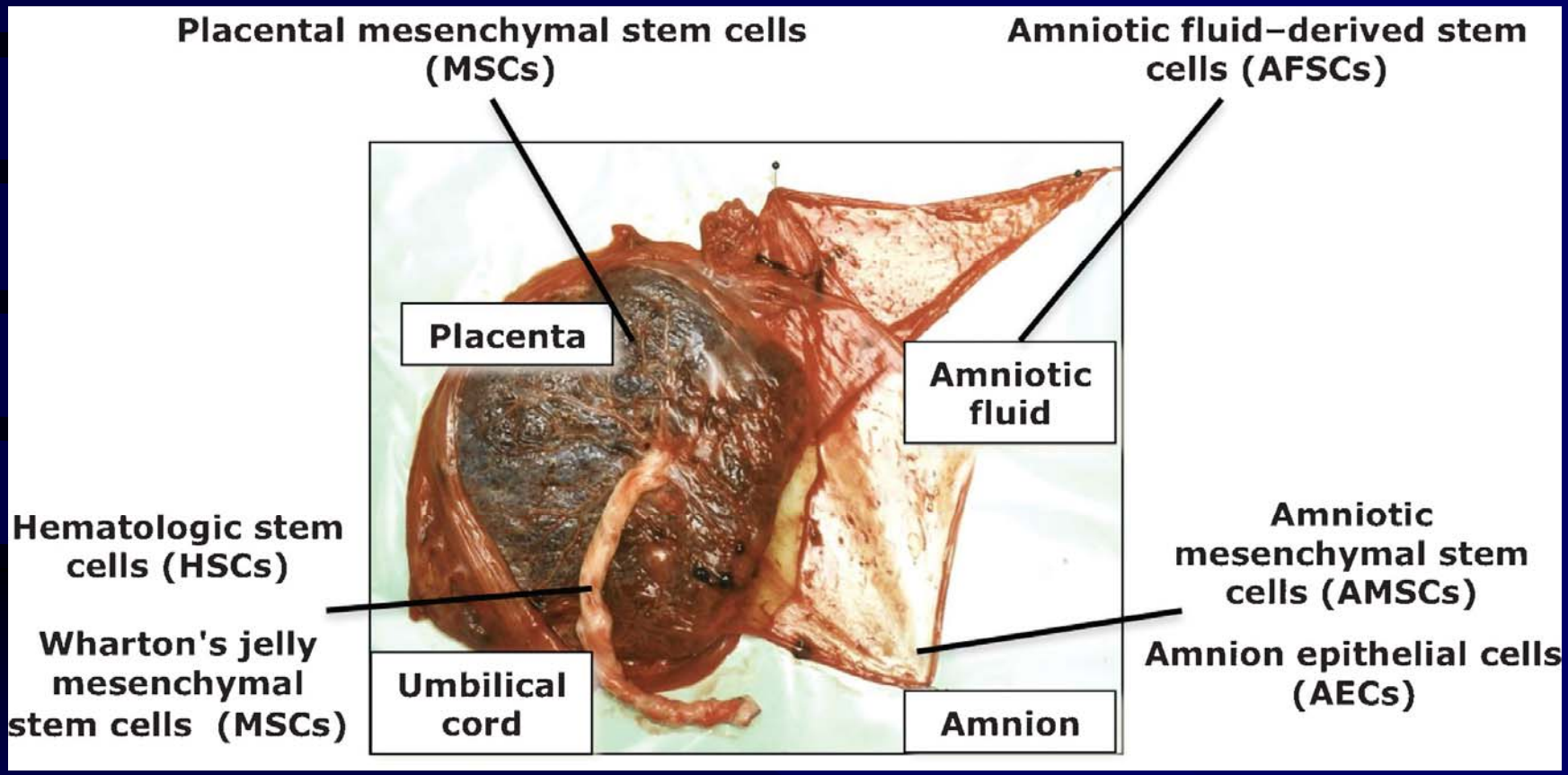
- Contains numerous growth factors and bioactive compounds
- Cellular elements, if present, are not known to be tumorigenic
- Current uses
  - Orthopedic indications
  - Pulmonary indications
    - Cellular elements

Gestational Stem Cells

- In clinical and preclinical studies, gestational stem cells have shown efficacy in the treatment of
  - Crohn's disease,
  - lung disease,
  - diabetes,
  - repair of bone defects,
  - heart disease,
  - kidney disease,
  - neural degeneration, and
  - blood disorders.
- Stem cells derived from the placenta, placental membranes, and amniotic fluid are a valuable resource for the field of regenerative medicine.

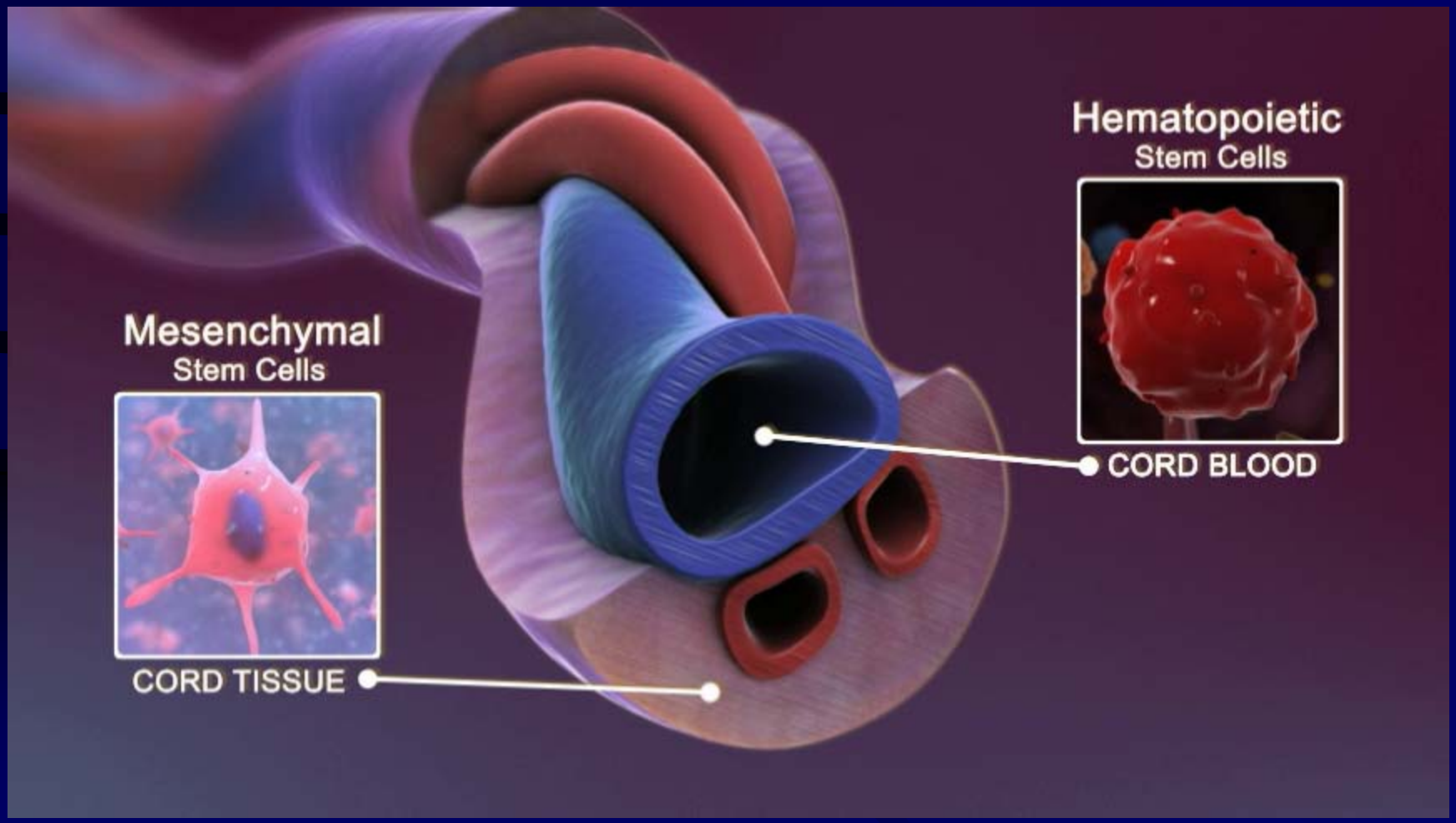
Murphy SV, Atala A: Amniotic Fluid and Placental Membranes: Unexpected Sources of Highly Multipotent Cells. Semin Reprod Med 2013;31:62–68

Gestational Stem Cell Sources



Murphy SV, Atala A: Amniotic Fluid and Placental Membranes: Unexpected Sources of Highly Multipotent Cells. Semin Reprod Med 2013;31:62–68

Cord Blood


Hematopoietic
Stem Cells
Mesenchymal
Stem Cells
CORD BLOOD
CORD TISSUE

Cord Blood

- Çil N: Effects of umbilical cord blood stem cells on healing factors for diabetic foot injuries
  - Biotechnic & Histochemistry 2017, Early Online: 1–14
- El-Badawy A: Clinical Efficacy of Stem Cell Therapy for Diabetes Mellitus: A Meta-Analysis
  - PLoS ONE 11(4), April 13, 2016
- Reddi AS: The Use of Human Umbilical Cord Blood for Wound Healing, Burns, and Brain Injury in Combat Zones
  - **MILITARY MEDICINE,** 176,4:361,2011

Wharton‘s Jelly Stem Cells

- **Hu J, et al: Long term effect and safety of Wharton's jelly-derived mesenchymal stem cells on type 2 diabetes**
  - ***EXPERIMENTAL AND THERAPEUTIC MEDICINE 12: 1857-1866, 2016***
- **Liu X: preliminary evaluation of efficacy and safety of Wharton’s jelly mesenchymal stem cell transplantation in patients with type 2 diabetes mellitus**
  - **Stem Cell Research & Therapy 2014, 5:57**

Providers of Regenerative Therapy

- Credentialing
  - Evidence of education and training
    - Residencies
      - None currently
    - Fellowships
      - A4M:
        - » American Association for Anti-Aging Medicine
- Training
  - Skills instruction
    - Weekend workshops

Regenerative Therapy

for Neuropathic Pain

- Numerous experimental studies demonstrating
  - Regenerative effects
  - Trophic effects
    - Growth factors
      - Healing qualities

Vadivelu S, Willsey M: Potential role of stem cells for neuropathic pain disorders. Neurosurg Focus 35 (3):E11, 2013

Regenerative Therapy

for Neuropathic Pain

"…the ability of stem cells to modify cellular processes provides for a protective and restorative microenvironment that can potentially fully reverse the causes behind the onset of neuropathic pain."

Fortino VR, Pelaez: Concise Review: Stem Cell Therapies for Neuropathic Pain. STEM CELLS TRANSLATIONAL MEDICINE 2013;2:394–399

Regenerative Therapy for neuropathic pain

- **The literature to date is very limited for evaluating the therapeutic role of MSCs in treating neuropathic pain in humans.**

Vickers ER, Karsten E: A preliminary report on stem cell therapy for neuropathic pain in humans. Journal of Pain Research (7)255-263, 2014

Regenerative Therapy
for Neuropathic Pain

- **Challenges:**
  - Sourcing of stem cells,
    - quality
  - considerations on autologous versus allogeneic transplants,
    - Your cells v someone else's
  - pre-commitment to neuronal lineages,
    - Cell types
  - characterization of neurotrophic factor release, and
    - Which factors are helpful?
  - dosing requirements
    - How many cells are necessary?

Fortino VR, Pelaez: Concise Review: Stem Cell Therapies for Neuropathic Pain. STEM CELLS TRANSLATIONAL MEDICINE 2013;2:394–399

Regenerative Therapy for CRPS

- Adipose Stem/Stromal Cells in RSD, CRPS, Fibromyalgia (ADcSVF-CRPS)
  - ClinicalTrials.gov Identifier:
    - NCT02987855
- Nature of Study
  - Study is an interventional study to document the safety and efficacy of use of adipose-derived cellular stromal vascular fraction (AD-cSVF) in chronic pain and dysfunction disease groups
- Point of contact
  - Robert W. Alexander, MD, FICS,
    - 406.777.5312
    - Healeon Medical Inc

Source: ClinicalTrials.gov Website

Regenerative Medicine Therapy for CRPS

Estimated Enrollment:	**100**
Study Start Date:	**December 2016**
Estimated Study Completion Date:	**June 2019**
Locations	
Estimated Primary Completion Date:	**December 2018 (Final data collection date for primary outcome measure)**

United States, Montana
Regenevita LLC **Recruiting**
Stevensville, Montana, United States, 59870
Contact: Susan Riley, CMA 406-777-5312 irbtrials1@gmail.com
Contact: Nancy L Smith, MA,ORT 406777.5312 irbtrials2@gmail.com

Source: ClinicalTrials.gov Website

Interventional Therapy for CRPS

- What works?
  - At the present
    - IV Ketamine
    - Sympathetic Blocks
    - Neuraxial Stimulation
    - Scrambler Therapy
    - Intrathecal Pumps
  - Future
    - Regenerative Medicine

Conclusions

- Our lack of understanding has made CRPS a difficult disease to treat
- However, several interventions have proven to provide
  - Improved pain relief
  - Improvement in function
- Regenerative Medicine Therapy is very promising
  - But we are very early in our knowledge

Questions?