

Mission Neuromodulation NOUMEA 2022

Neurostimulation médullaire implantée



Prof. Philippe RIGOARD (MD, PhD, HDR)

Service de Neurochirurgie du Rachis, de la Douleur et du Handicap
CHU de Poitiers

Institut P', UPR 3346, CNRS

PRISMATICS Lab



Synopsis

- I. D'où je viens, ce que je fais, qui je suis...
- II. C'est quoi la Neurostimulation médullaire ?
- III. Les évolutions techniques et technologiques
- IV. Electrode chirurgicale ou (/et !) percutanée ?
- V. Un parcours patient complexe, un itinéraire médical passionnant

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Head of Department
Spinal Neurosurgery & Neurostimulation
Poitiers University Hospital
Institut P', UPR 3346, CNRS
PRISMATICS Lab

NEUROMODULATION

10 procedures in 2006
203 procedures in 2016
242 procedures in 2018



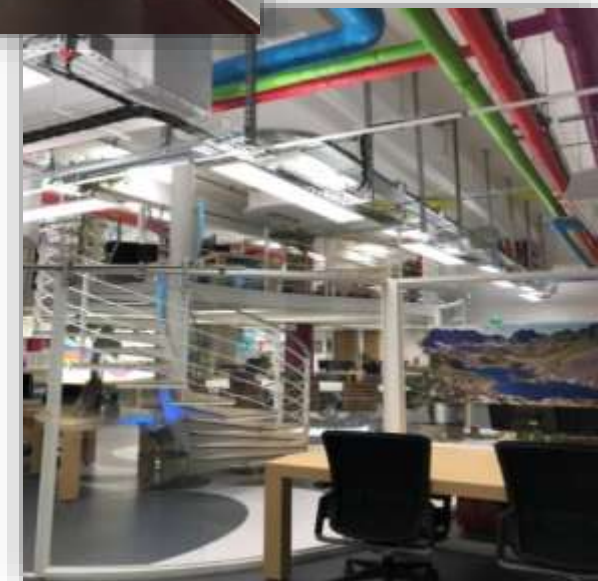
RACHIS, DOULEUR & HANDICAP



RACHIS	DOULEUR	HANDICAP



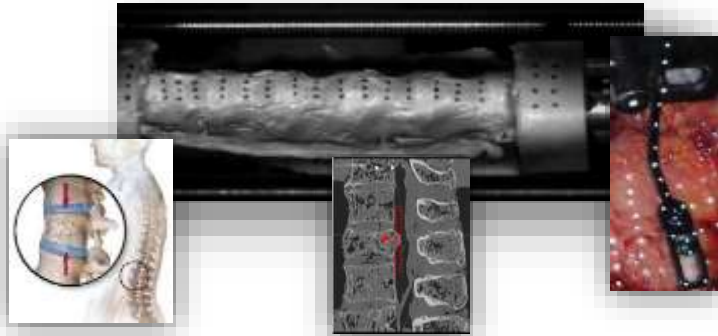
Predictive Research In Spine/Neuromodulation Management And Thoracic Innovation/Cardiac Surgery



Recherche Translationnelle

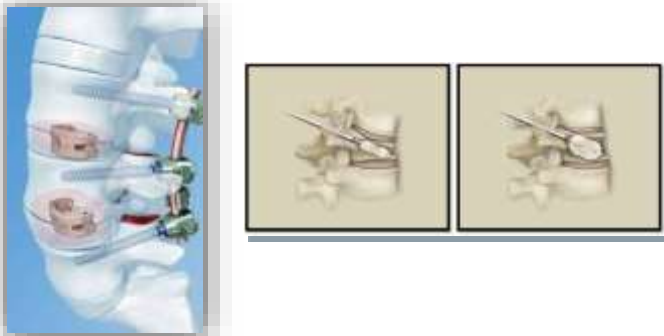
Focus 1

Biomécanique Humaine



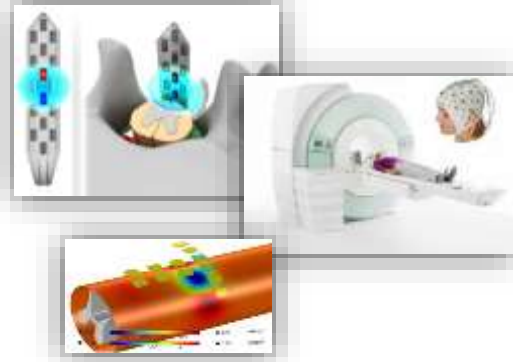
Biomécanique

Chirurgie innovante



Focus 2

Neuromodulation - Douleur



Neurostimulation

Gestion de la douleur



Focus 3

Spasticité - Handicap



Fonction motrice & Handicap

Mobilité & Autonomie



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Le terreau.....



LES DOULEURS CHRONIQUES: UN PROBLÈME SOCIÉTAL COMPLEXE

30% des français (> 20 Millions)

30-40% des patients opérés du rachis

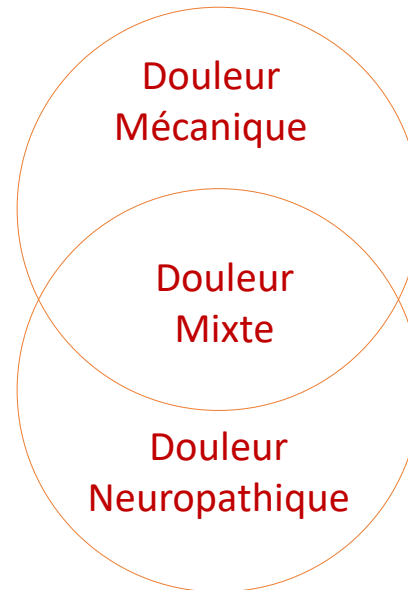
1^{ère} cause d'arrêt maladie en France

Qualité de Vie des Douleurs chroniques Réfractaires : EQ(5)D=19%

Physique : Fatigue, sommeil, capacités fonctionnelles

Psychologique : Dépression, anxiété, capacités cognitives

Social : Isolement, travail, réduction de la communication



Lomboradiculalgies post-opératoires (LRPO/PSPS-T2)

Épidémiologie



30,000 – 40,000 nouveaux cas de LRPO diagnostiqués tous les ans



300 000 chirurgies du rachis /an
100 000 LRPO /par an

- La qualité de vie et les capacités fonctionnelles sont considérablement réduites chez les patients du LRPO
 - EQ-5D ~ 0.15 pour LRPO (généralement plus bas que les autres pathologies chroniques)
 - ODI = 55 – 60
- 78% des patients LRPO sont incapables de travailler
- La prise en charge des patients LRPO avec CMM = £81,986

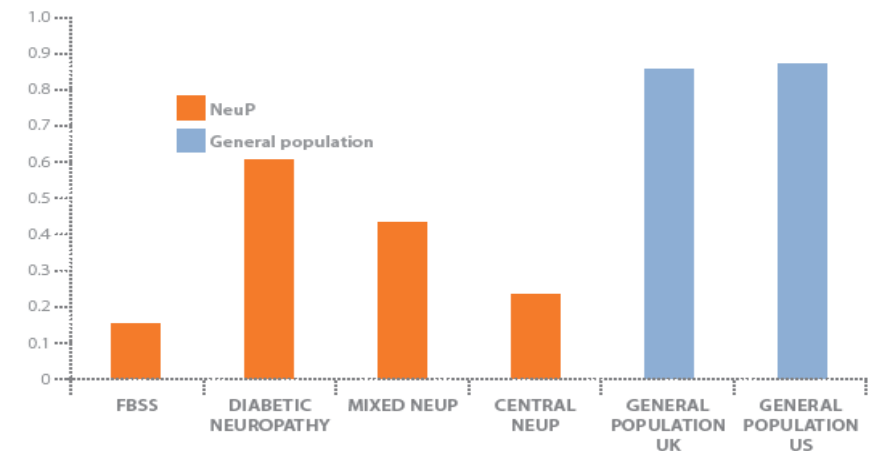


Tableau mixte



Lomboradiculalgies post-opératoires (LRPO/PSPS-T2)

D'où vient l'échec..?



WHO / WHAT HAS FAILED?

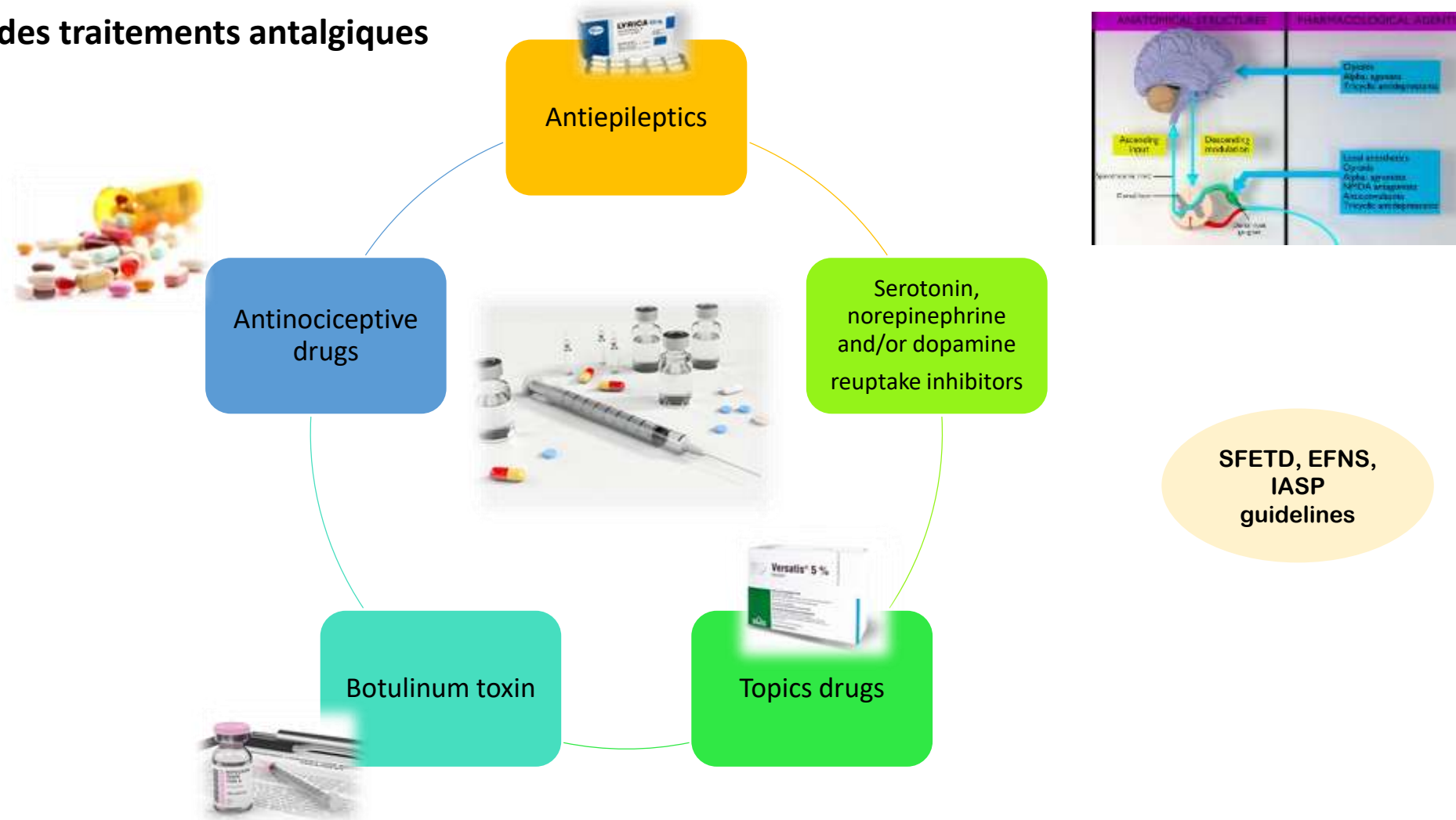


Why not combining techniques, solutions, expertises?

Our patient outcomes and indications

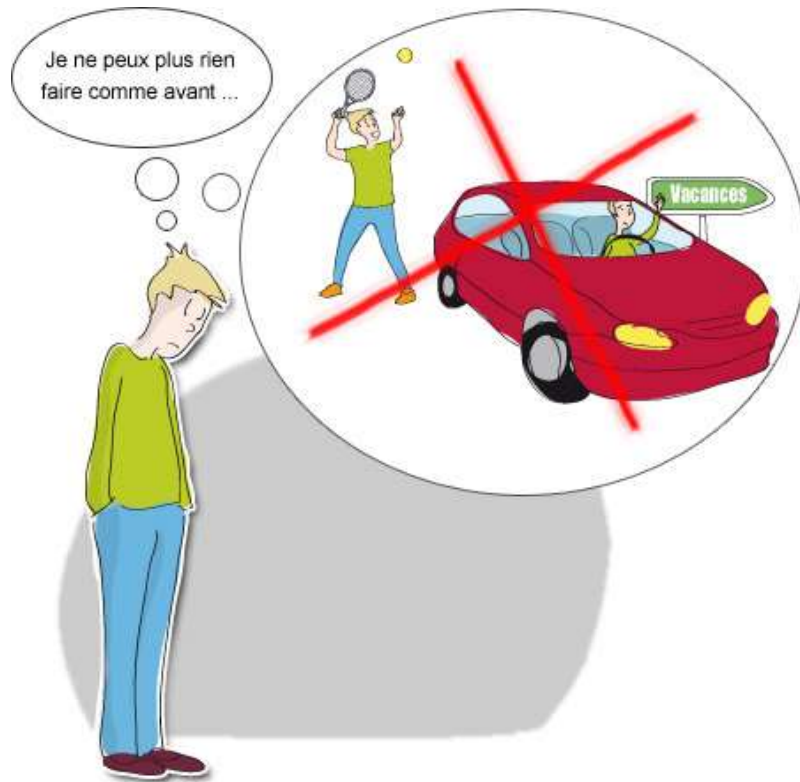
Le management des LRPO...(LRPO/PSPS-T2)

Optimisation des traitements antalgiques



Lomboradiculalgies post-opératoires (LRPO/PSPS-T2)

Du point de vue du patient



Prise en charge de la douleur: LA CRISE DES OPIOÏDES



Antiepileptics

SFETD, EFNS,
IASP

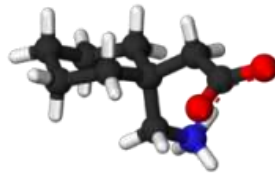
SCIENCES

Les Etats-Unis tentent de réagir face à la crise des opioïdes

Les opiacés représentent les deux tiers des 72 000 morts par overdose outre-Atlantique. Devant ce chiffre record, villes, Etats et autorité fédérale se mobilisent.

Par Stéphanie Le Bars - Publié le 15 octobre 2018 à 18h27 - Mis à jour le 17 octobre 2018 à 12h33

antalgiques



Botulinum toxin

Topic drugs



SCIENCES

L'addiction aux opiacés, première cause de mort par overdose en France

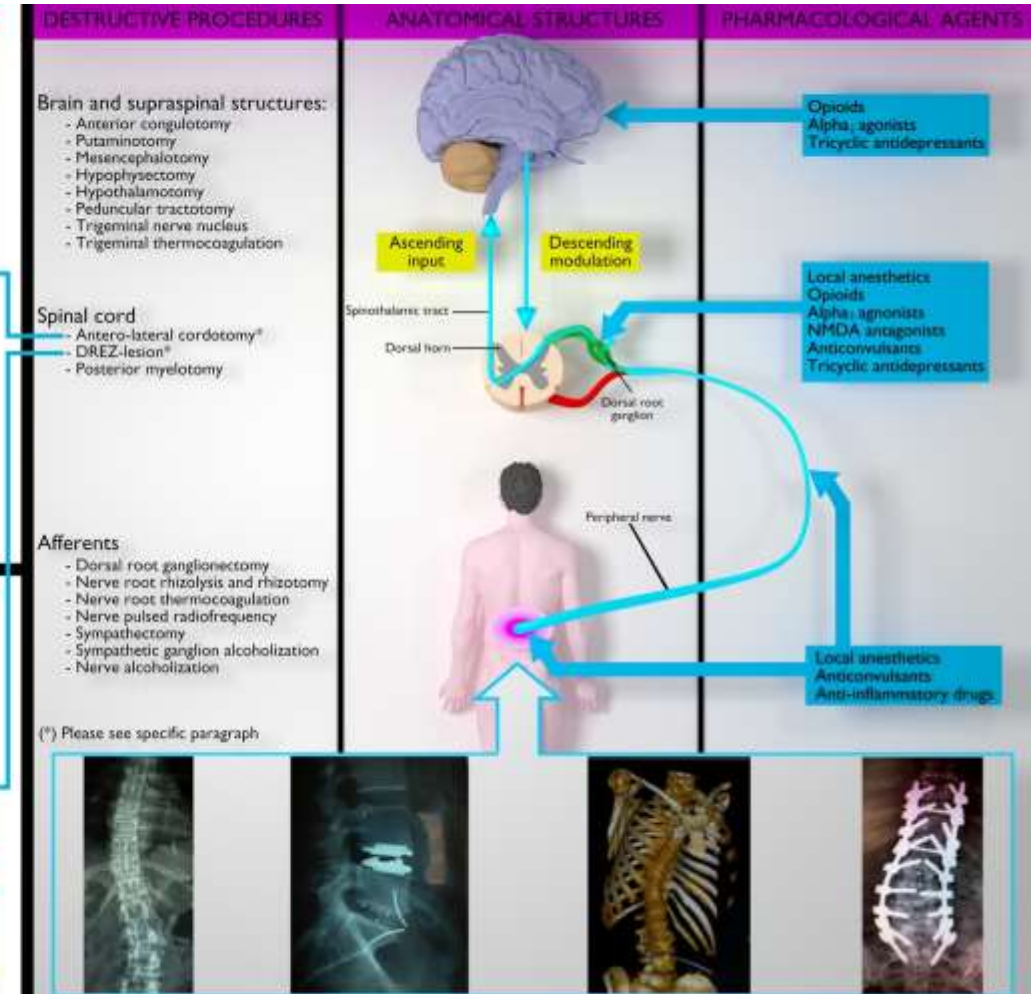
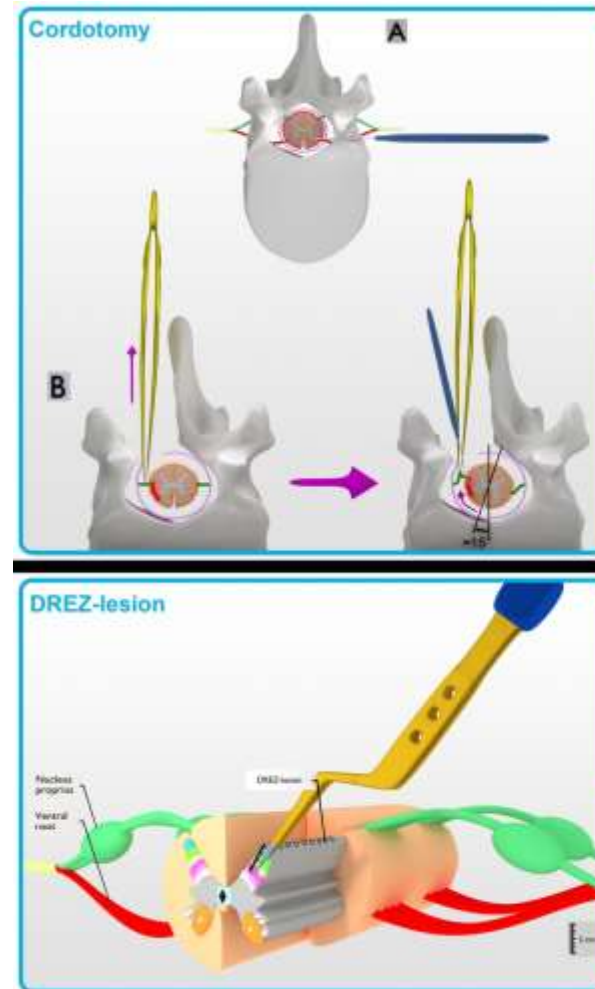
L'abus et la dépendance aux antidouleurs constituent l'une des pires crises sanitaires de l'histoire récente. Aux Etats-Unis, elle fait des ravages croissants depuis dix ans.

Du médicament à la chirurgie...



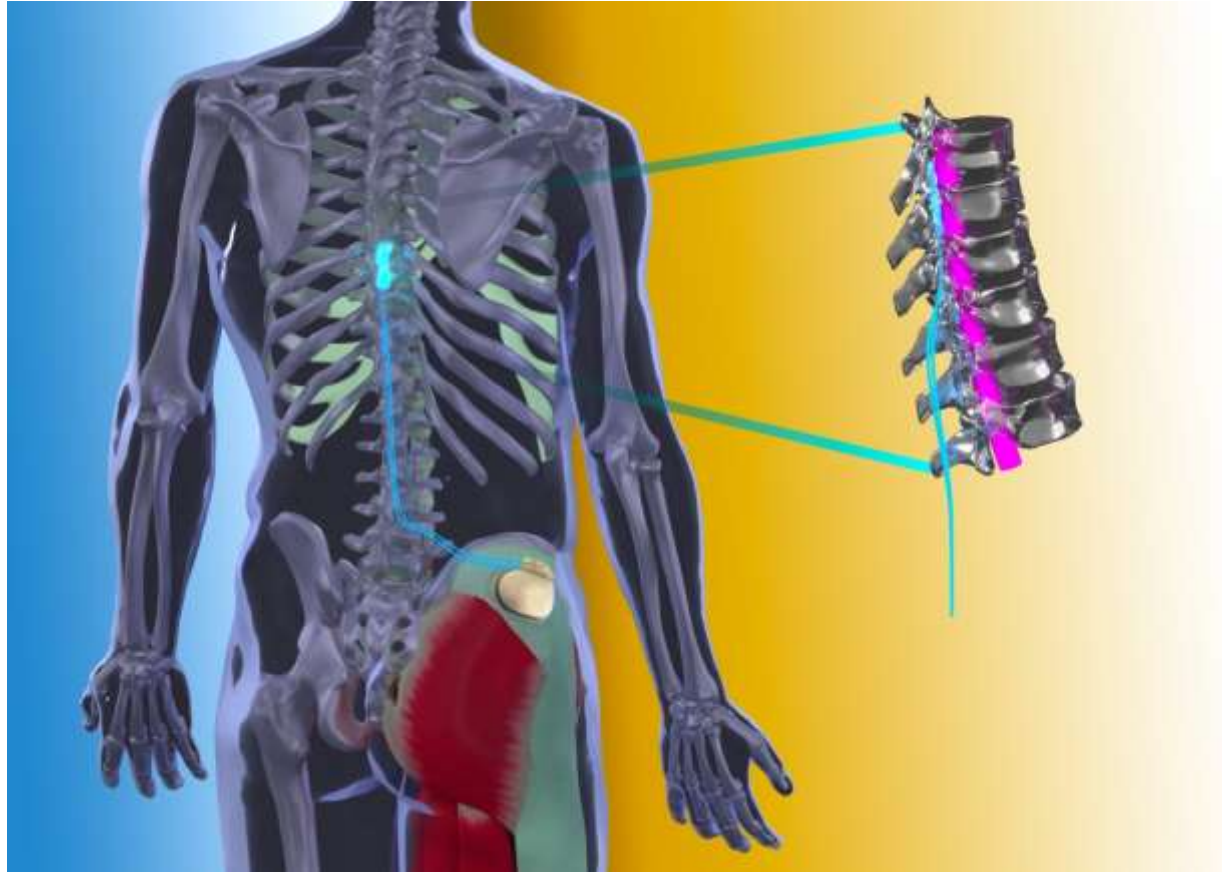
Du médicament à la chirurgie...

Cibles : Chirurgies lésionnelles



Du médicament à la chirurgie...

Au lieu de détruire...STIMULER

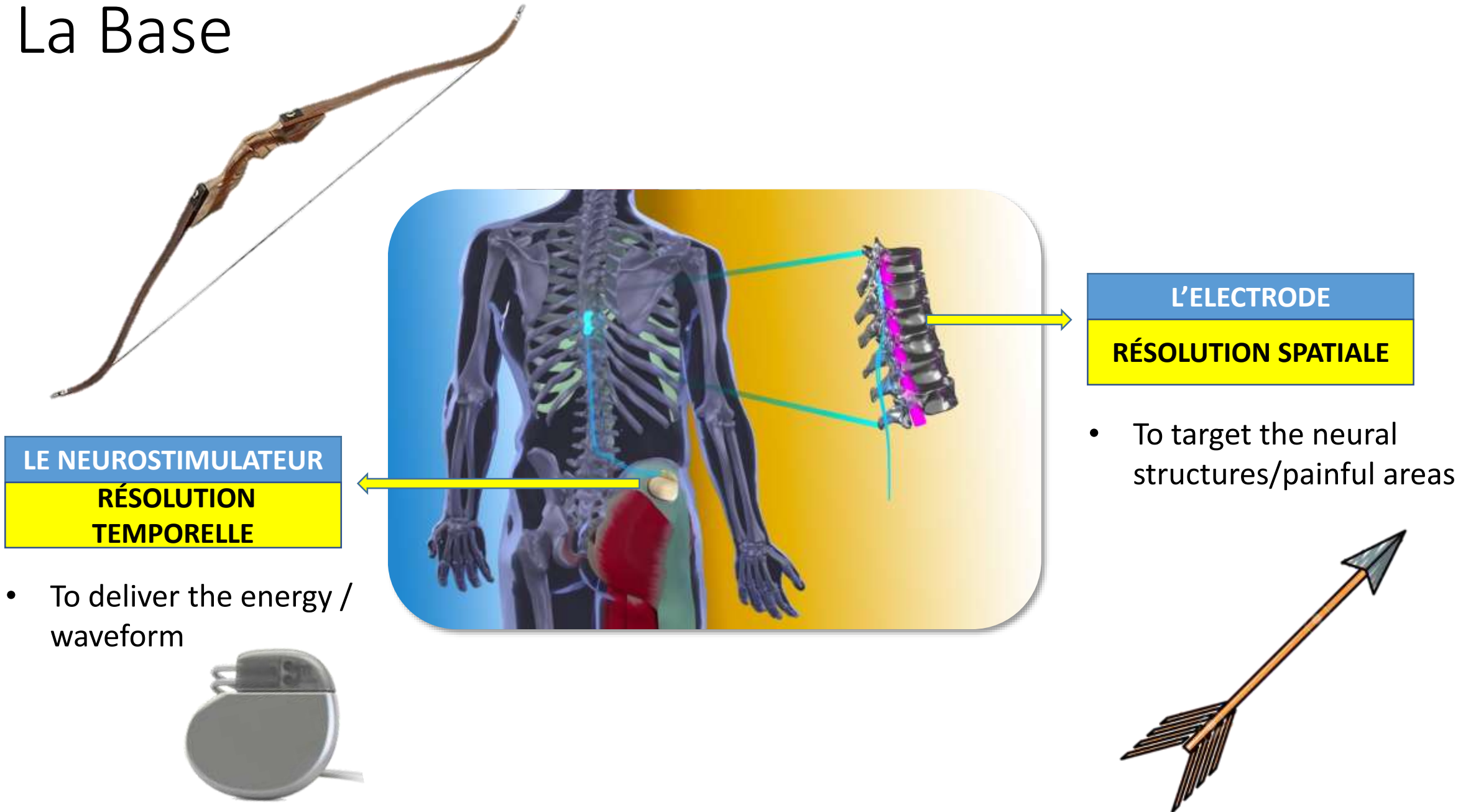


Qu'est ce que la neuromodulation ?



La Base

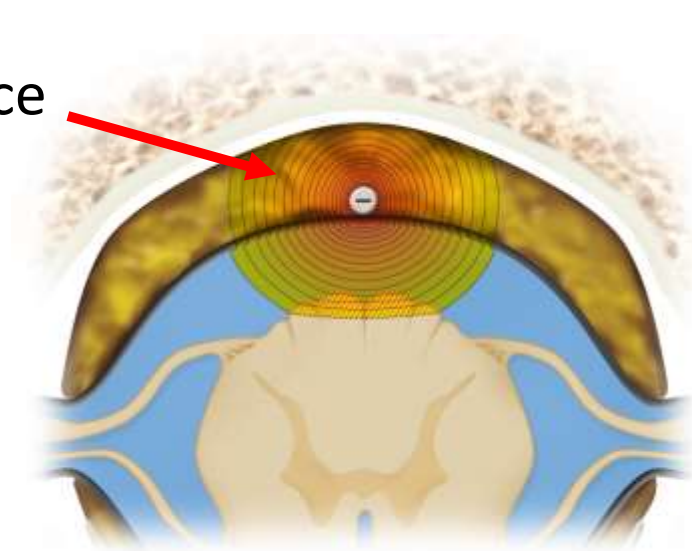
22



La stimulation médullaire



Epidural space

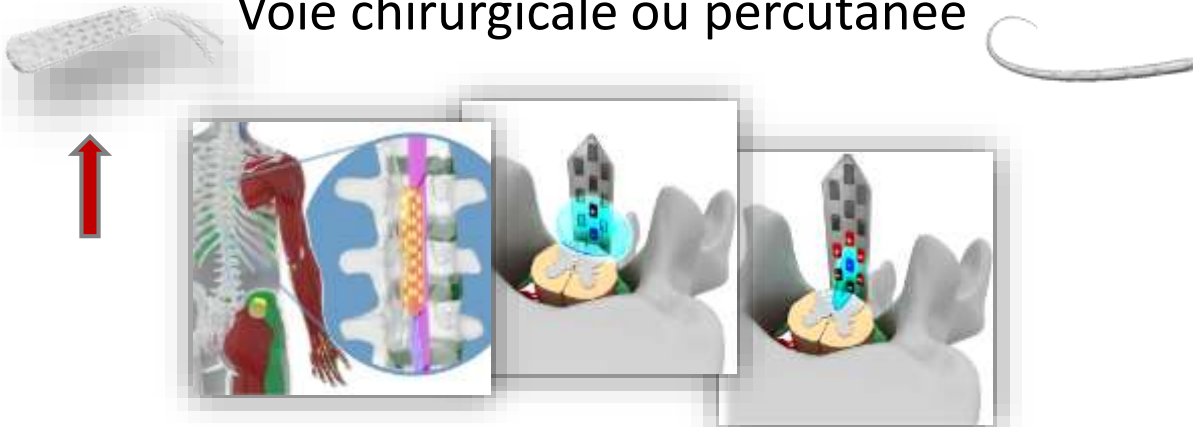


Perception d'une technique
compliquée et invasive



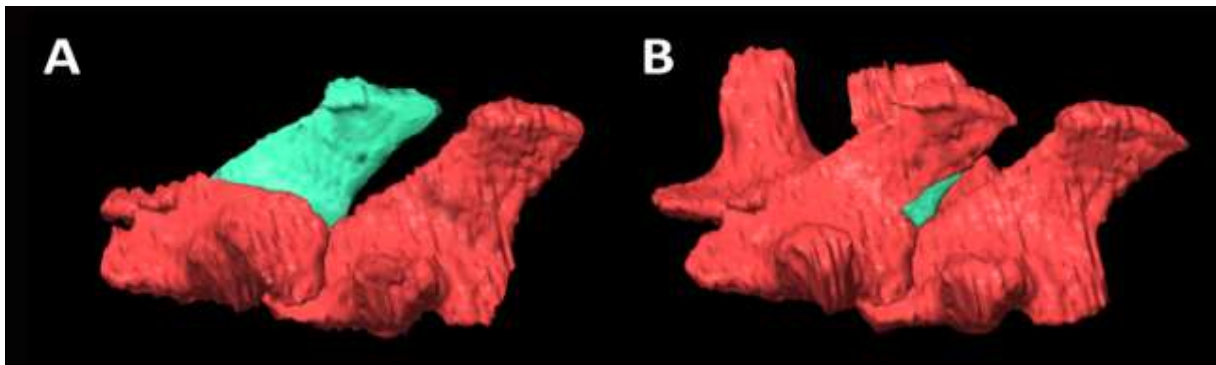
La stimulation médullaire

Voie chirurgicale ou percutanée



Billot et al. Trials, 2020.
Rigoard et al. Neuromodulation, 2020.

Technique mini-invasive



Prof. Rigoard

EEPIN

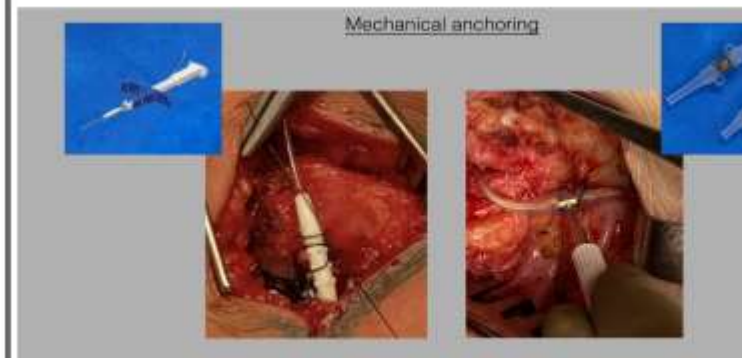
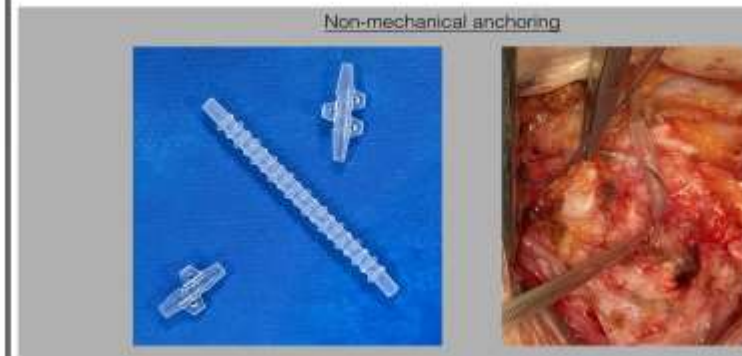
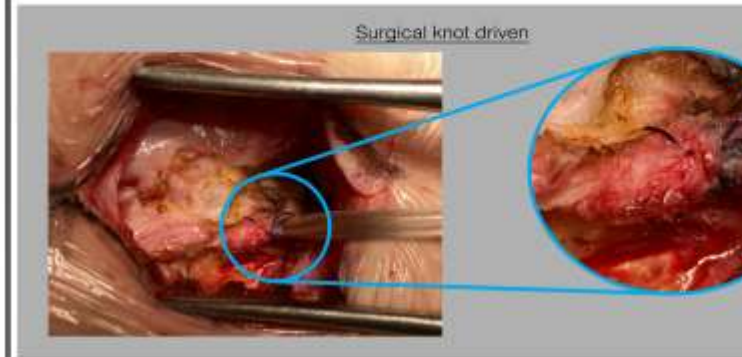
Percutaneous Lead Implantation

Poitiers University Hospital

PRISMATICS
Team

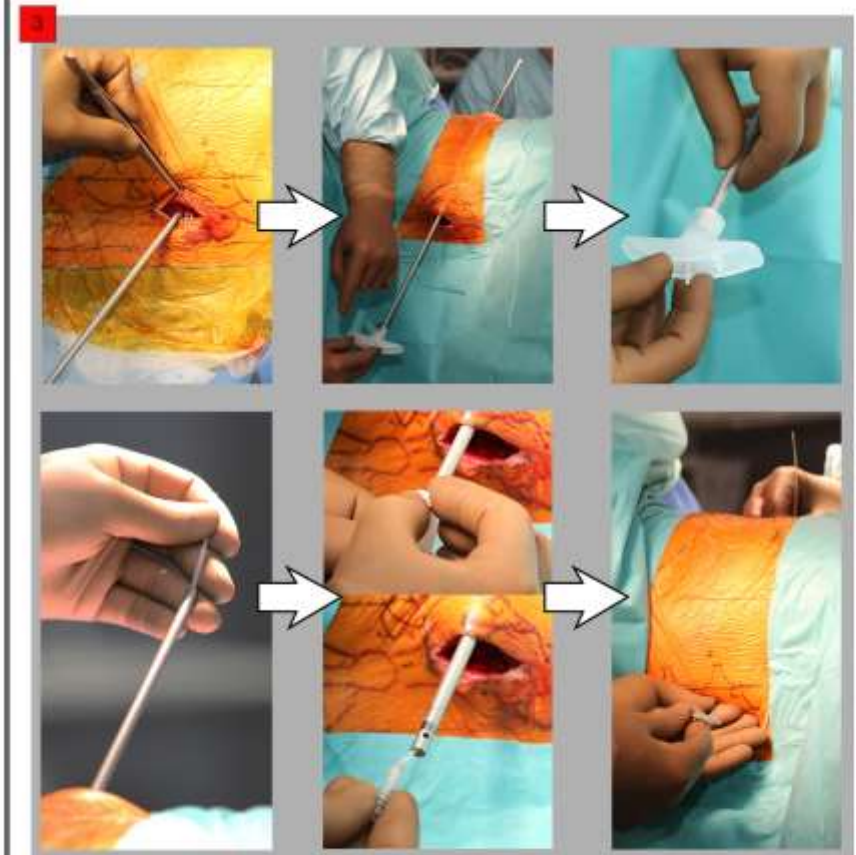
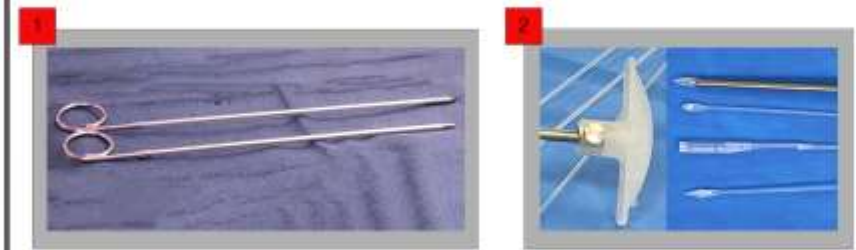


Anchoring



Graphic conception : K.Nivole, H.Chaigne & P.Rigoard
NACC 2021 : Recommendations for surgical techniques for Neurostimulation

Tunneling



Graphic conception : K.Nivole, H.Chaigne & P.Rigoard
NACC 2021 : Recommendations for surgical techniques for Neurostimulation

Prof. Rigoard

EEPIN

IPG
Implantation

Poitiers University Hospital

PRISMATICS
Team



La stimulation médullaire une efficacité démontrée

Objectif : réduction de 50% de la douleur de patients atteints de douleurs chroniques réfractaires

→ Etudes prospectives contrôlées randomisées

FBSS

Rigoard et al. Pain, 2019

Rigoard et al. Neuromodulation, 2020

Al-Kaisy et al. Neuromodulation, 2018

Deer et al. Neuromodulation, 2018

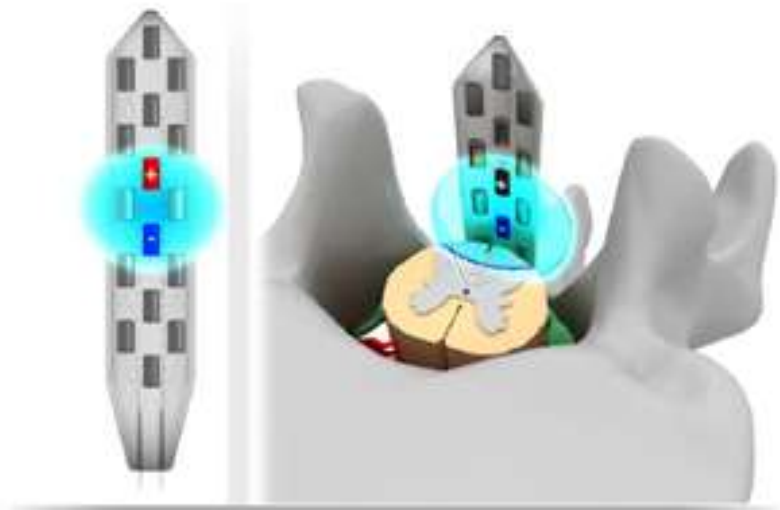
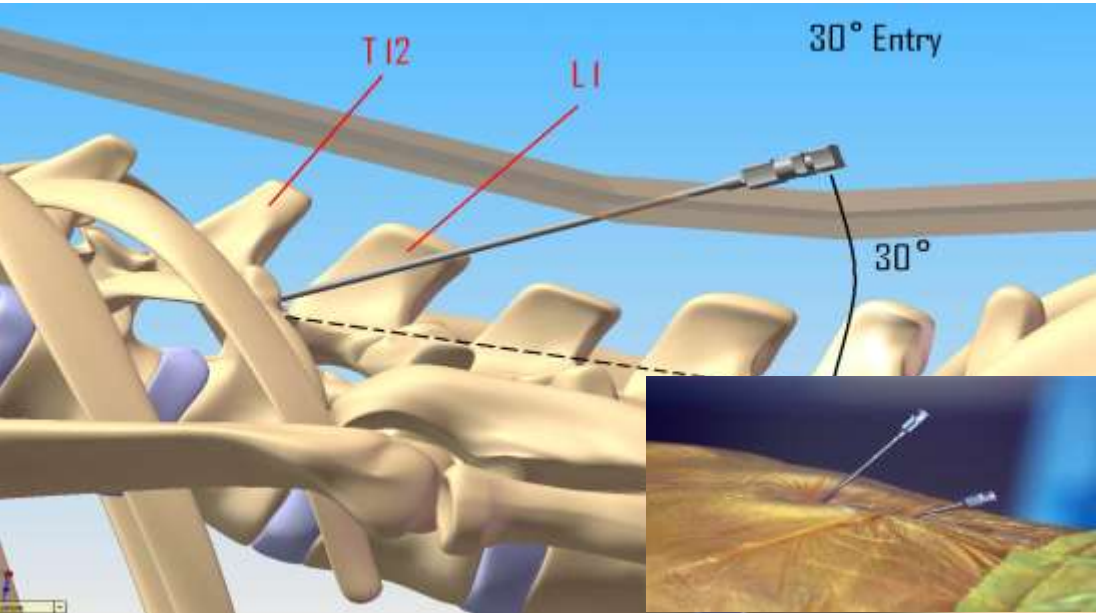
→ Revues systématiques et méta-analyses récentes

Duarte et al. Pain, 2020.

Deer et al. Pain Medicine, 2020.

→ Pour d'autres types de douleurs :

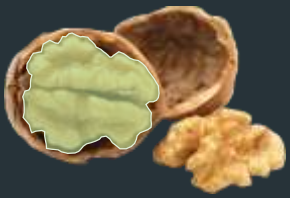
- Neuropathie diabétique (de Vos et al. Neuromodulation, 2014)
- Syndrome douloureux régional complexe (Deer et al. Pain, 2017)
- Scoliose thoracolombaire (Cheng et al. Anesthesia & Analgesia, 2020)



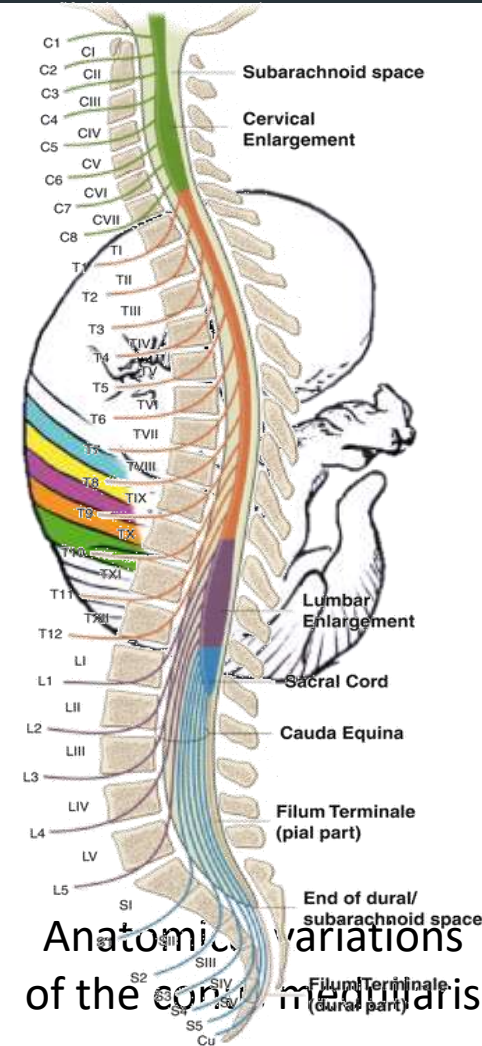
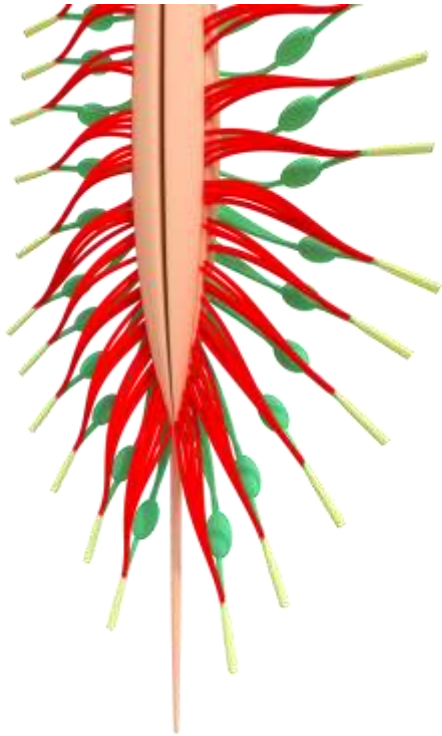
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L'Anatomie est extrêmement variable !

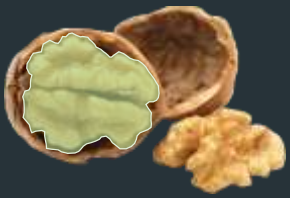


En MACRO...

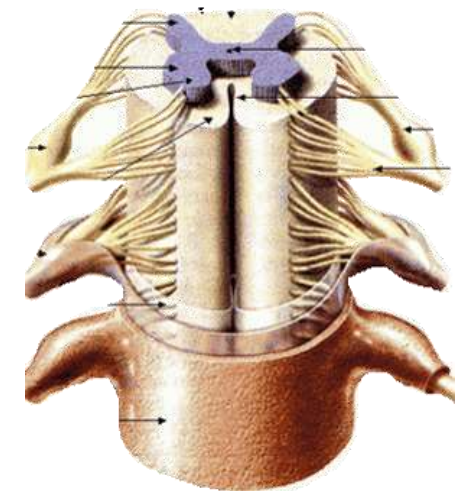
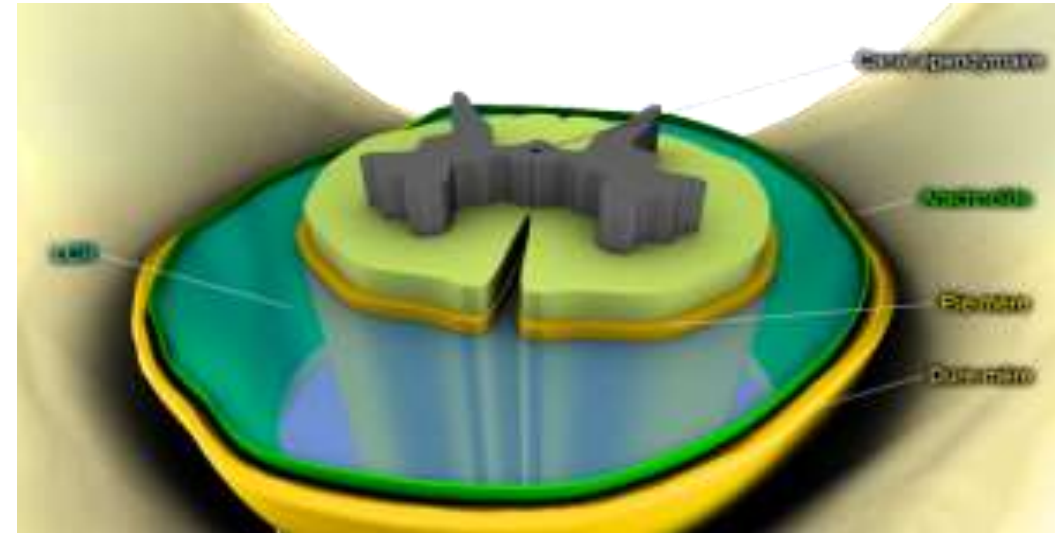
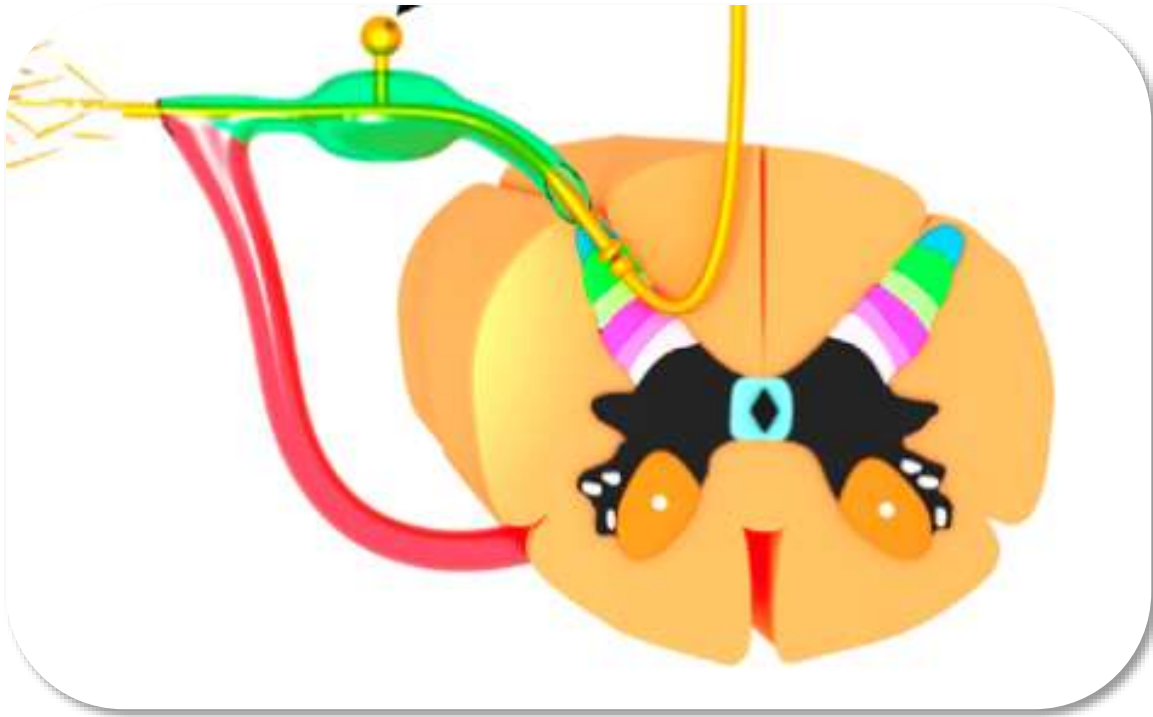


Anatomic variations
of the conus medullaris

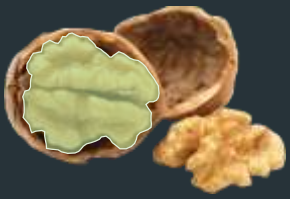
L'Anatomie est extrêmement variable !



En micro...

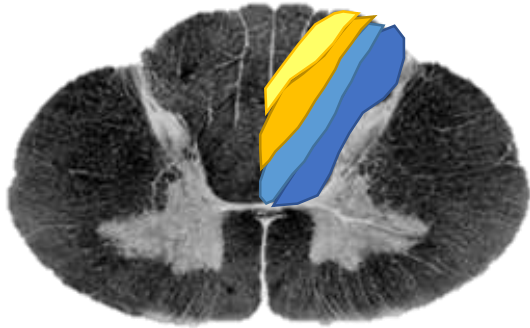


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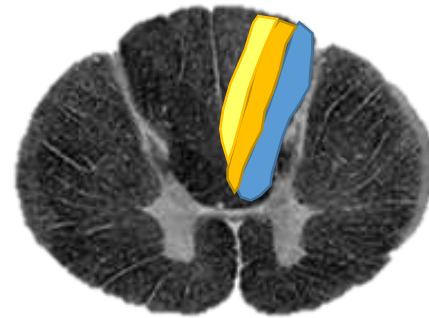


En micro...

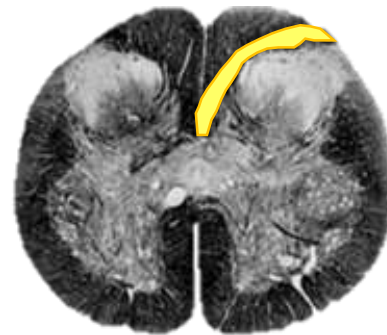
Cervical



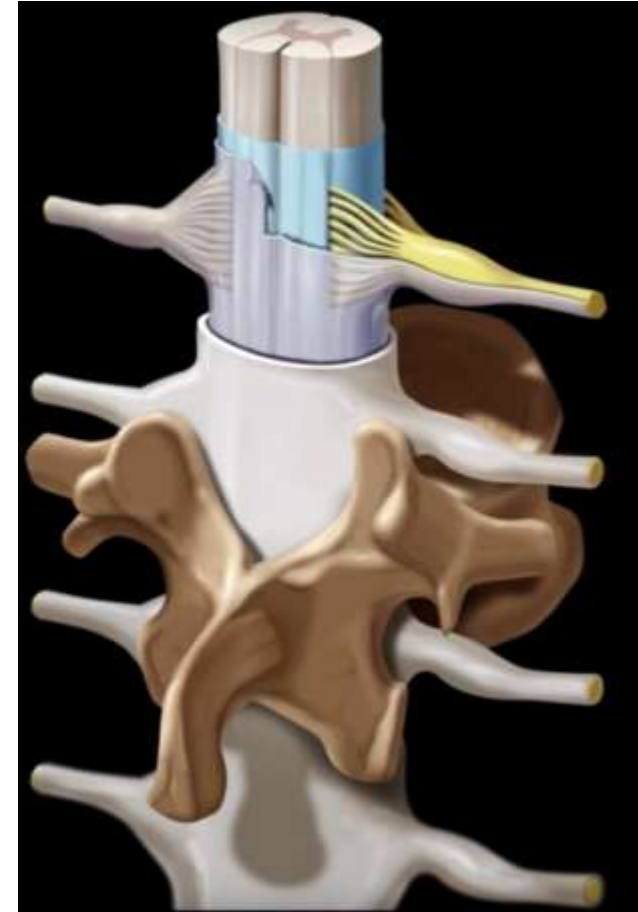
Thoracic



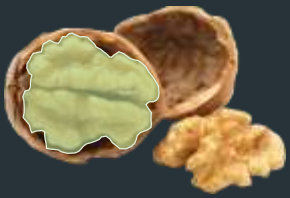
Lumbar



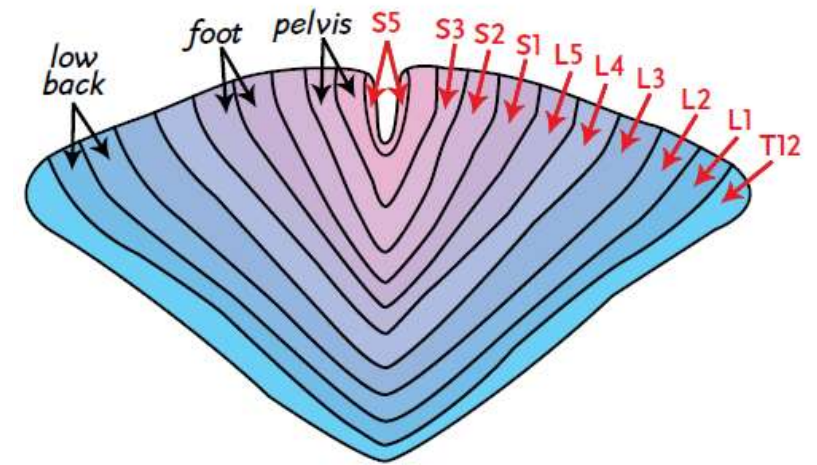
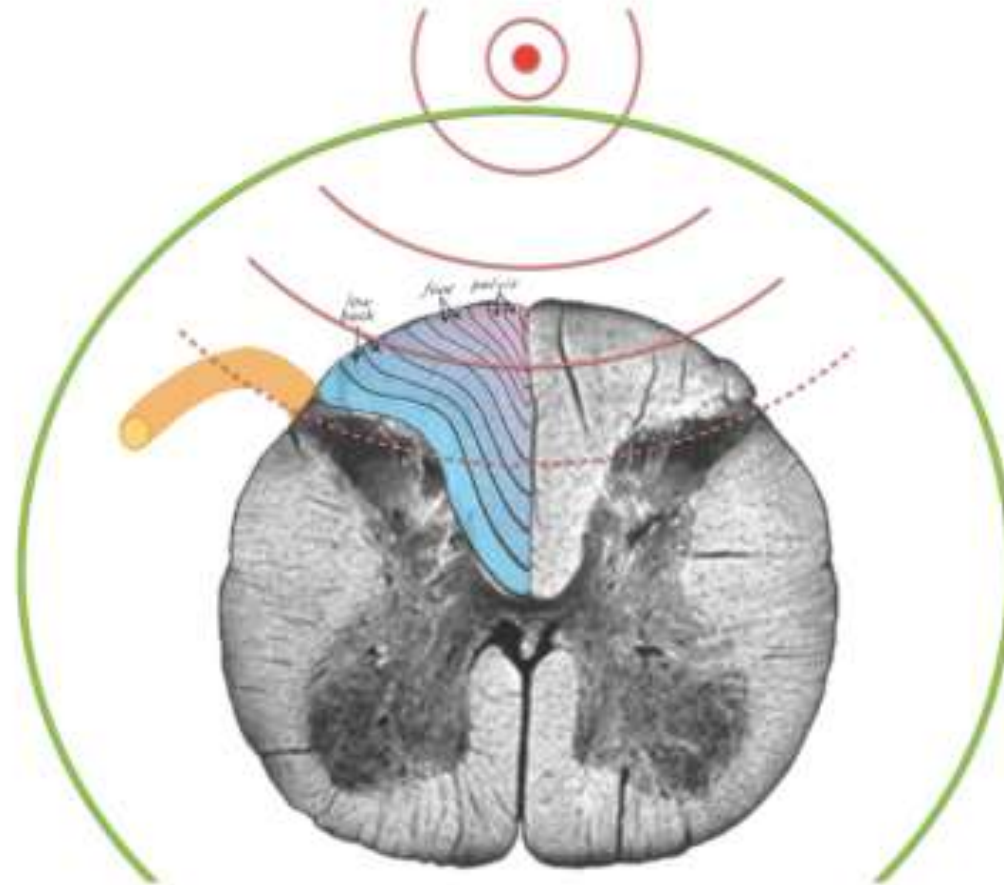
Sacral



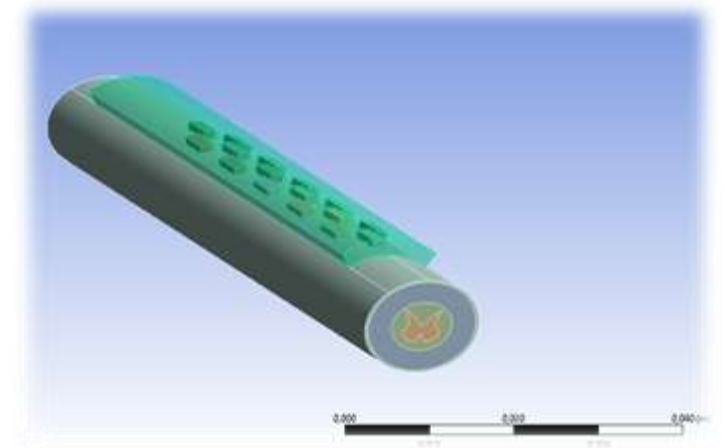
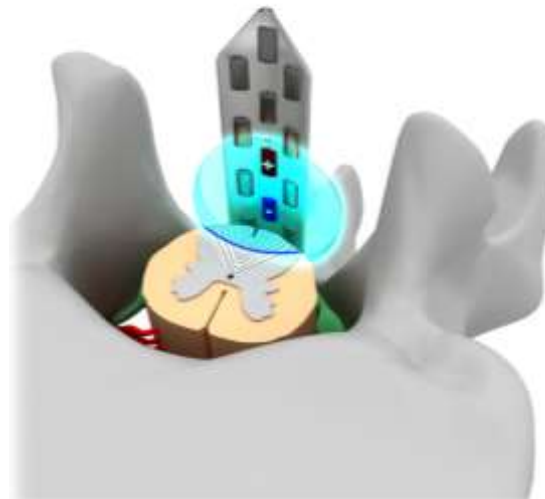
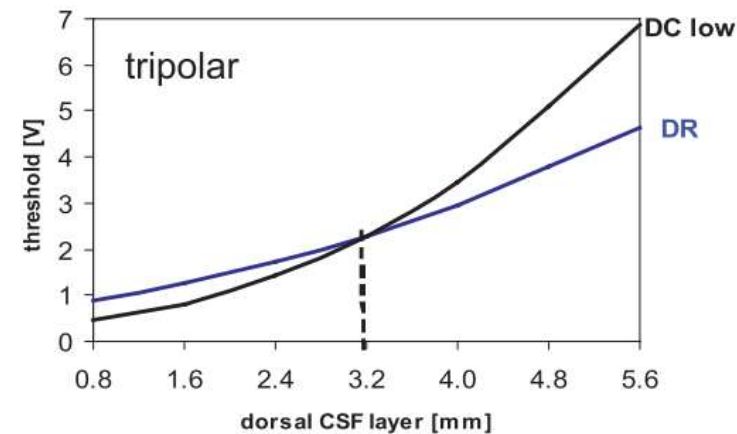
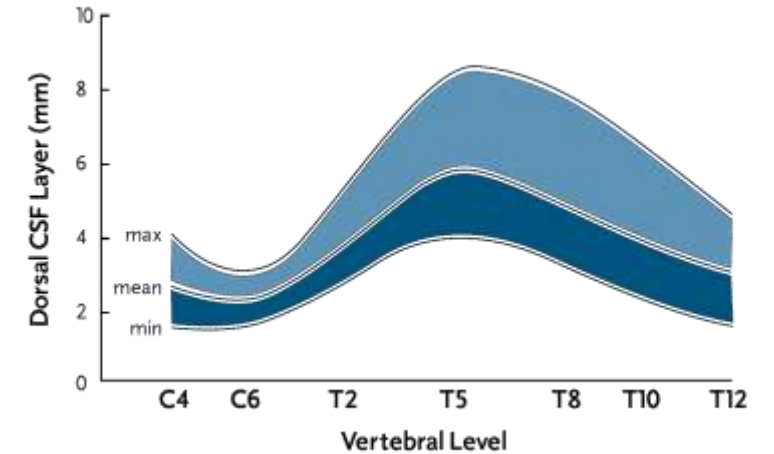
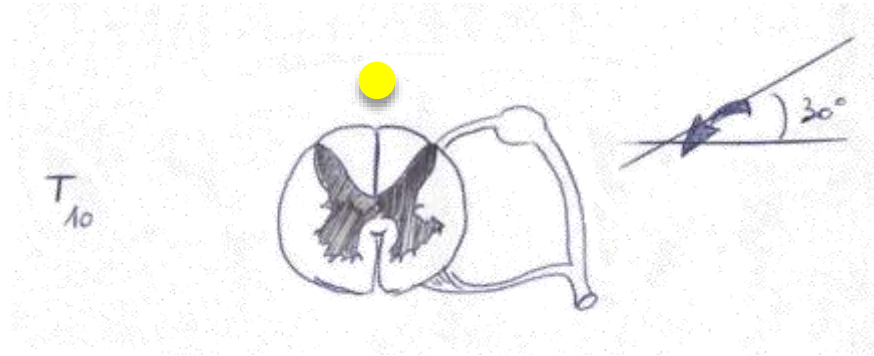
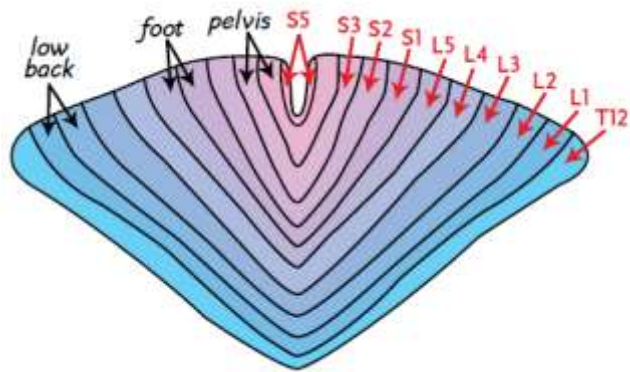
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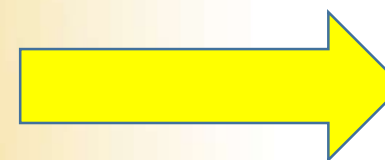
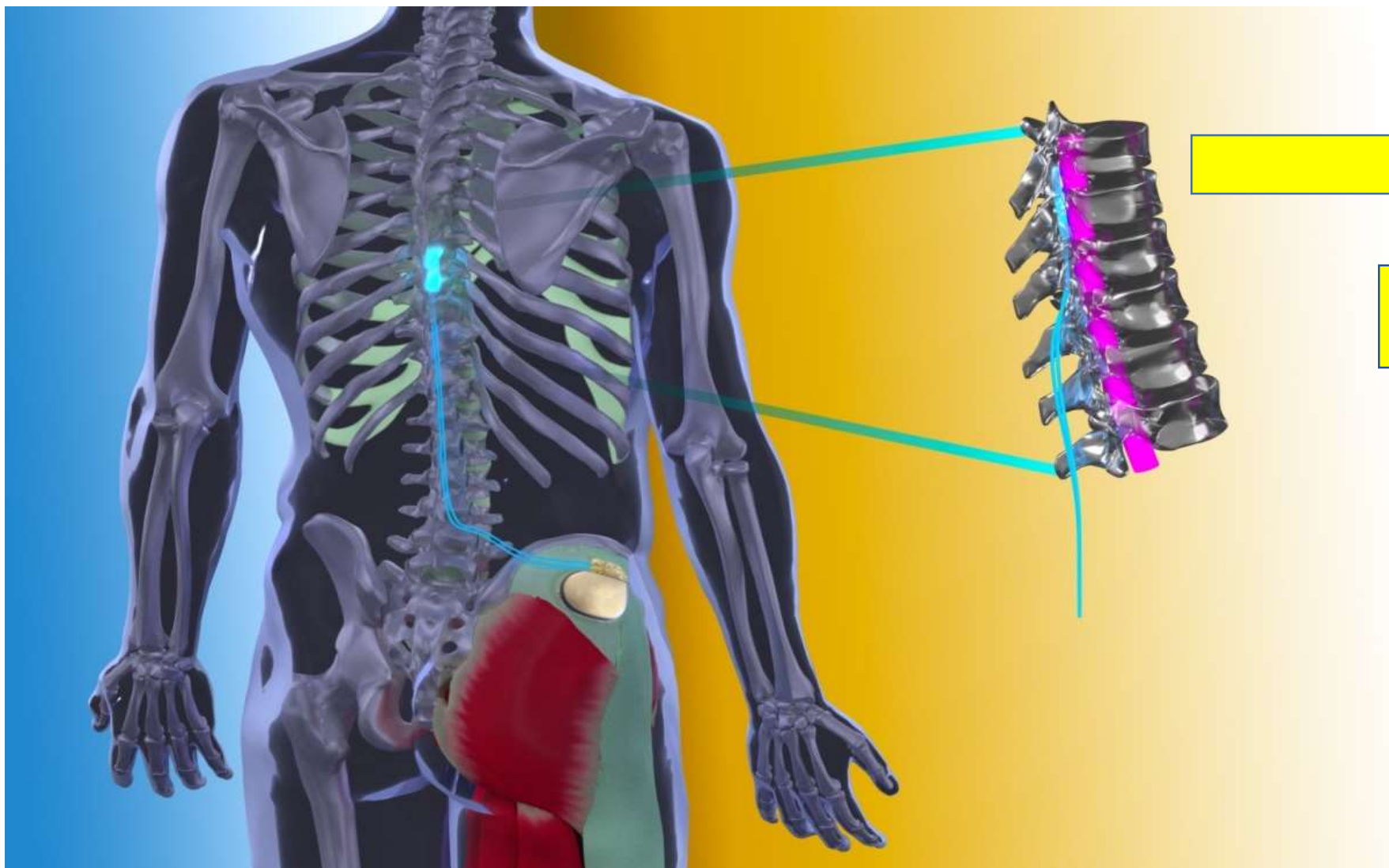


En micro...



PARAMÈTRES ANATOMIQUES A INTÉGRER

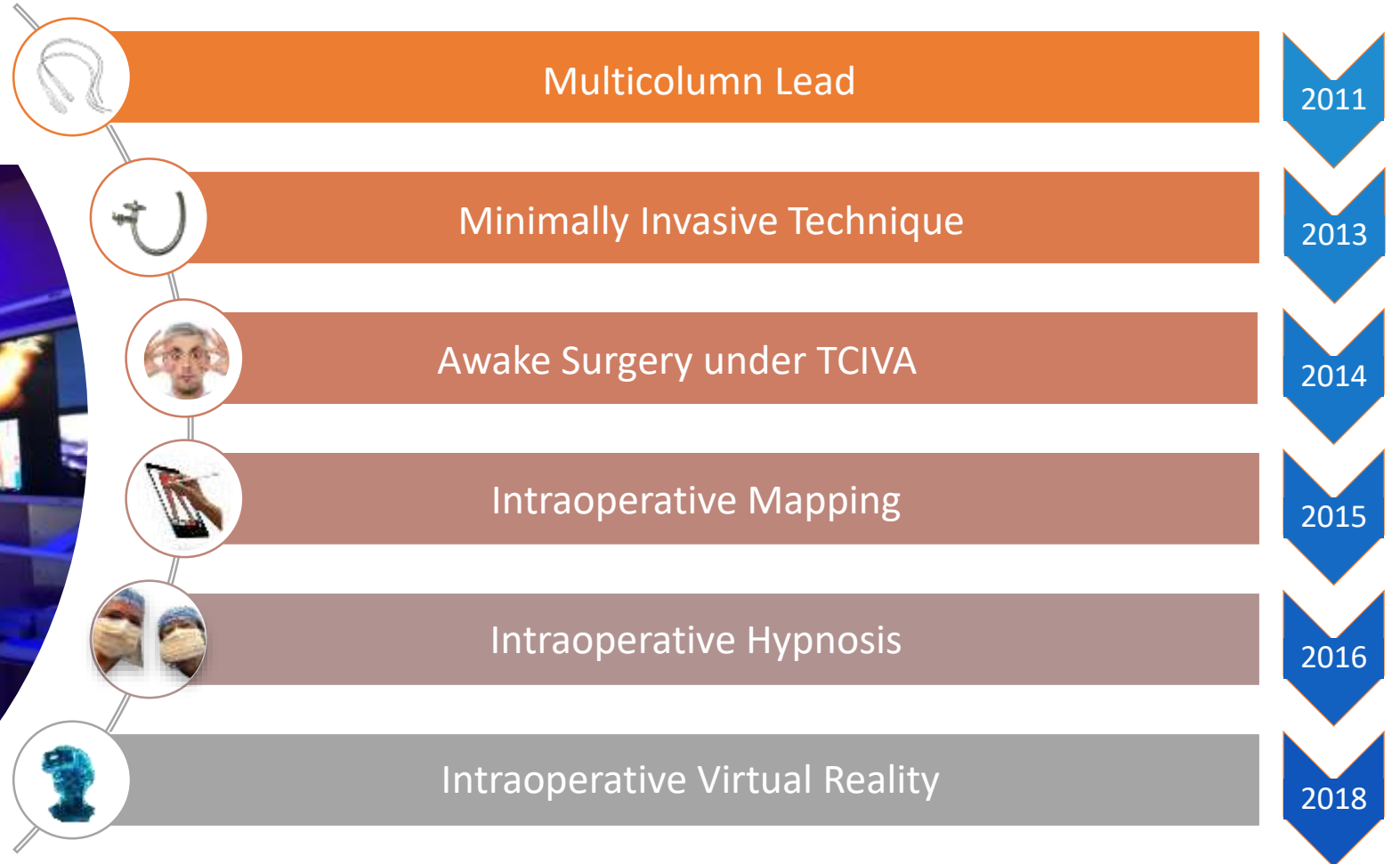




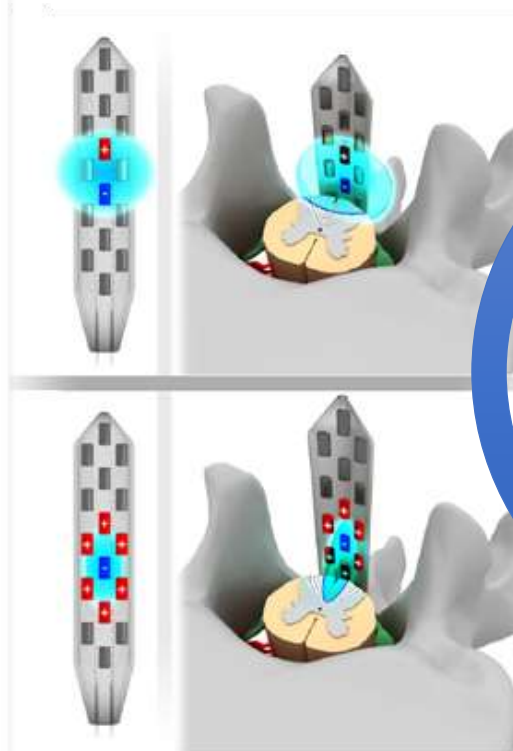
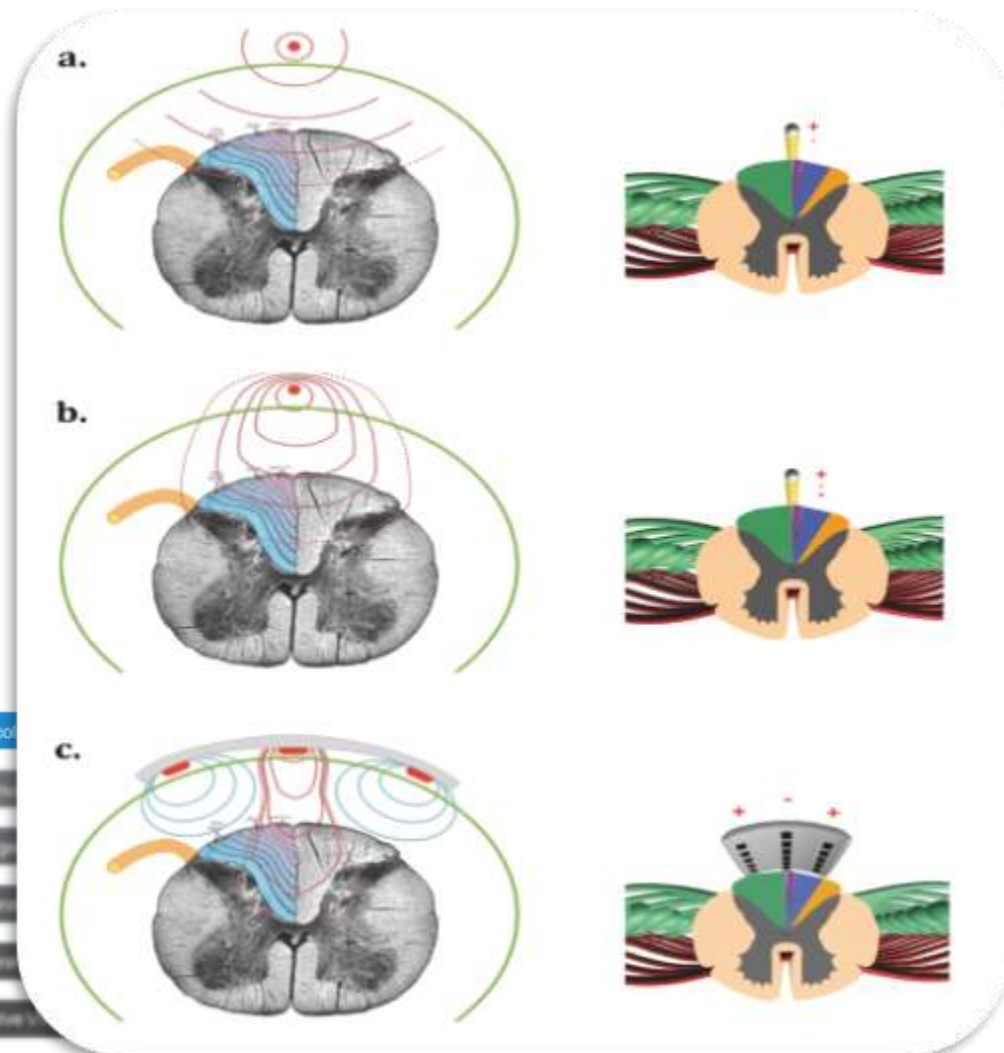
RÉSOLUTION SPATIALE

ELECTRODE

Technological Innovations to optimize lead implantation



ELECTRODES CHIRURGICALES MULTICOLONNES



Observational Study | Pain Pract. 2015;15(3):195-207. doi:10.1111/papr.12172. Epub 2014 Feb 27.

An algorithmic programming approach for back pain symptoms in failed back surgery syndrome using spinal cord stimulation with a multicolumn surgically implanted epidural lead: a multicenter international prospective study

Rigoard P, Basu S, Desai M, et al. *Pain Pract.* 2015;15(3):195-207. doi:10.1111/papr.12172.

Neuromodulation. 2020 Aug 31. doi:10.1111/ner.13251. Online ahead of print.

How Should we Use Multicolumn Spinal Cord Stimulation to Optimize Back Pain Spatial Neural Targeting? A Prospective, Multicenter, Randomized, Double-Blind, Controlled Trial (ESTIMET Study)

Philippe Rigoard ^{1,2,3,4}, Maxime Billot ⁵, Pierre Ingrand ⁶, Babette Durand-Zaleski ⁷, Manuel Roulaud ⁸, Philippe Fenuzzi ⁹, Phong Dam Hieu ¹⁰, Jimmy Voisin ¹¹, Sylvie Rault ¹², Philippe Page ¹³, Marie-Christine Djan ¹⁴, Denis Fontaine ^{15,16}, Michel Lantieri-Minet ^{17,18,19}, Serge Blond ²⁰, Nadia Buisser ²¹, Emmanuel Cury ²², Myriam Cademine ²³, François Calvi ²⁴, Danièle Rancou ²⁵, Patrick Mertens ²⁶, Hussein Nabou ²⁷, Emile Simon ²⁸, Evelyne Emery ²⁹, Guillaume Béraud ³⁰, Françoise Deblais ³¹, Géraldine Durand ³², Alain Serrie ³³, Bakari Diallo ³⁴, Julie Bulot ³⁵, Amine Ounajm ³⁶, Kevin Nivole ³⁷, Sophie Duranton ³⁸, Nicolas Faldut ³⁹, Olivier Morlezen ⁴⁰, Benoit Bataille ⁴¹

Affiliations + expand

PMID: 32853444 DOI: 10.1111/ner.13251

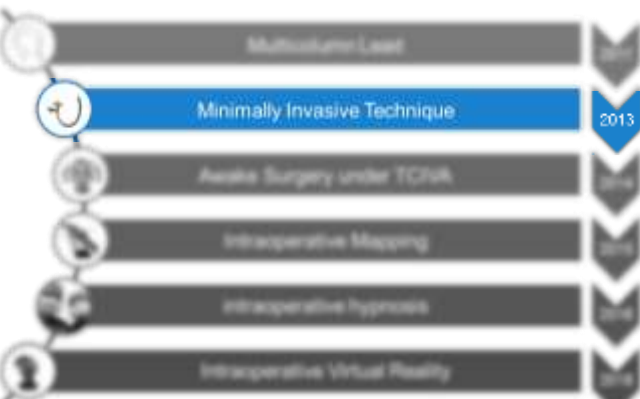
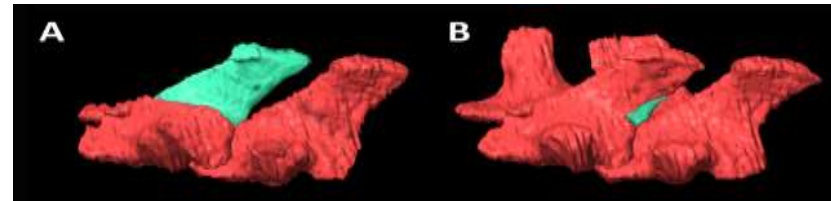
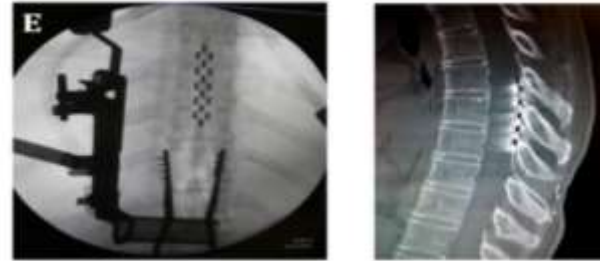
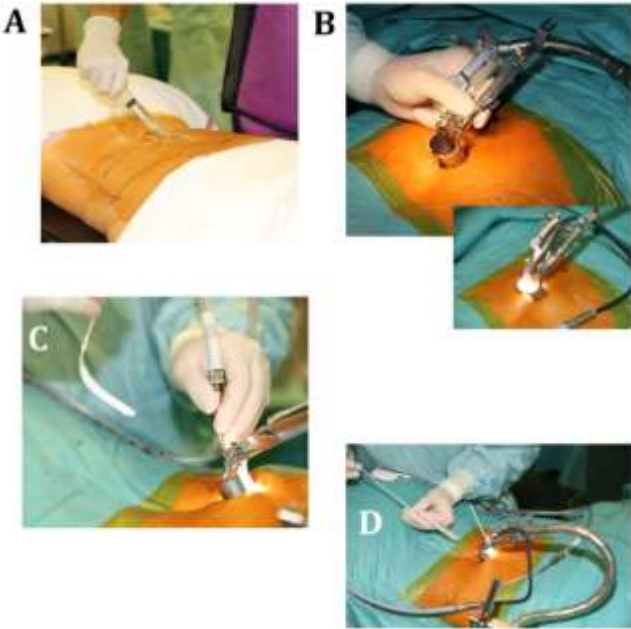
Multicolumn Spinal Cord Stimulation to Optimize Back Pain Spatial Neural Targeting? A Prospective, Multicenter, Randomized, Double-Blind, Controlled Trial (ESTIMET Study). *Neuromodulation*. 2020;10.1111/ner.13251. doi:10.1111/ner.13251

A prospective study evaluating sleep quality in Failed Back Surgery Syndrome patients treated by multicolumn spinal cord stimulation: study design protocol and presentation of the study population

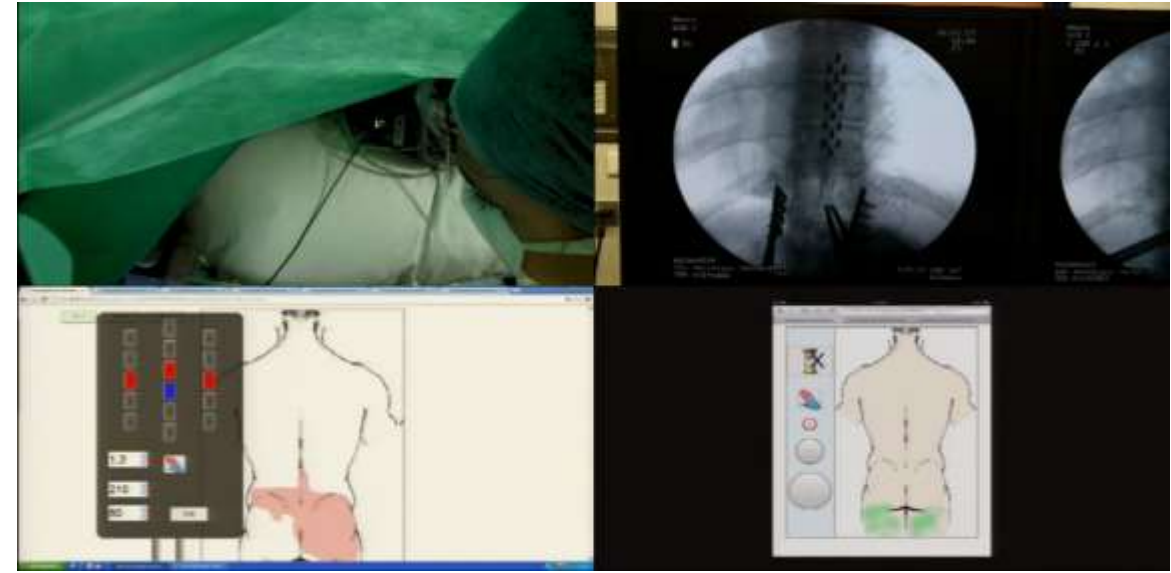
O Moukoko ¹, E Lode-kuit ², M Roulaud ³, J Piquereau ⁴, P Ingrand ⁵, C Veyries ⁶, C Baisset ⁷, F Guetani ⁸, A Pélissier ⁹, B Bataille ¹⁰, P Rigoard ¹¹, le groupe Estimet



Minimally Invasive Spinal Techniques (MAST)



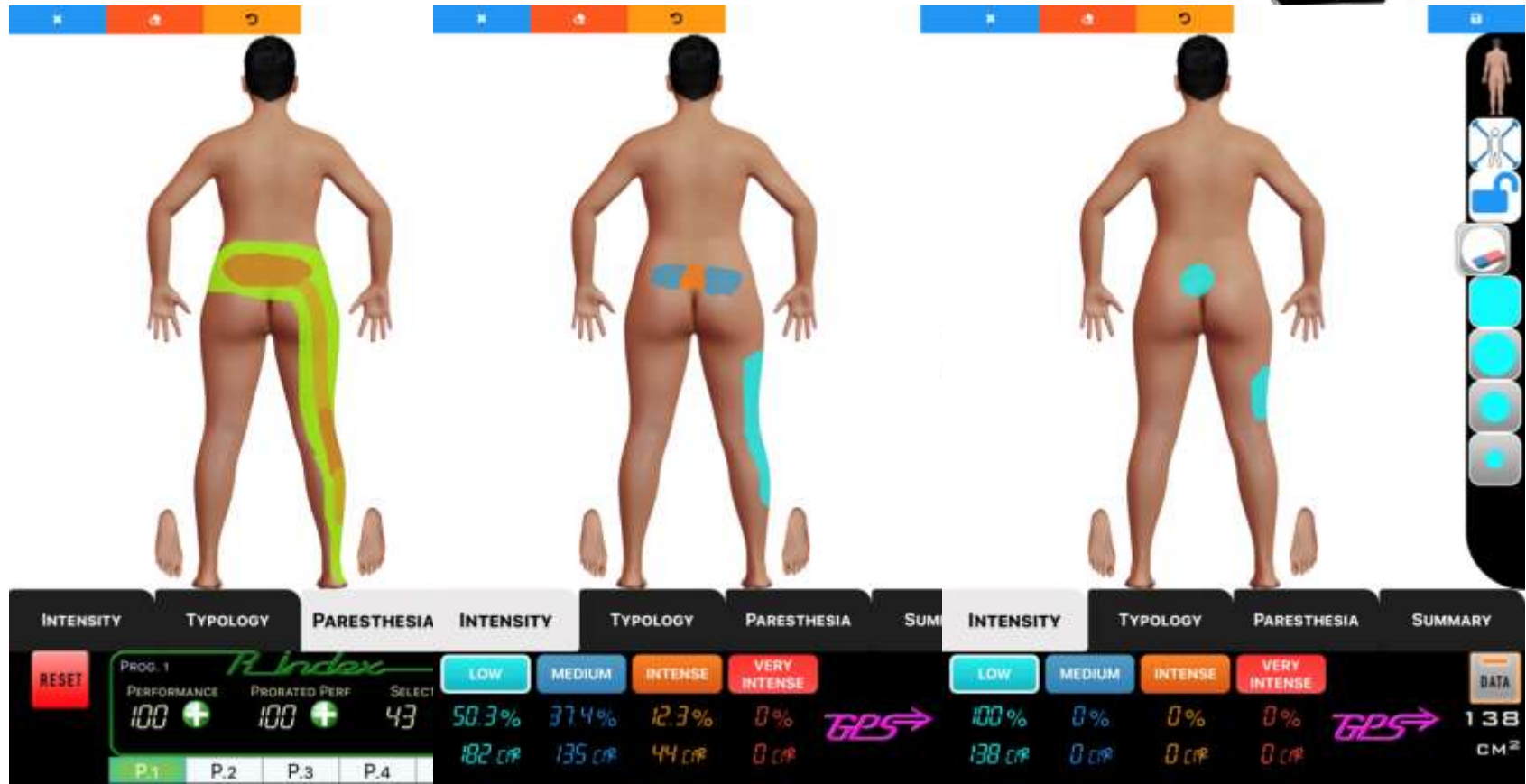
AIVOC & Mapping intra-opératoire



Pain
Intensity

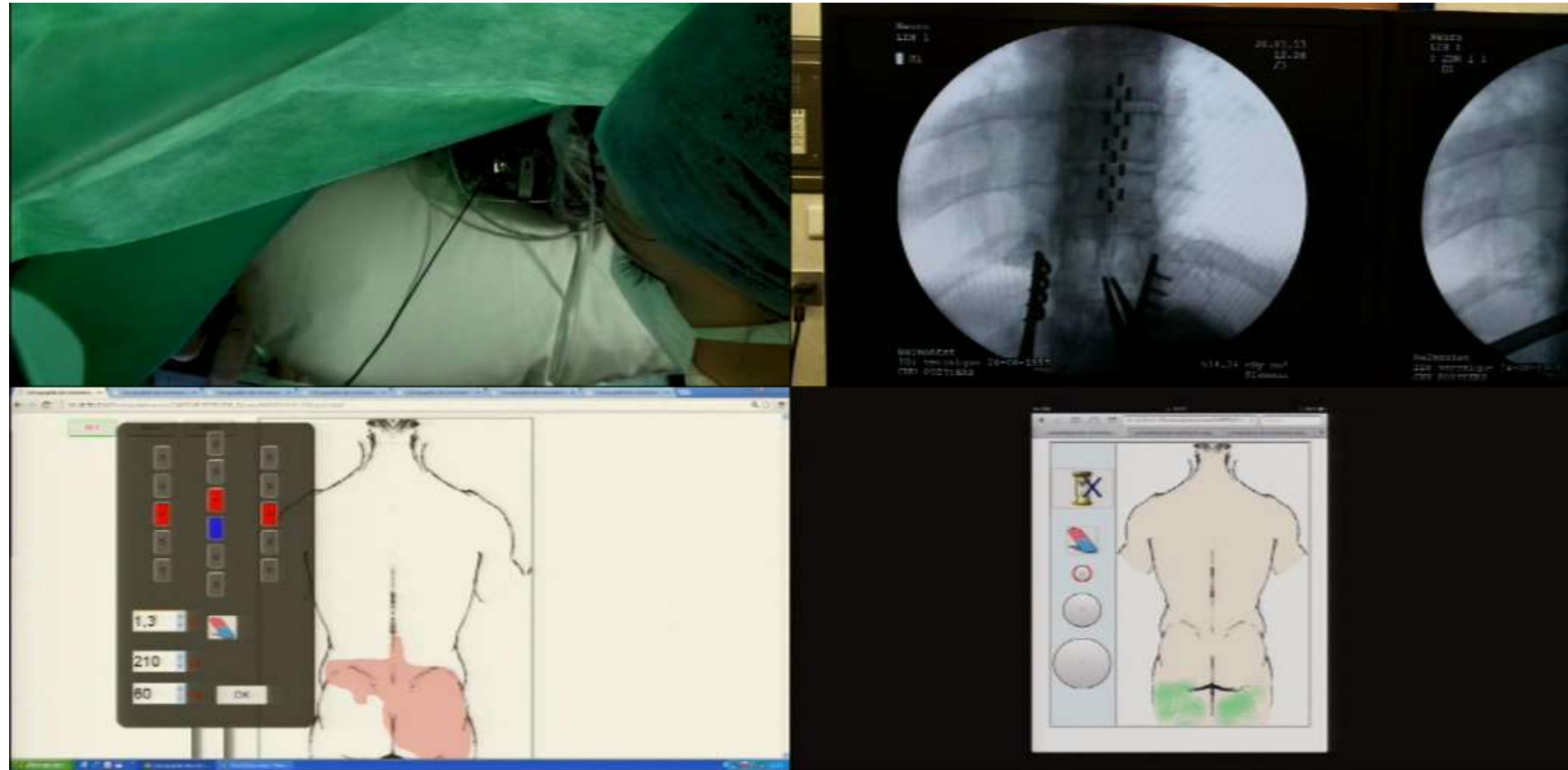
Pain
Typology

Pain
Surface

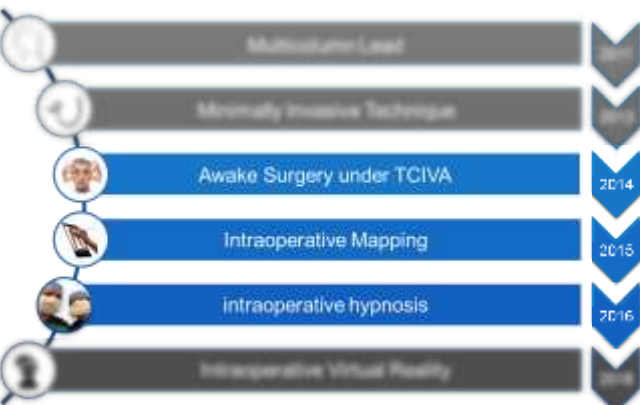
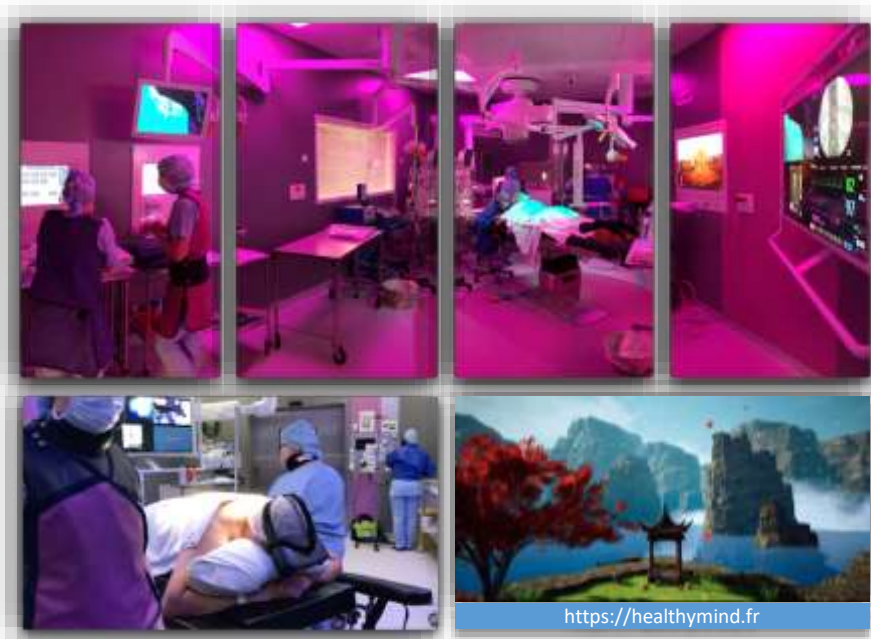


La technologie au service du patient...

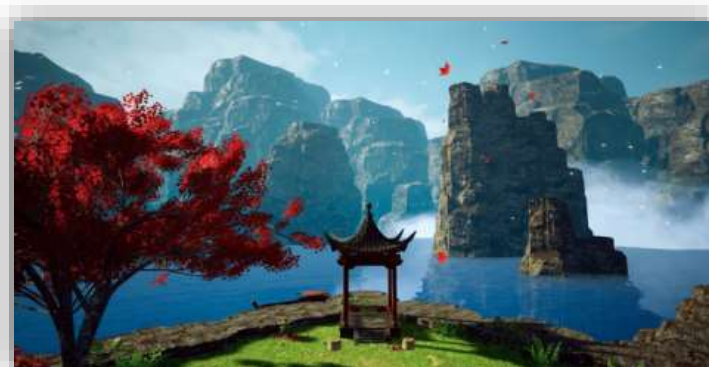
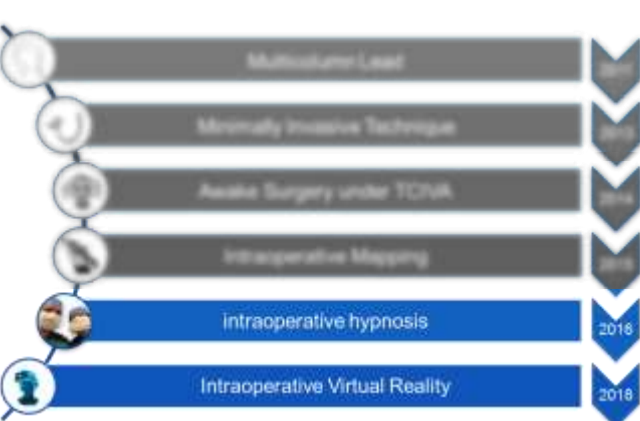
TCIVA & IntraOperative Mapping



AIVOC & Hypnose Intra-opératoire



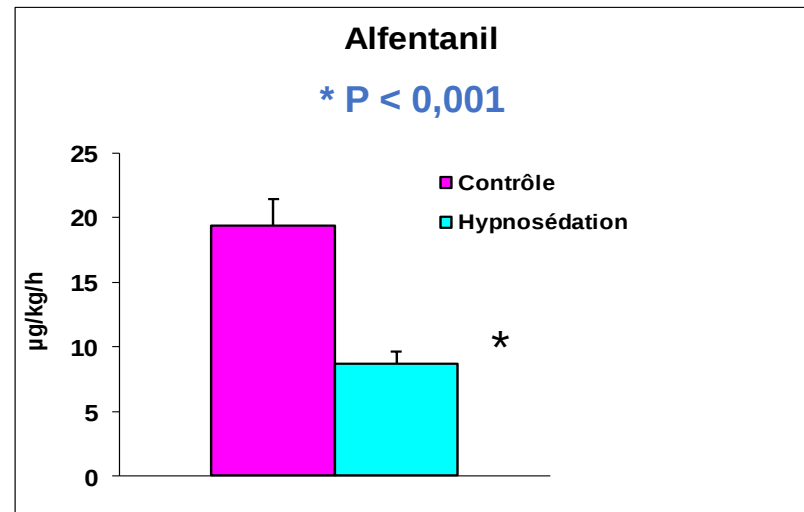
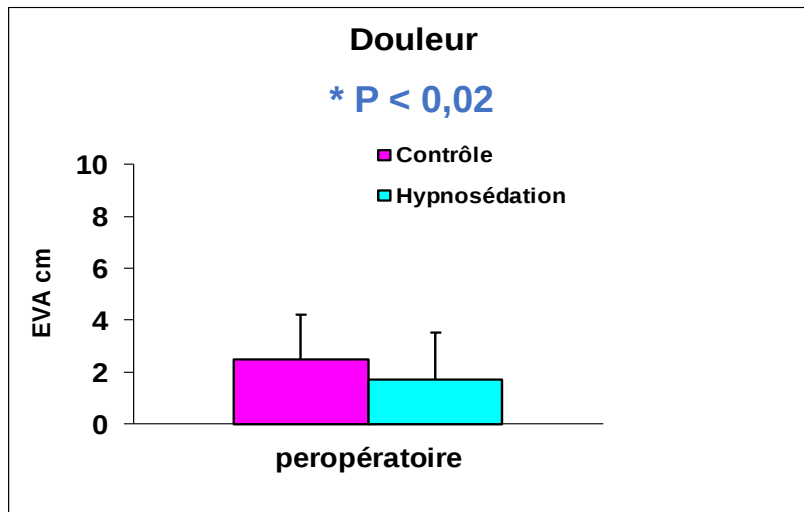
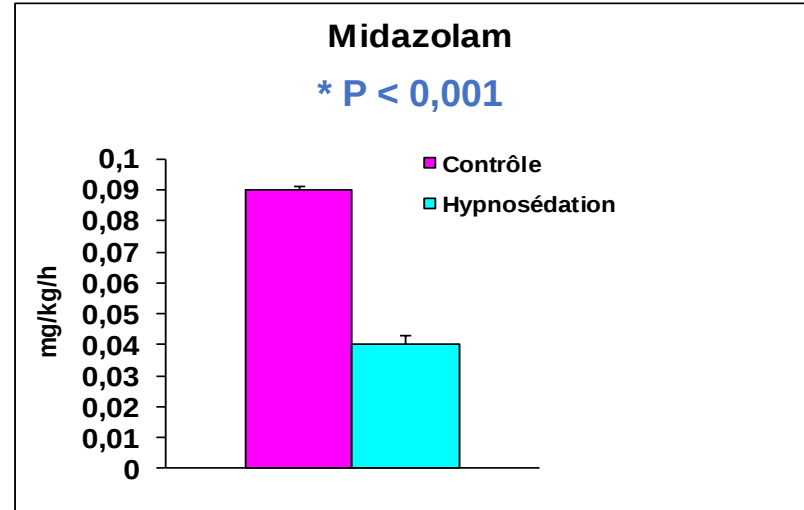
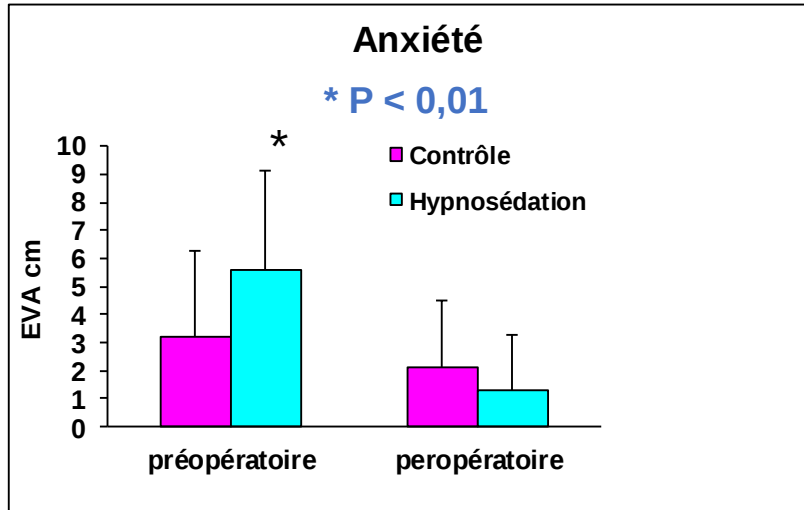
AIVOC, Hypnose & Réalité Virtuelle

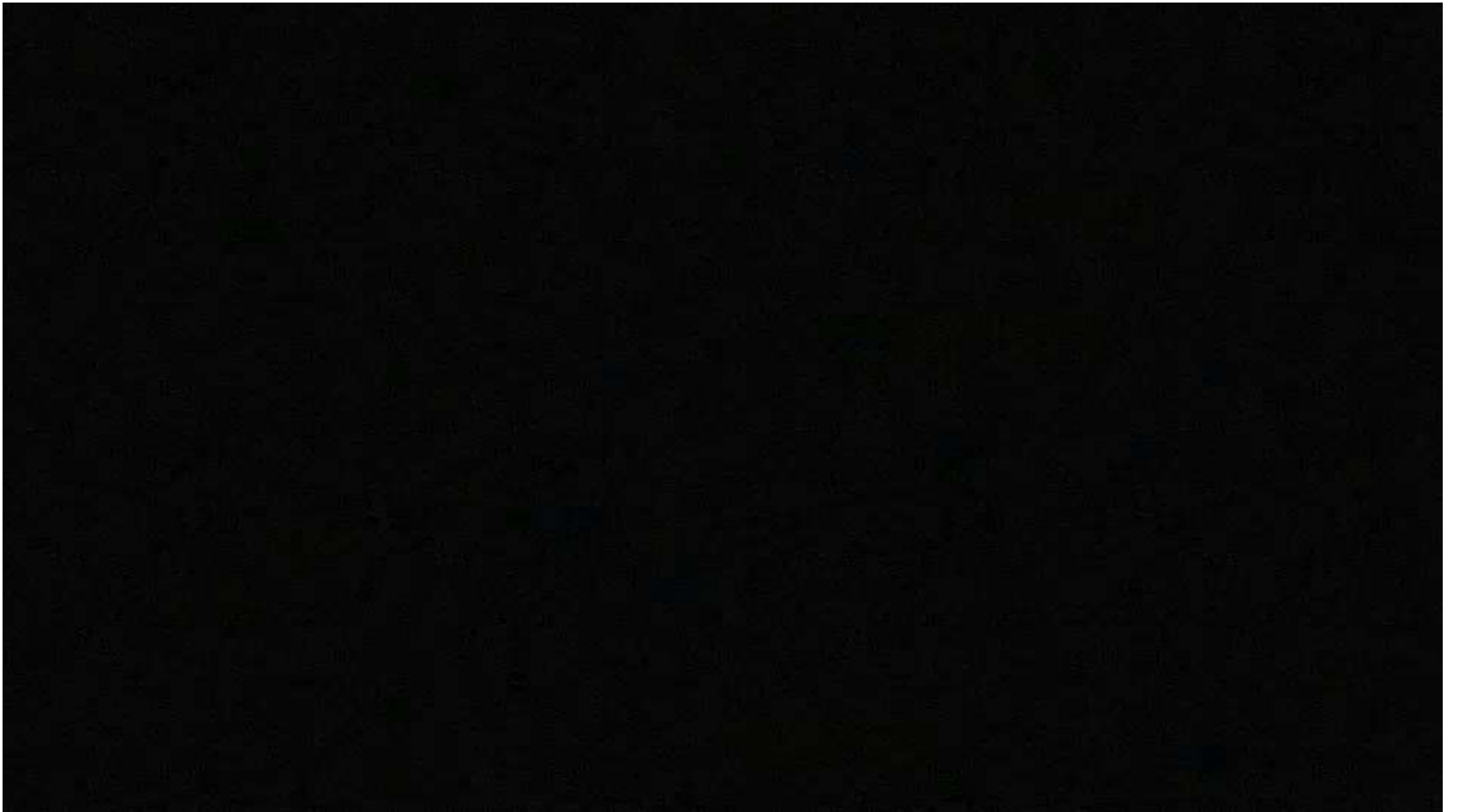




Hypnose intra-opératoire Comment ça marche ?

Hypnosedation for plastic surgery





Hypnose et AIVOC

46

- Coopération de toute l'équipe
 - Fondamentale
 - Dans leurs attitudes verbales et non verbales
- Plus de confort pour tout le monde, chirurgien compris
- L'alliance avec le patient est fondamentale :
 - Si possible, rencontrer le patient avant la chirurgie
 - Expliquer l'importance de la focalisation sur autre chose: technique du gant magique, augmenter l'analgésie du dos
 - Toucher interactif durant la chirurgie pour augmenter la concentration du patient sur autre chose
 - Participation active du patient ++++



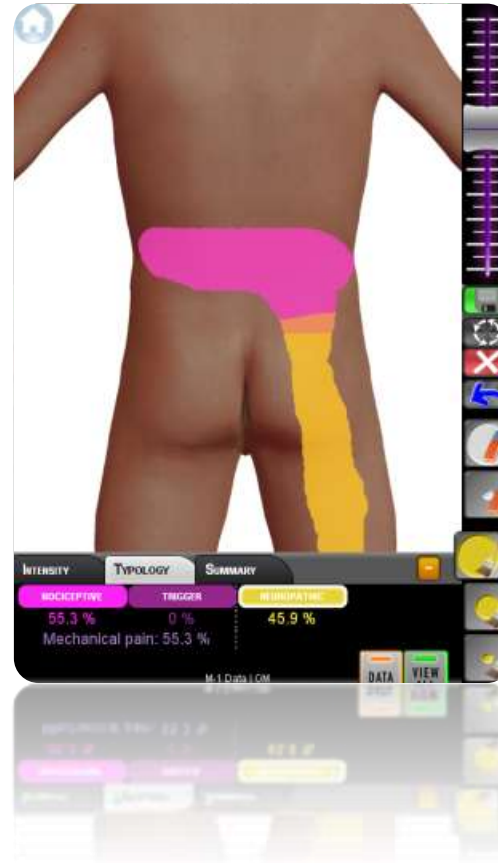
Synthèse:

47



• Pour le chirurgien :

- Critères objectifs d'évaluation du positionnement de l'électrode et de la couverture initiale
- Critères objectifs de comparabilité des techniques au moment de l'implantation
- Décision per-opératoire de préparer d'emblée la logette du boîtier ou **pas**



➤ Pour l'hypnothérapeute :

- L'hypnose ainsi utilisée en chirurgie est différente de l'hypnosédation et aide à améliorer le placement exact de l'électrode
- Les patients rapportent un **grand confort, une douleur minimale, et surtout une expérience agréable**
- **Ambiance agréable** plébiscitée par les professionnels
- Cette prise en charge est **le travail de toute une équipe**

What's Hot in 2020-2021 ?

Adaptive close-loop stimulation:

Could we automatically adjust stimulation?

THE LANCET Neurology

Volume 19, Issue 2, February 2020, Pages 123-134

> Lancet Neurol, 19 (2), 123-134 Feb 2020

Long-term Safety and Efficacy of Closed-Loop Spinal Cord Stimulation to Treat Chronic Back and Leg Pain (Evoke): A Double-Blind, Randomised, Controlled Trial

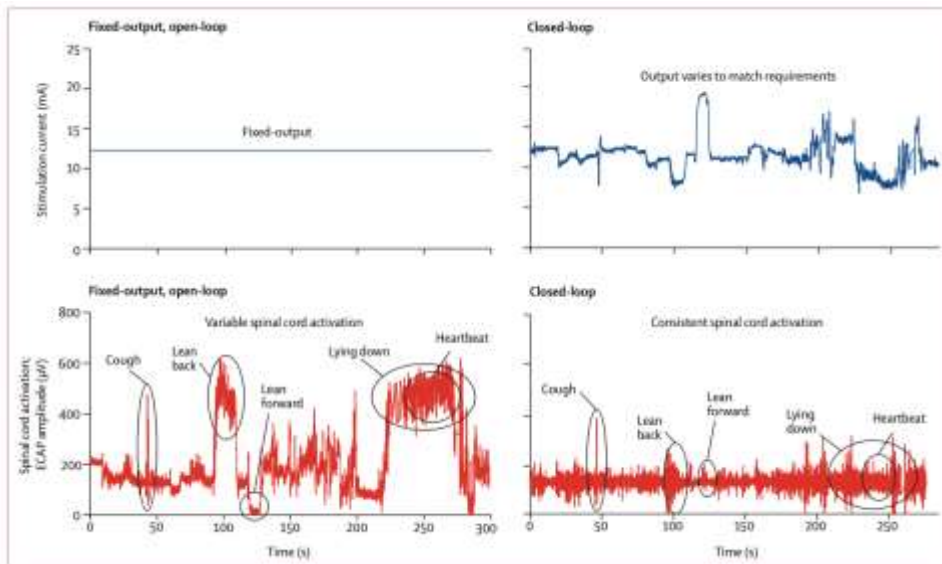
Nagy Mekhail¹, Robert M Levy², Timothy R Deer³, Leonardo Kapural⁴, Sean Li⁵, Kasra Amirdelfan⁶, Corey W Hunter⁷, Steven M Rosen⁸, Shrif J Costandi⁹, Steven M Falowski¹⁰, Abram H Burgher¹¹, Jason E Pope¹², Christopher A Gilmore¹³, Farooq A Qureshi¹⁴, Peter S Staats⁵, James Scowcroft¹⁵, Jonathan Carlson¹⁶, Christopher K Kim³, Michael I Yang¹⁷, Thomas Stauss¹⁸, Lawrence Poree¹⁹, Evoke Study Group



The EVOKE study: main results

49

Prospective, multicentric, parallel-arm,
randomized, double-blind, controlled study,
comparing
**closed-loop VS open-loop
stimulation**



n=134 (67 in each group)

12 months

	Closed-loop group	Open-loop group	Difference (95% CI)	p value
VAS percentage change from baseline*				
Overall pain	72.3% (29.0)	56.2% (38.5)	16.0% (3.6 to 28.5)	0.012
Back pain (hierarchical secondary outcome)	69.4% (30.6)	54.0% (39.5)	15.4% (2.5 to 28.3)	0.0205
Leg pain (hierarchical secondary outcome)	72.9% (31.0)	62.1% (37.5)	10.7% (-1.8 to 23.3)	0.00071

EVOKE study main conclusions:

**Higher pain relief in
Back and Leg Pain with closed-loop**

**Sustained effect of closed-loop SCS
at 12 months**

Mekhail, et al. Long-term safety and efficacy of closed-loop spinal cord stimulation to treat chronic back and leg pain (Evoke): a double-blind, randomised, controlled trial. The Lancet Neurology, 2020.

2ème focus: Le système nerveux autonome

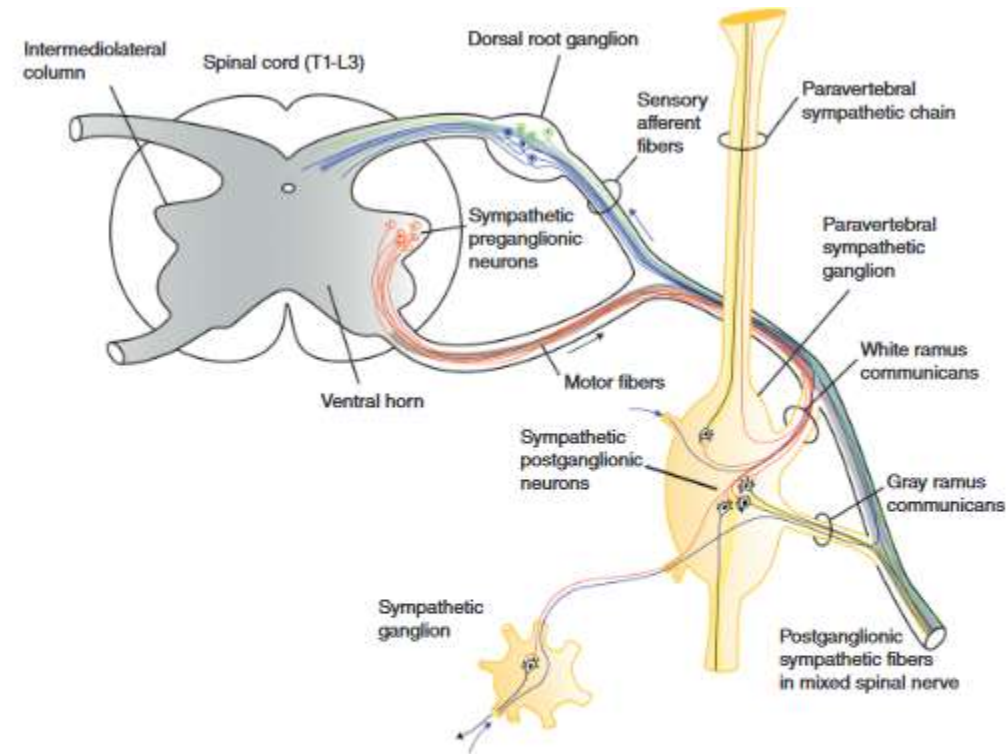
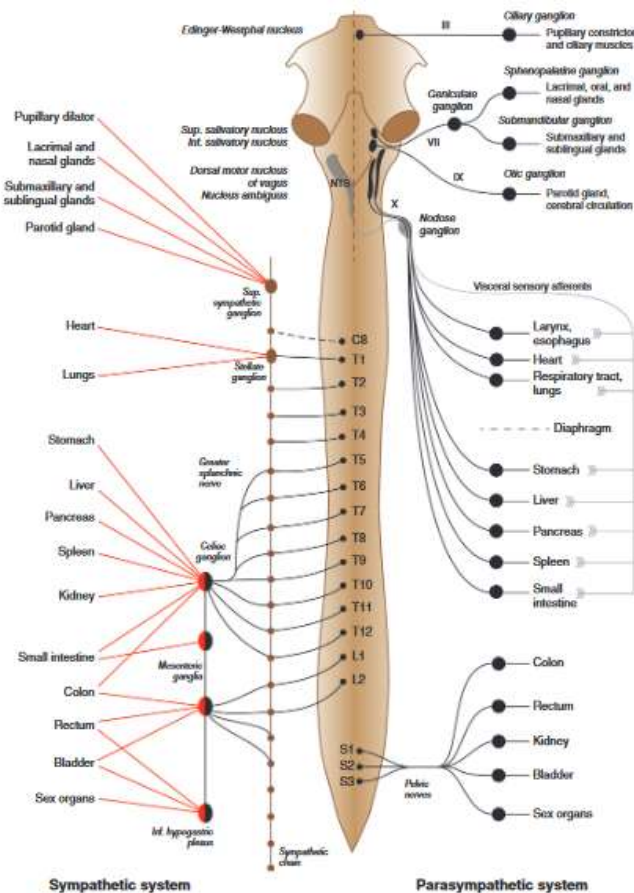
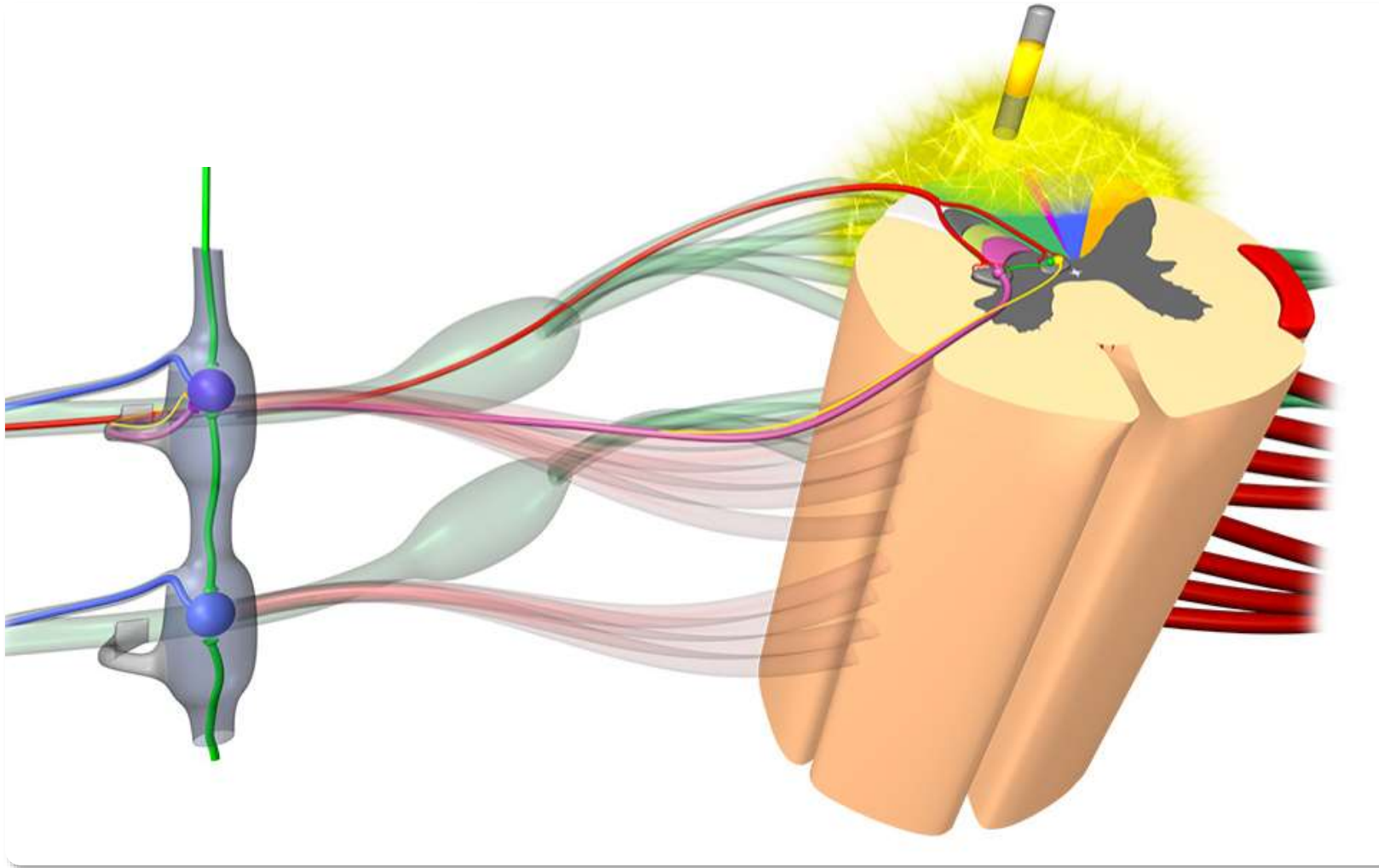


Figure 2 Projections of sympathetic preganglionic neurons to paravertebral or prevertebral ganglia or the adrenal medulla. The axons of sympathetic preganglionic neurons leave the spinal cord at the segment of origin of their cell bodies within the IML column. These fibers exit via the ventral root with the axons of α - and γ -motor neurons; sympathetic preganglionic fibers separate from the ventral root to form the white ramus to then terminate on postganglionic neurons in the adjacent or distant paravertebral ganglia or in prevertebral ganglia in the abdominal and pelvic region. Another possible trajectory is to terminate on chromaffin cells in the adrenal medulla (not shown). Visceral sensory afferents are intermingled with sympathetic efferent fibers and travel with somatic afferents via the dorsal root to terminate in the spinal cord dorsal horn. Preganglionic nerves are shown in red, postganglionic nerves are shown in black, visceral sensory afferents are shown in blue, and somatic afferents are shown in green.

Basic Anatomy & Physiology



The autonomous nervous system

Another example: CRPS

Thermogram in spinal cord stimulation with complex regional pain syndrome and a review of the literature

Billy Keon Huh MD, PhD, Chan-Hong Park MD, PhD, Matthew Ranson MD, Garlon Lee Campbell MD, Jason Ravanbakht MD

Abstract

Introduction: Spinal cord stimulation (SCS) is an efficient procedure for treatment of intractable pain.

Methods: We present a patient who underwent SCS lead placement for severe left lower extremity pain. The patient had experienced good pain. He underwent thermographic imaging before, just after and ten days later of procedure.

Results: Thermogram study revealed from blue color (hypothermic) pattern at before procedure to reddish or pink color (hyperthermic) pattern at ten days later.

Discussion: SCS may be increase microcirculation and seems to have sympatholytic effects.

Conclusion: We experienced that improvement of blood flow as result of SCS in CRPS.

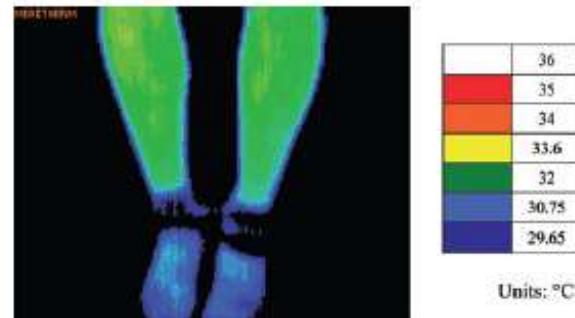


Figure 1. Thermographic image of both legs before spinal cord stimulation. Hypothermia is shown on both legs.

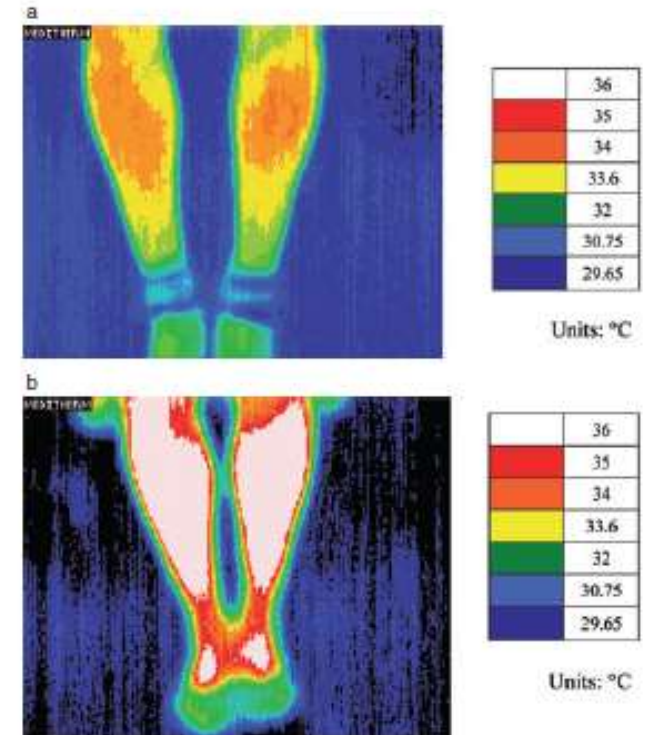
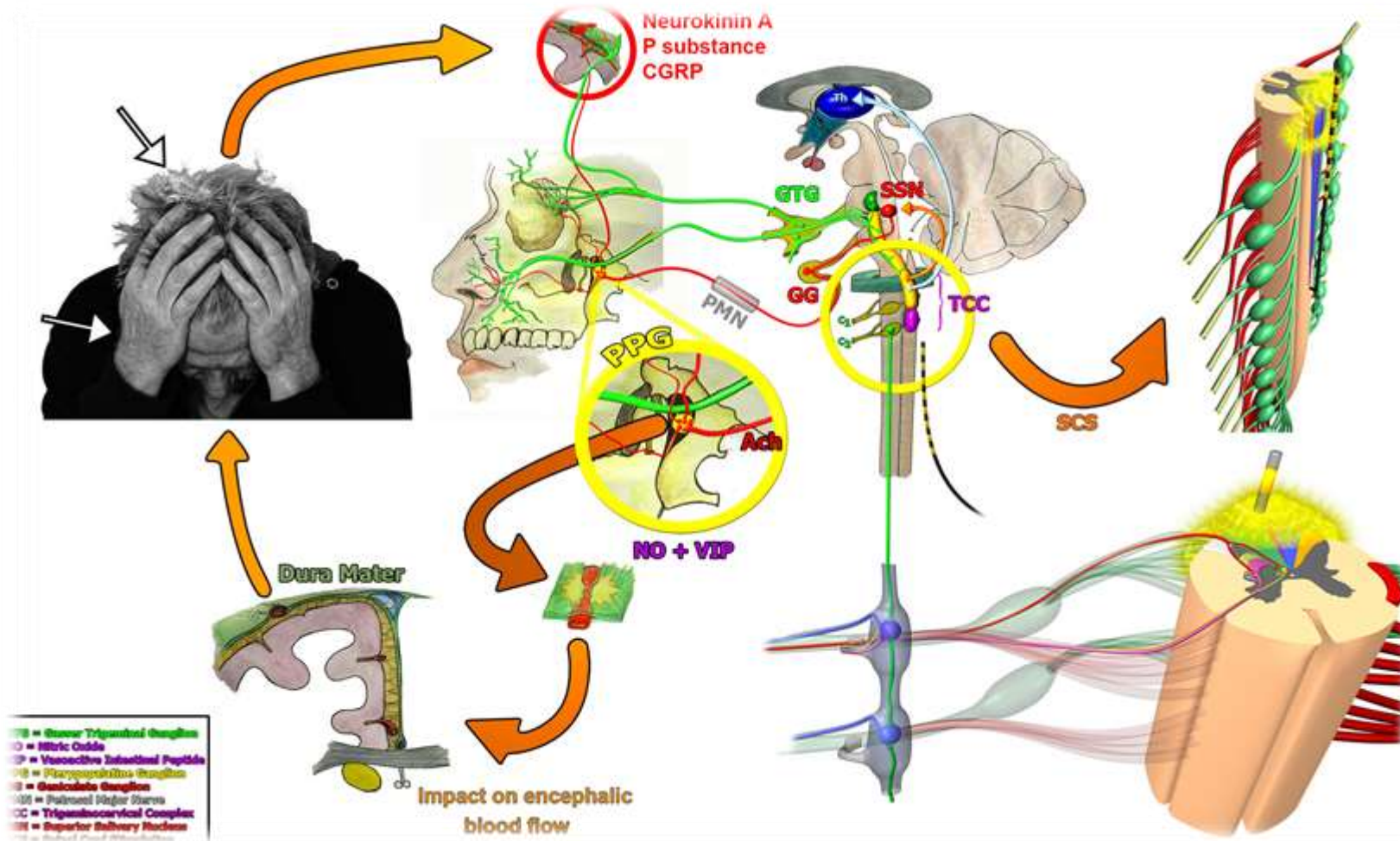
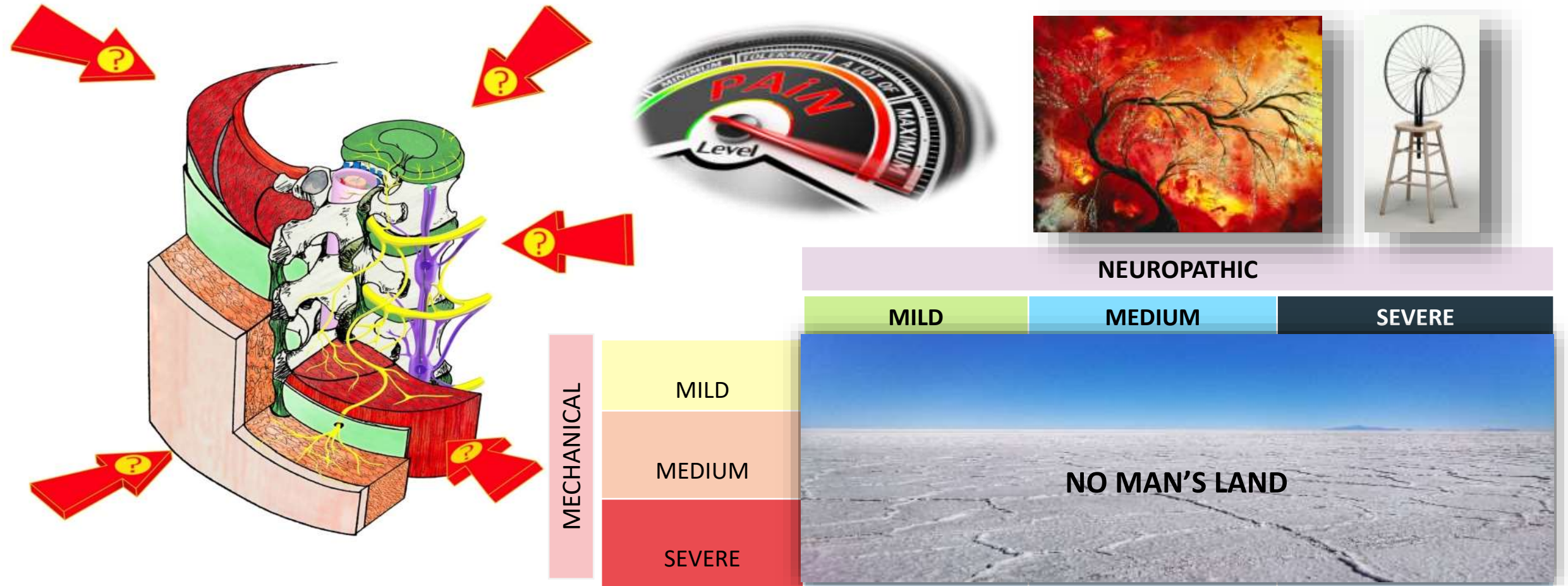


Figure 2. (a) This image shown both legs temperature increased just after spinal cord stimulation. (b) Spinal cord stimulation after ten days is shown both leg hyperthermias.

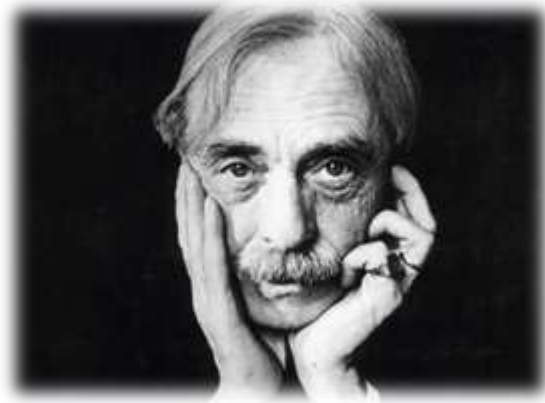
Anatomy, physiology and neurobiology of the nociception



3ème Focus, la complexité du dos

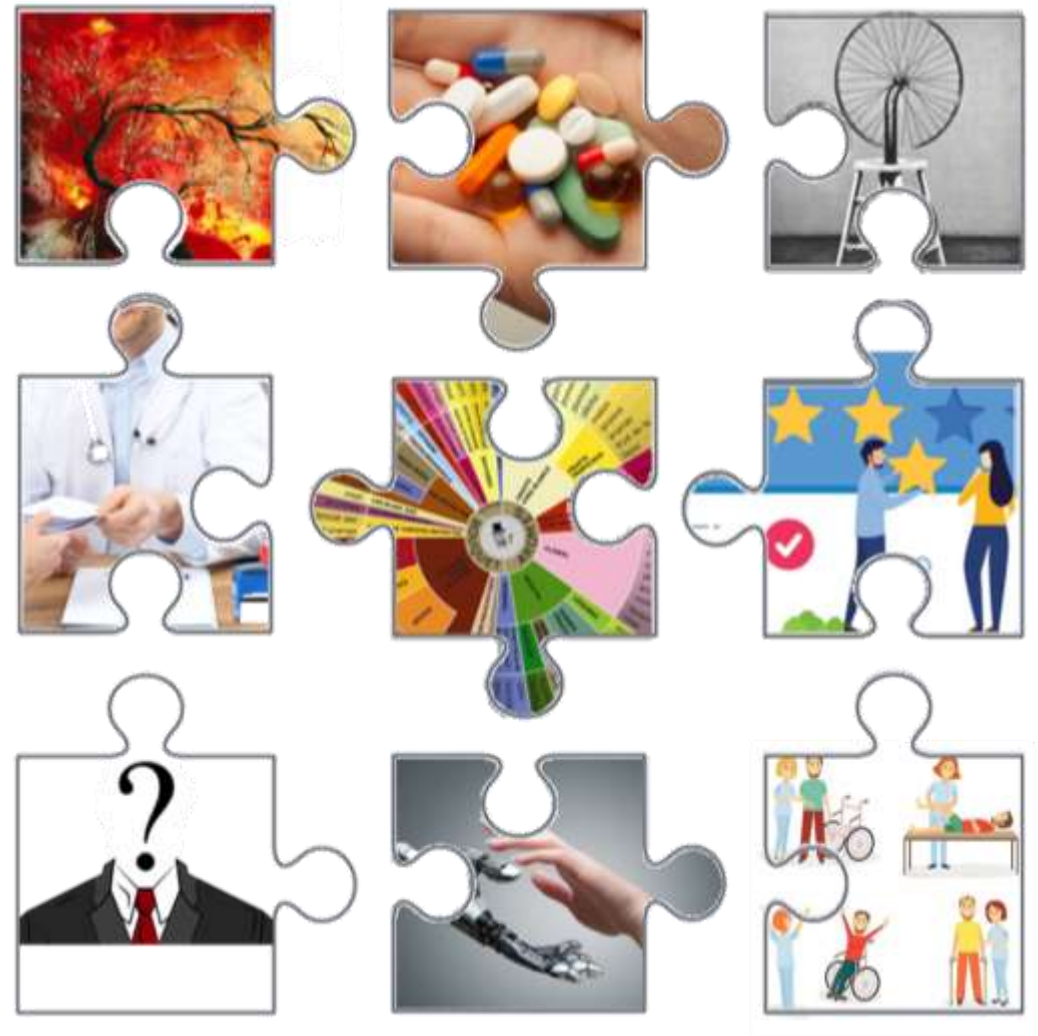


Low back pain, a complex puzzle



« Everything that is simple is
theoretically false, everything that is
complicated is pragmatically useless. »

Paul Valéry



Low back pain, a complex puzzle



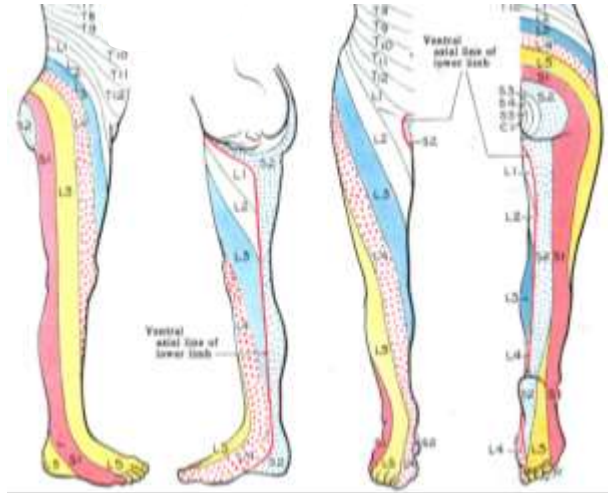
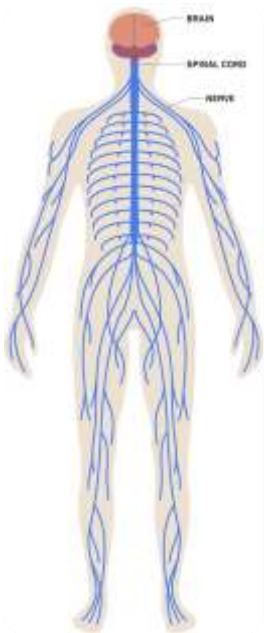
Health related Quality of Life

EQ5D-5L : EuroQol 5 Dimension



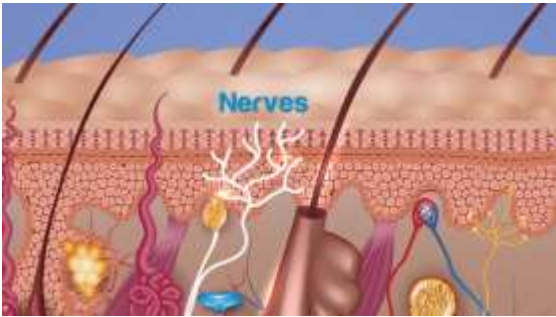
Functional disability

ODI : Oswestry Disability Index



Option préférentielle: PNfS !

PNfS



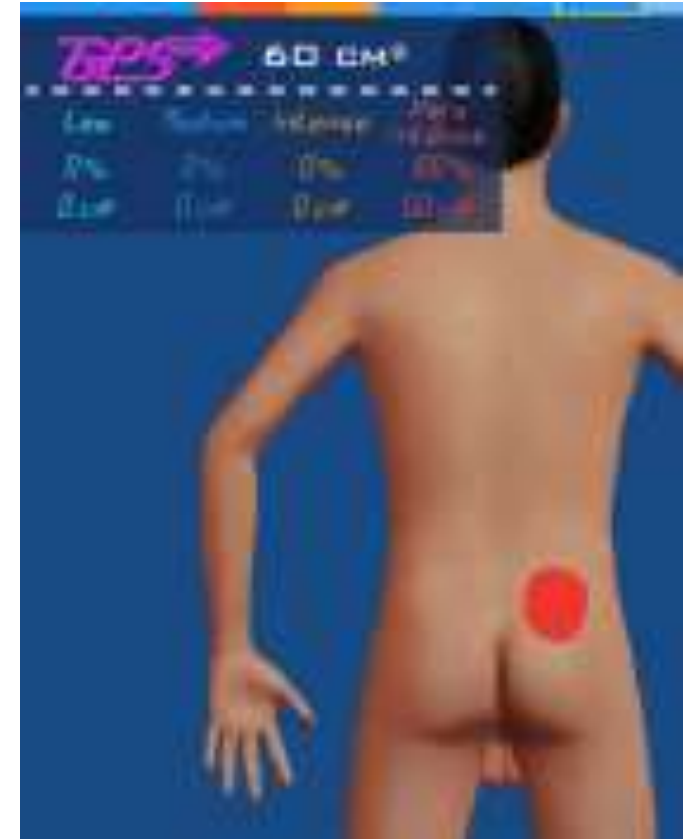
“Stimulation of painful areas by placing electrode arrays subcutaneously in the area of pain”

Abejón, D. and E. S. Krames (2009). “Peripheral Nerve Stimulation or Is It Peripheral Subcutaneous Field Stimulation; What Is in a Moniker?” *Neuromodulation: Technology at the Neural Interface* 12(1): 1-4.



Subcutaneous Nerve Stimulation

- Sub-Q stim (SQS)
- Peripheral Nerve Field stim (PNfS)
- Peripheral Subcutaneous Electrostim (SENS)
- Subcutaneous Peripheral Nerve Stim (SPNS)
- Subcutaneous Targeted Neuromodulation (STN)



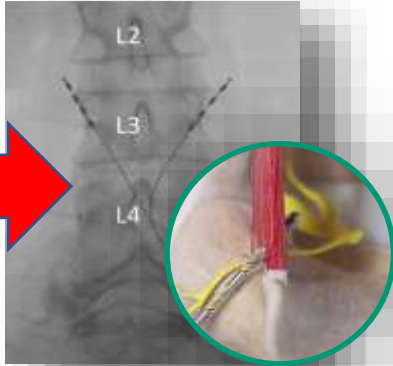
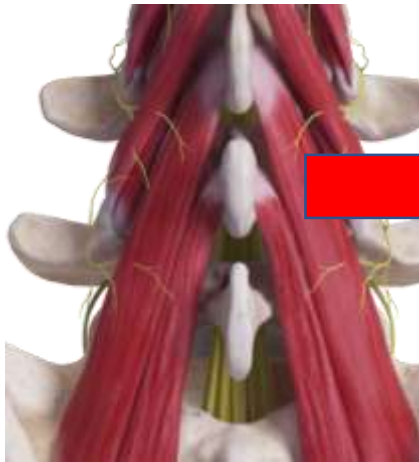
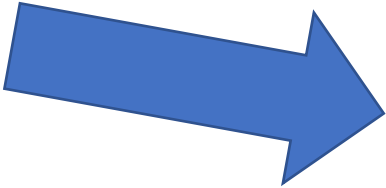
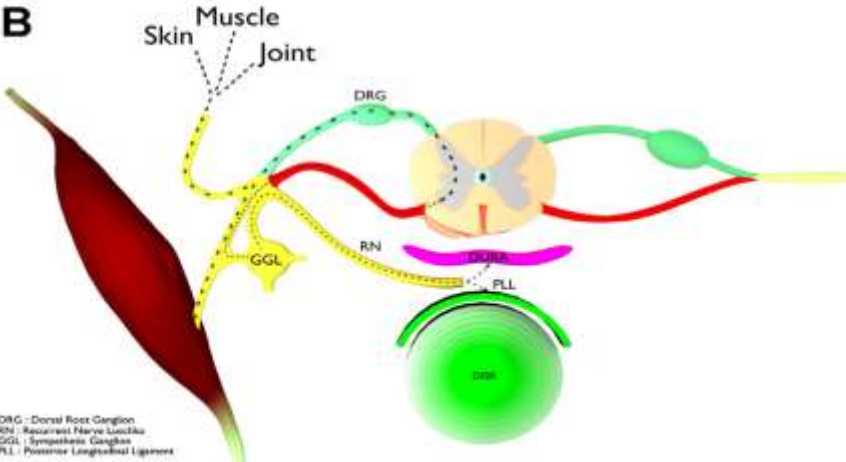
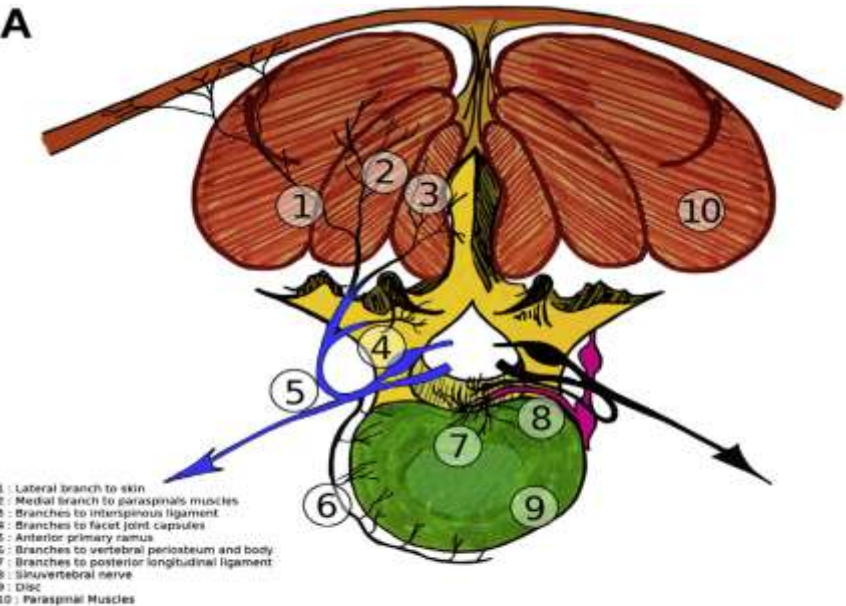
STIMULATION SOUS-CUTANÉE

Peripheral Nerve field Stimulation



Physical & Rehabilitation Medicine (MPR)

Before or after PNS?



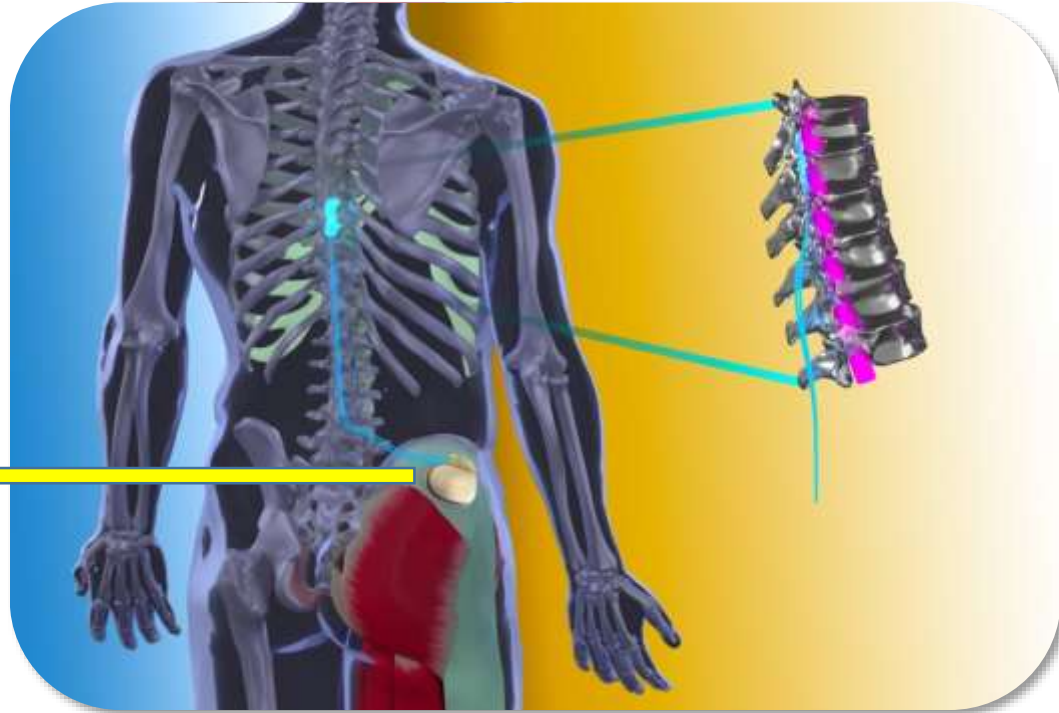
ReActiv8 for Chronic Low Back Pain (PMCF) (ReActiv8-A)

ClinicalTrials.gov Identifier: NCT01985230

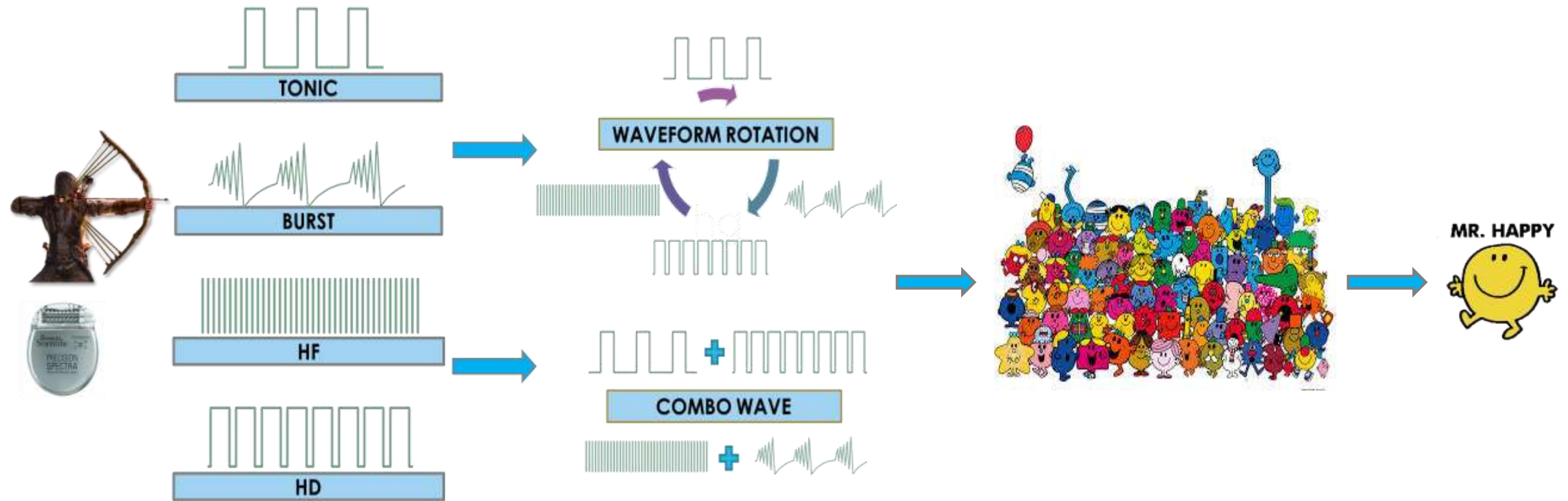
Dernier concept récent: la forme d'onde

LE NEUROSTIMULATEUR RÉSOLUTION TEMPORELLE

- To deliver the energy / waveform



Multi & Combo Wave Concepts



The legacy of
the past

SCS Evolution

Building the
future

Improving SCS

New targets

Paresthesia

Convictions?
Rationale?

Their preferences:



→ Both of them



→ Paresthesia



→ No sensation



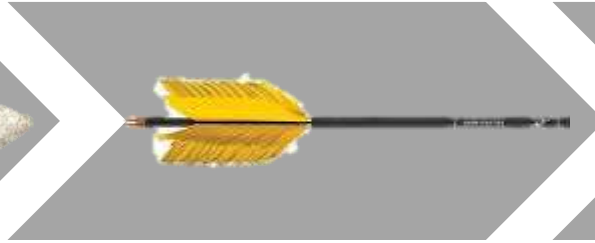
→ Paresthesia
(Two different IPG)

Synopsis

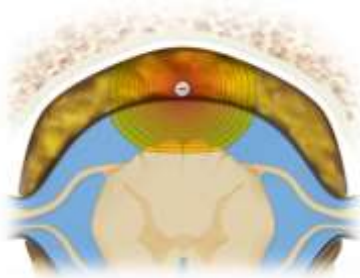
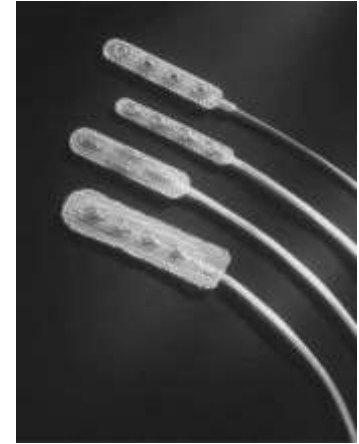
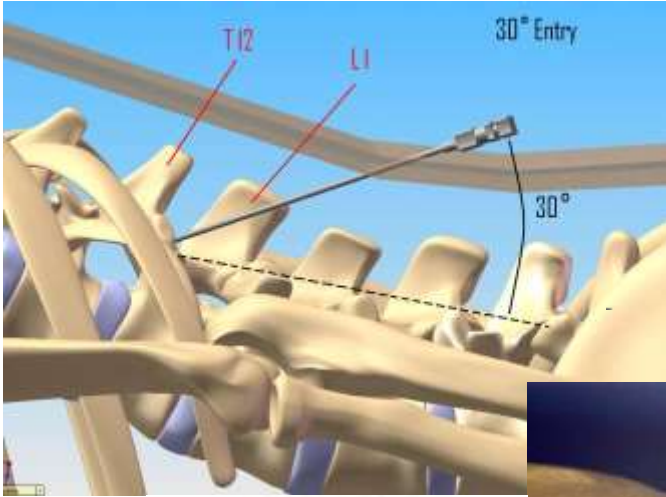
- I. D'où je viens, ce que je fais, qui je suis...
- II. C'est quoi la Neurostimulation médullaire ?
- III. Les évolutions techniques et technologiques
- IV. Electrode chirurgicale ou (/et !) percutanée ?
- V. Un parcours patient complexe, un itinéraire médical passionnant

L'ÉLECTRODE: OÙ ENVOYER LE SIGNAL ?





ELECTRODE CHIRURGICALE OU PERCUTANÉE ?



JE SUIS UN CHIRURGIEN !

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Red VS blue?

Anesthetists:

Take interest in
paddle lead!



Surgeons:

Take interest in
percutaneous lead!

Same goal, different methods!

Des convictions...Peu de rationnel



En fait...

69



*Failed Back
Surgery Syndrome?*

Mechanical Pain?



*Cervical
Neuropathic Pain?*

Cela depend aussi



De l'indication!

Vascular Pain?



*Complex Regional
Pain Syndrome?*

*Cervicarhrosic
myelopathy?*



Perineal Pain?

Synthèse

► Cas simple : FBSS / Douleur radiculaire

➡ Électrode percutanée



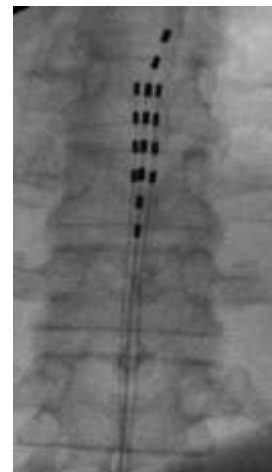
Conclusion

▶ Cas simple: FBSS / Leg pain

➡ **Électrode Percutanée**

▶ Complex Case: FBSS / Back pain

➡ **Concept Multicolonnes**



Indications périnéales

A difficult-to-target area
with percutaneous leads



Lead
migration

Lead instability

Coverage

**Non selective
coverage**



**Less lead
migration**

**Reliable,
reproducible
And
hyperselective
coverage**



Complications des électrodes chirurgicales

Device dependent



- Lead Fracture
- Connector Break
- Device Dysfunction
- Migrating device
- Flipping device

Surgery dependent



- Hematoma
- Anticoagulants
- Infection
- CSF leakage
- Spinal Cord Injury

Patient dependent



- Suboptimal indication
- Allergies
- Tolerance
- Psychological complications

SÉLECTION DES PATIENTS QUELLE ELECTRODE ?



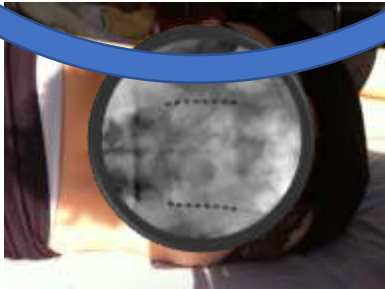
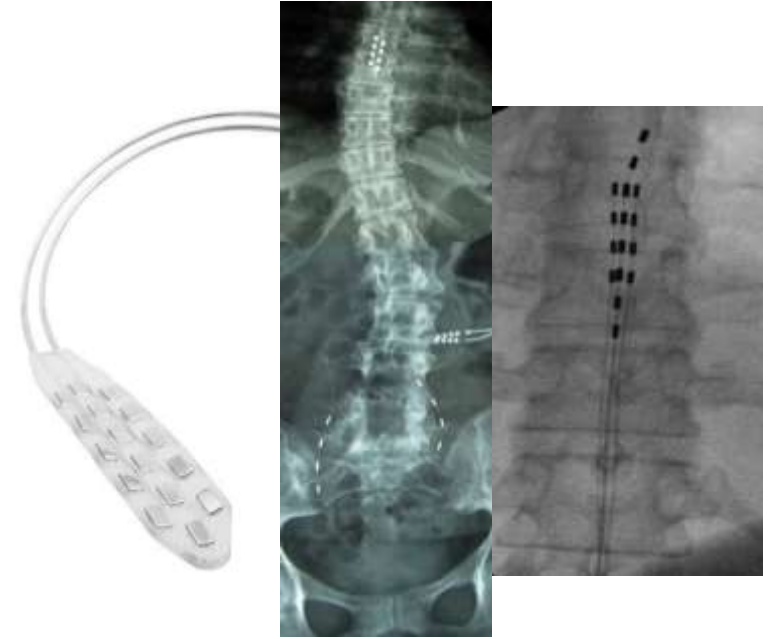
BSS
LEG > BACK

FBSS
LEG+BACK

FBSS
**Exclusive and/or
focal backpain**

TENS -
SCS -
Intrathecal Test +

ECHEC ?

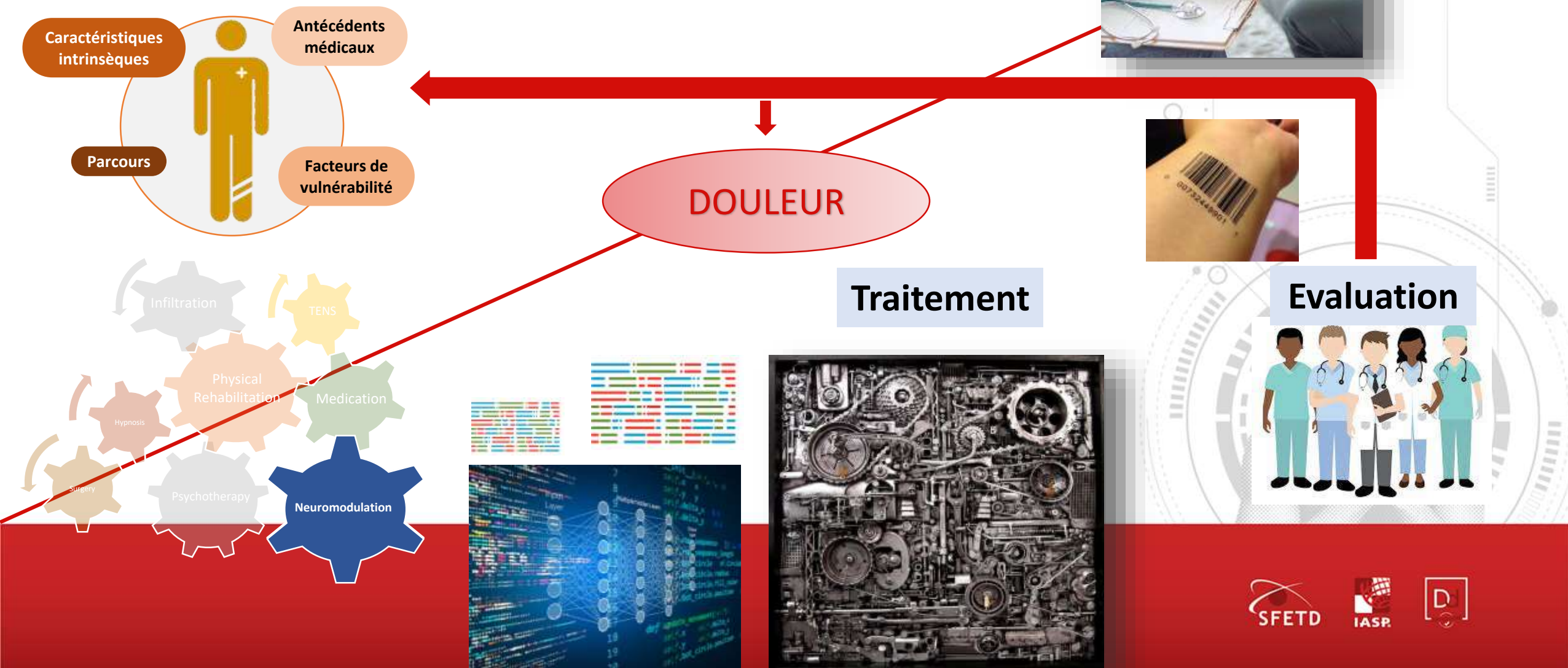


Kumar et al, Neurosurgery 2006. Spinal cord stimulation in treatment of chronic benign pain: challenges in treatment planning and present status, A 22-year experience .
Sator-katzenschlager S et al, Pain Practice 2010. Subcutaneous target stimulation (STS) in chronic non cancer pain: a nationwide retrospective study.
Eldabe et al, Trials 2013. Assessing the effectiveness and cost effectiveness of subcutaneous nerve stimulation in patients with predominant back pain due to failed back surgery syndrome (SubQStim study): study protocol for a multicenter randomized controlled trial.
Gatzinsky K et al, Pain Pract 2017. Evaluation of the effectiveness of percutaneous octopolar leads in pain treatment with failed back surgery syndrome during a 1-year follow-up: A prospective multicenter international study.

Synopsis

- I. D'où je viens, ce que je fais, qui je suis...
- II. C'est quoi la Neurostimulation médullaire ?
- III. Les évolutions techniques
- IV. Electrode chirurgicale ou (/et !) percutanée ?
- V. Un parcours patient complexe, un itinéraire médical passionnant

● Un patient, un parcours (complexe...)



Médecine prédictive: Parcours patient

Chronic pain world is complex



MECHANICAL

MILD

MEDIUM

SEVERE

NEUROPATHIC

MILD

MEDIUM

SEVERE

NO MAN'S LAND

Médecine prédictive: Parcours patient

Quels sont les besoins et les attentes des patients ?



Clustering the impact of pain dimensions on Quality of life



Journal of
Clinical Medicine



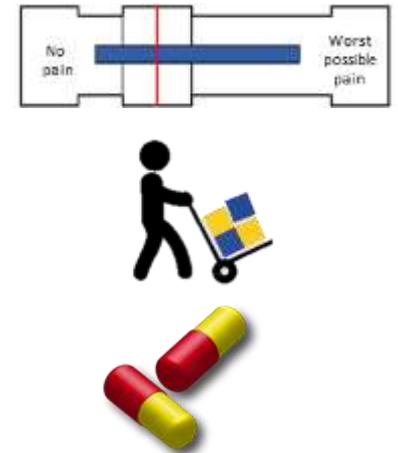
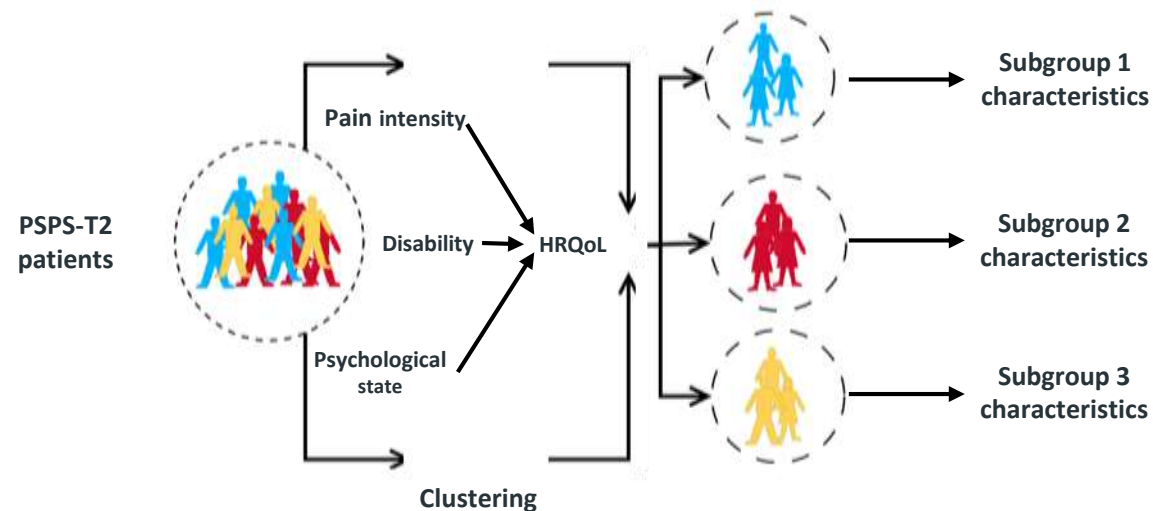
Article

Finite Mixture Models based on pain intensity, functional disability and psychological distress composite assessment allow to identify two distinct classes of Persistent Spinal Pain Syndrome after surgery patients related to their quality of life

Amine Ouanjiri^{1,2}, Maxime Billot³, Pierre-Yves Louis^{3,4}, Youari Slaoui⁵, Denis Frasca^{3,6}, Lisa Goodman^{3,7}, Manuel Roulaud¹, Nicolas Naiditch^{3,8}, Bertille Lorgeoux¹, Sandrine Baron¹, Kevin Nivole¹, Mathilde Many¹, Nihel Adjali¹, Philippe Fage^{1,9}, Benedicte Bouche¹, Elodie Charrier¹, Laure Foupin¹, Delphine Rannou¹, Géraldine Brumaud de Montgazon¹, Aline Roy-Moreau¹, Chantal Wood¹, Raphaël Rigoard¹, Romain David^{1,10}, Maarten Moens^{1,11} and Philippe Rigoard^{1,12,13}

Objectives:

1. To identify different population subgroups based on the specific impact of pain intensity, functional disability and psychological distress on health-related quality of life (HRQoL) PSPS-T2 refractory patients.
2. To characterize these subgroups using clinical, psychological and social factors to refine the model of personalized medical management.



Results



Class 1 model

Class 2 model

Psychological distress
+
Functional Disability

Psychological distress
+
Pain Intensity

PSPS-T2 Health-related Quality Of Life
impacted by:

	Class 1 model (n=136; 68.7%)		Class 2 model (n=62; 31.3%)	
Variables	Standardized coefficient	p-value	Standardized Coefficient	p-value
ODI	-0.76	<0.0001	-0.11	0.23
HADS depression	-0.19	<0.0001	-0.22	0.0001
NPRS	0.039	0.46	-0.35	<0.0001

Disability class

68.7%

Characterized by

- High educational level
- Men with physical job
- Able to reinterpret pain
- Able to divert attention from pain

Pain intensity class

31.3%

Characterized by

- High pain intensity
- High depression score
- High catastrophizing score



Article

Finite Mixture Models based on pain intensity, functional disability and psychological distress composite assessment allow to identify two distinct classes of Persistent Spinal Pain Syndrome after surgery patients related to their quality of life

Amine Ouanjiri^{1,2}, Maxime Billat¹, Pierre-Yves Louis^{1,2}, Youcef Sfarou¹, Denis Frasca^{1,2}, Lisa Goudreau^{1,2}, Maxime Beaulieu¹, Nicolas Nalitch^{1,2}, Bertille Legeroux¹, Sandrine Baron¹, Kevin Nivole¹, Mathilde Many¹, Nihel Adjali¹, Philippe Page¹, Benoit Rouché¹, Hedi Cherier¹, Laure Poapin¹, Delphine Ramon¹, Géraldine Brunault de Montgazon¹, Aline Roy-Moreau¹, Chantal Wood¹, Raphaël Rigaud¹, Romain David^{1,2}, Martin Moens^{1,2} and Philippe Rigaud^{1,2,3,4}

STEP 1: Patient eligibility to NM



12,6 years

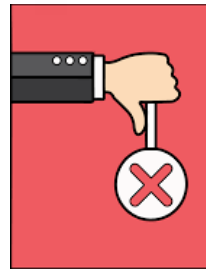


Multidisciplinary approach

Neurostimulation



Neurostimulation



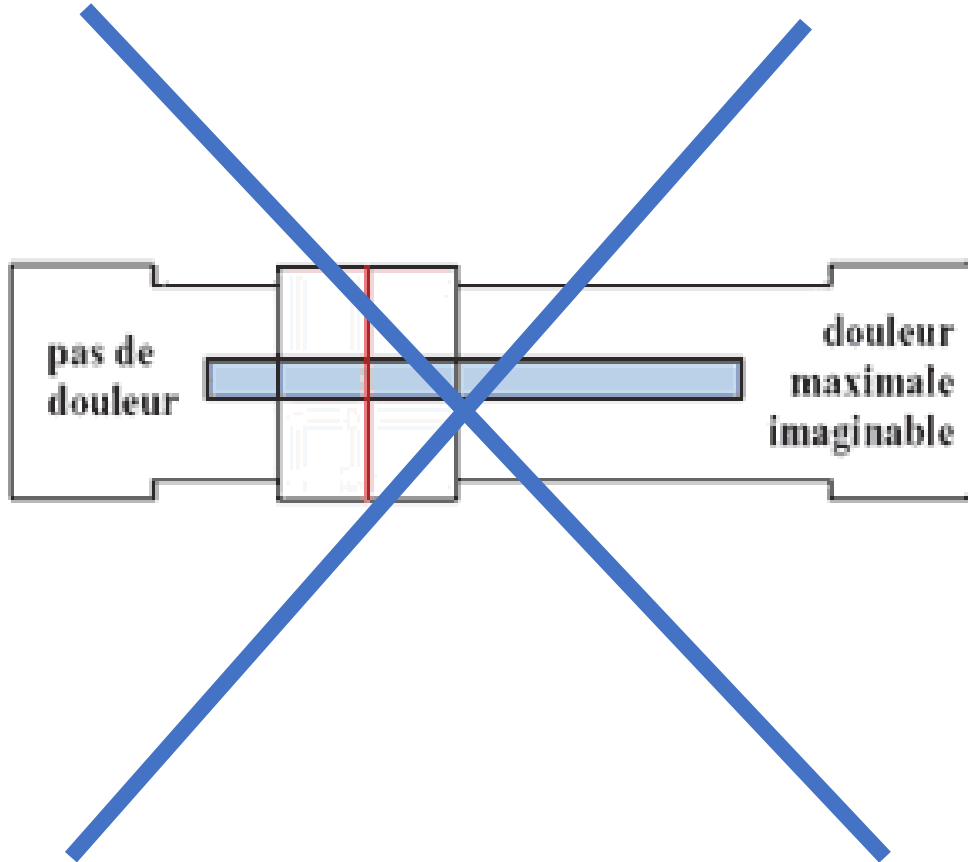
Médecine prédictive: Parcours patient

La Douleur, c'est quoi, Docteur ??!



Médecine prédictive: Parcours patient

Quels outils ? / 2013 = CASSER LES CODES +++



Comment “MESURER” la douleur ?





Le monde de la douleur chronique
et de la neuromodulation...

STEP 1: Patient eligibility to NM



12,6 years

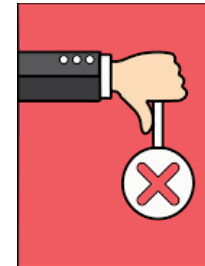


Multidisciplinary approach

Neurostimulation

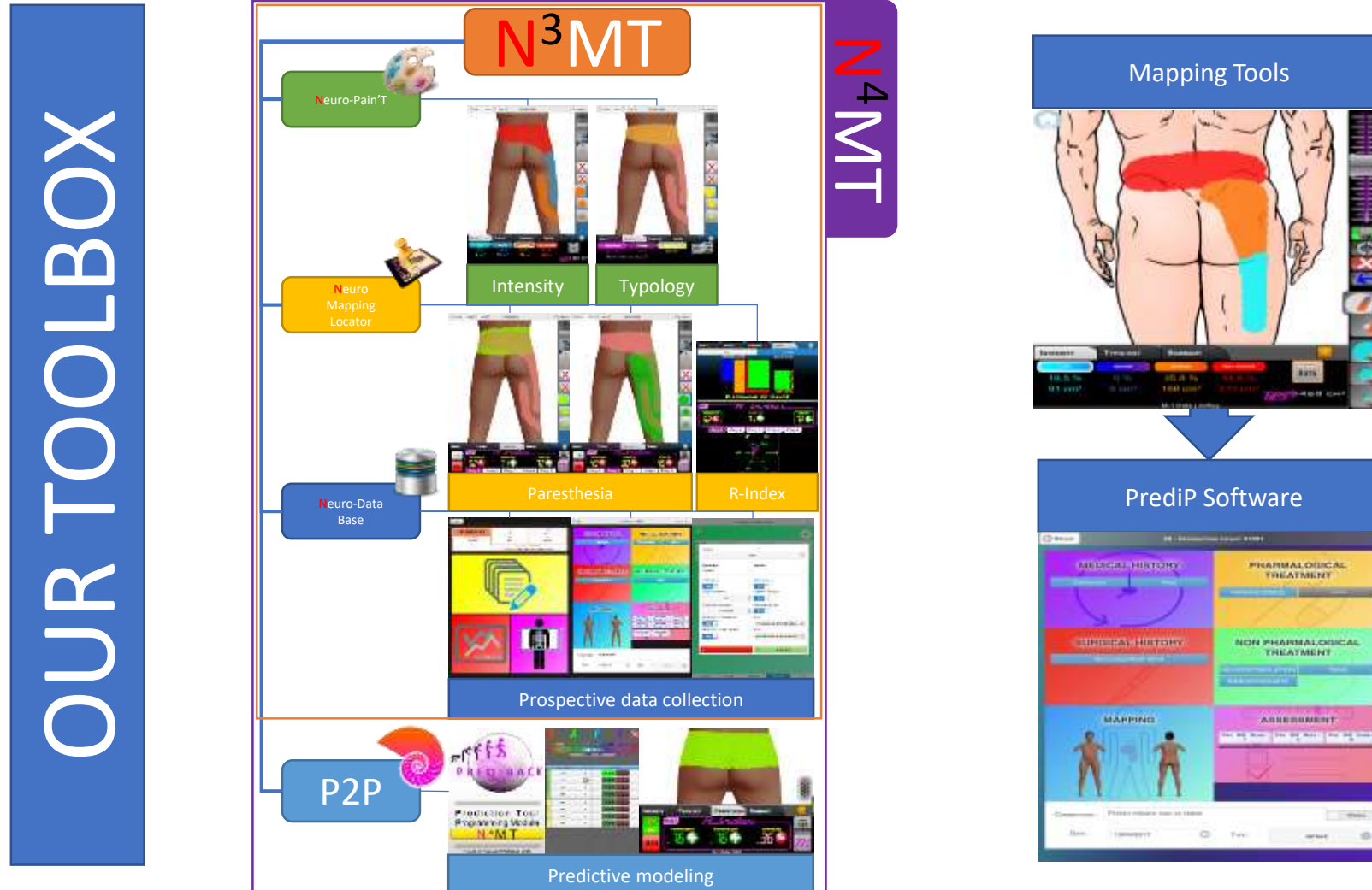


Neurostimulation

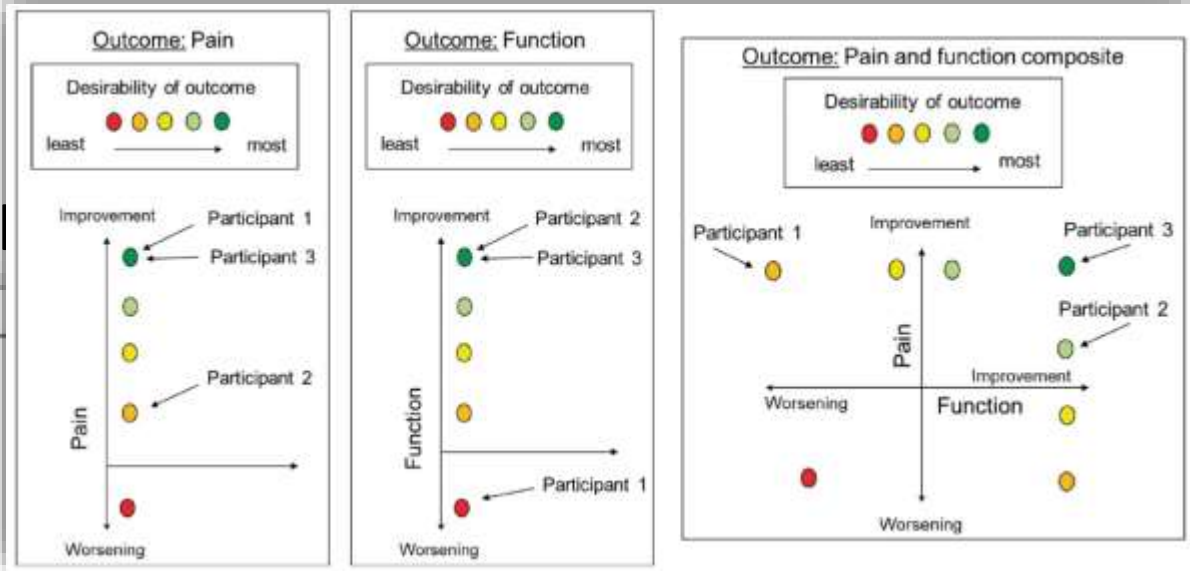


Database

Médecine prédictive: Parcours patient



Besoin d'un index composite



Topical Review

PAIN

Composite outcomes for pain clinical trials: considerations for design and interpretation

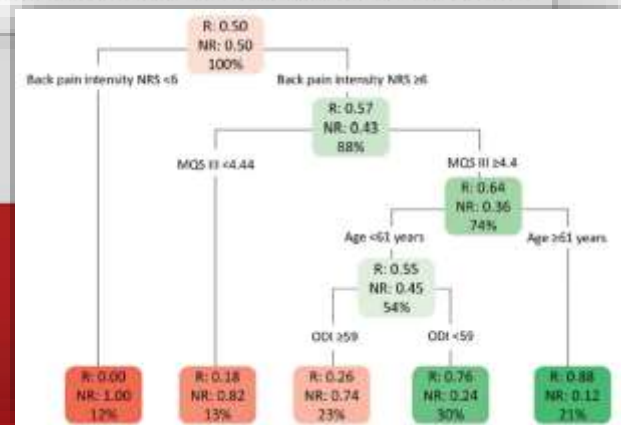
Jennifer S. Gewandter^{a,*}, Michael P. McDermott^b, Scott Evans^c, Nathaniel P. Katz^{d,e}, John D. Markman^f, Lee S. Simon^g, Dennis C. Turk^h, Robert H. Dworkin^g

Research Paper

PAIN

High-dose spinal cord stimulation for patients with failed back surgery syndrome: a multicenter effectiveness and prediction study

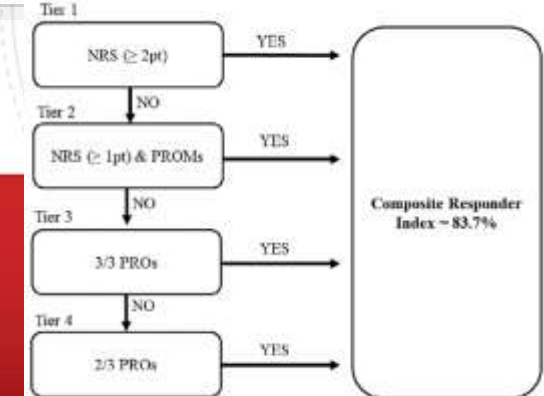
Lisa Goudman^{a,b,c,d}, Ann De Smedt^{b,c,e}, Sam Eldabe^f, Philippe Pligourd^{a,h,j}, Bengt Linderöthⁱ, Mats De Jaeger^d, Discover Consortium, Maarten Moens^{a,b,c,k,*}



Received February 14, 2020 · Revised April 29, 2020 · Accepted May 6, 2020
(online.library.wiley.com) DOI: 10.1111/ner.13212

Composite Score Is a Better Reflection of Patient Response to Chronic Pain Therapy Compared With Pain Intensity Alone

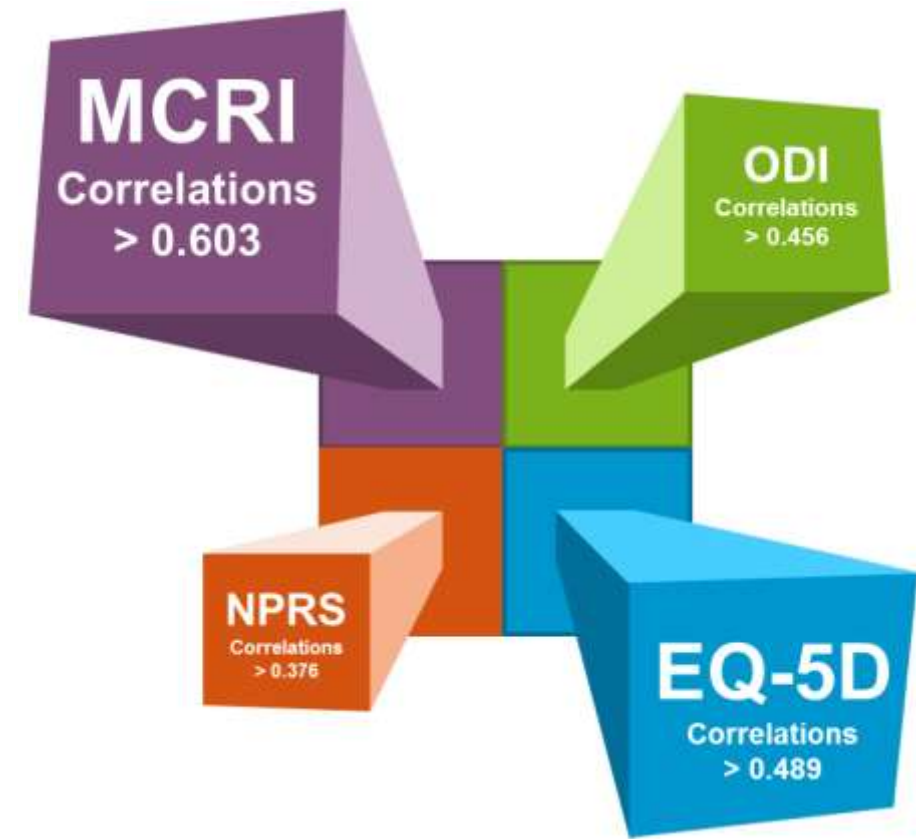
Julie G. Pilitsis, MD, PhD^{*†}; Marie Fahey, PhD[†]; Amanda Custozzo, BA/BS^{*}; Krishnan Chakravarthy, MD, PhD^{5†}; Robyn Capobianco, PhD[†]



● MCRI: échelle 0-10

Correlations between the MCRI score and the classical evaluation tools

Variables	ODI	EQ-5D	NPRS	Total HADS	Mapping Intensity
Correlations at baseline					
MCRI	-0.677 ***	0.690 ***	-0.677 ***	-0.622 ***	-0.423 ***
ODI	1	-0.631 ***	0.415 ***	0.279 ***	0.272 ***
EQ-5D	-	1	-0.346 ***	-0.434 ***	-0.250 ***
NPRS	-	-	1	0.289 ***	0.235 **
Total HADS	-	-	-	1	0.131
Mapping intensity	-	-	-	-	1
Correlations at 12 months					
MCRI	-0.758 ***	0.730 ***	-0.806 ***	-0.603 ***	-0.638 ***
ODI	1	-0.749 ***	0.514 ***	0.476 ***	0.456 ***
EQ-5D	-	1	-0.544 ***	-0.520 ***	-0.489 ***
NPRS	-	-	1	0.376 ***	0.553 ***
Total HADS	-	-	-	1	0.291 ***
Mapping intensity	-	-	-	-	1





Qualité des données

Variables des patients
P=431

Socio-démographiques

- Sexe
- Âge
- Profession
- Situation familiale
- Consommation tabac
- BMI
- Niveau d'éducation
-



Cliniques

- Nombre d'interventions chirurgicales
- Prédominance dos/jambes
- Type d'intervention
- Douleurs neuropathiques/mécaniques



Imagerie

- IRM
- TDM
- Rx
- EOS
- ...



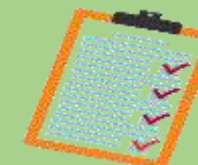
Cartographies

- Surface douloureuse
- Surface par intensité
- Surface par typologie
- ...

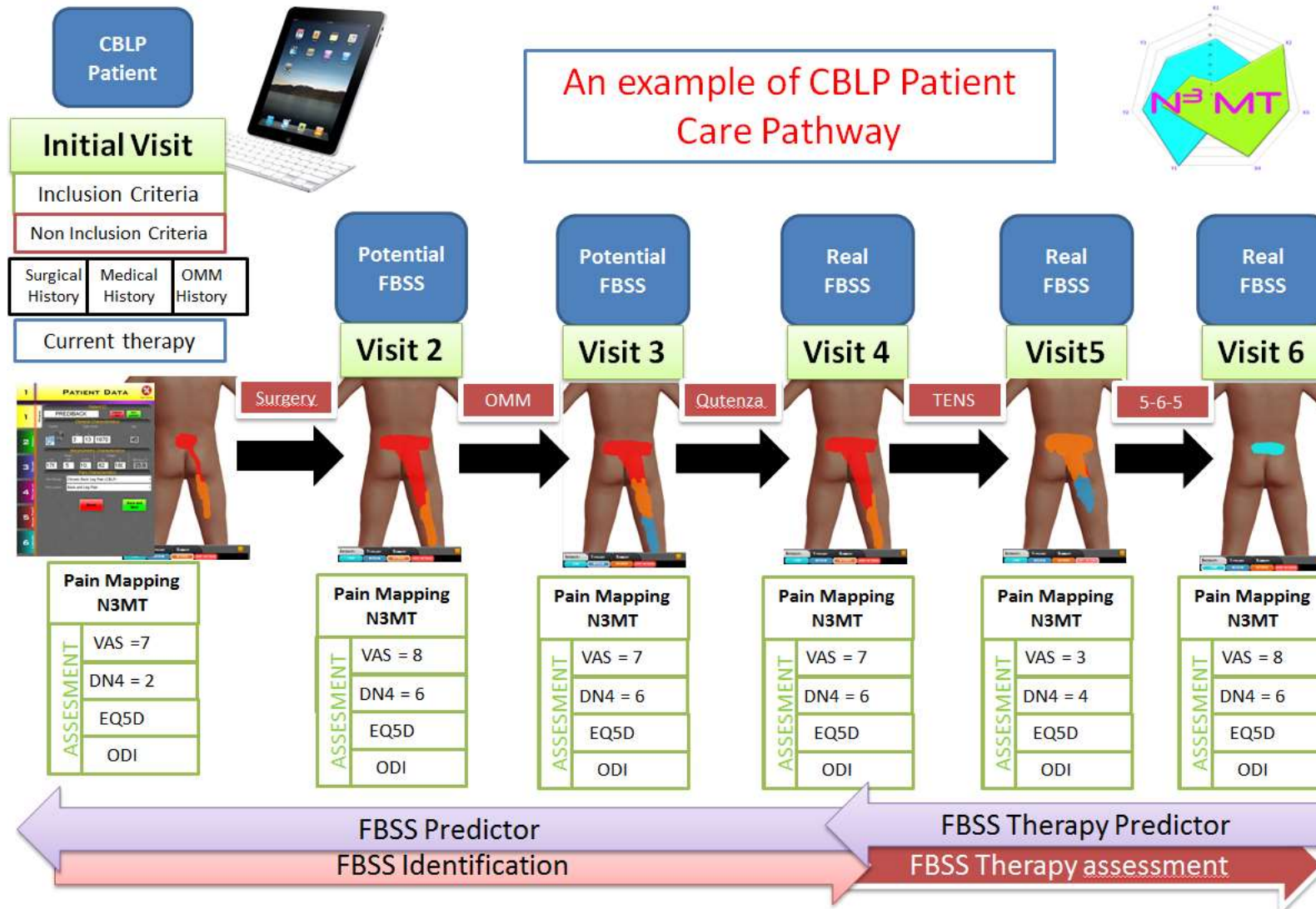


Questionnaires d'évaluation de la douleur

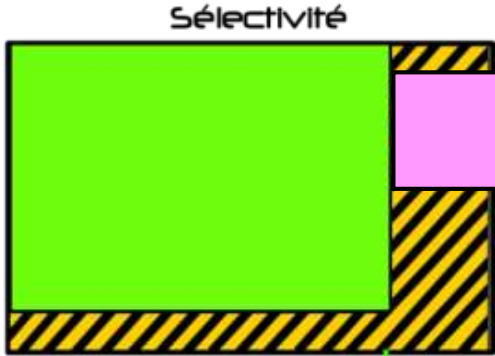
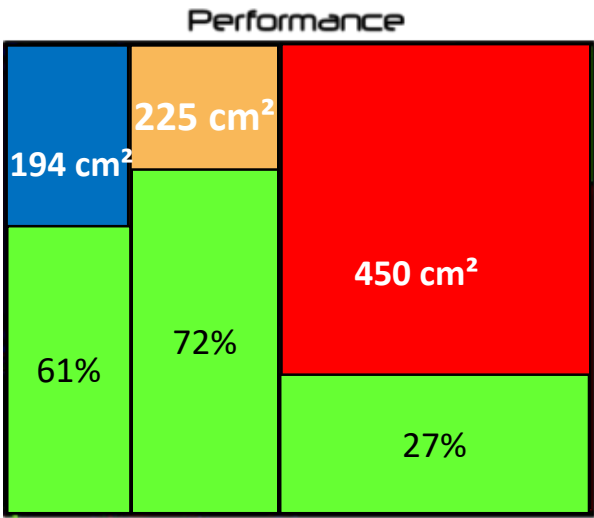
- EQ5D
- ODI
- PGIC
- PCS
- HAD
- CSQ
- MPI
- ...



Médecine prédictive: Parcours patient

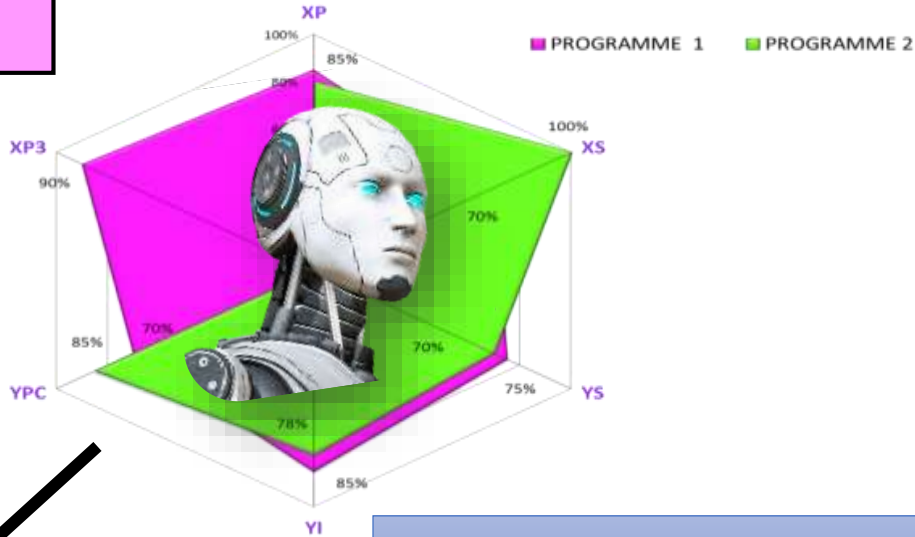


DATA SCIENCE



Variables

RFG Index

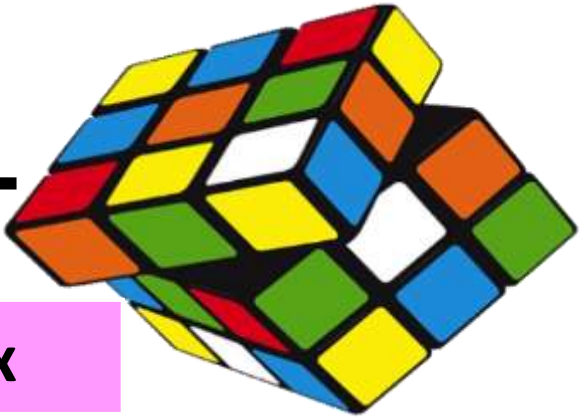


PREDICTORS



Neuro-Data
Base

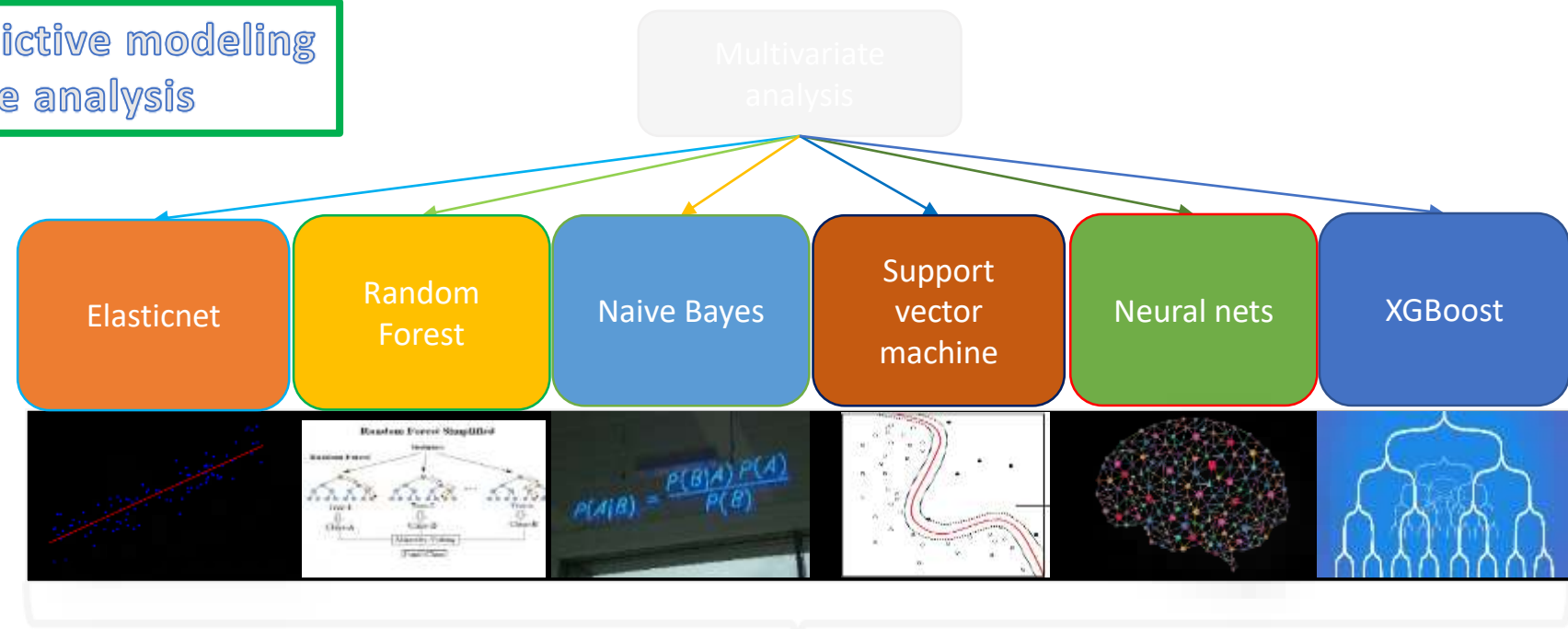
Patient Index



Objective Composite
Assessment

Summary of predictive modeling

Multivariate analysis



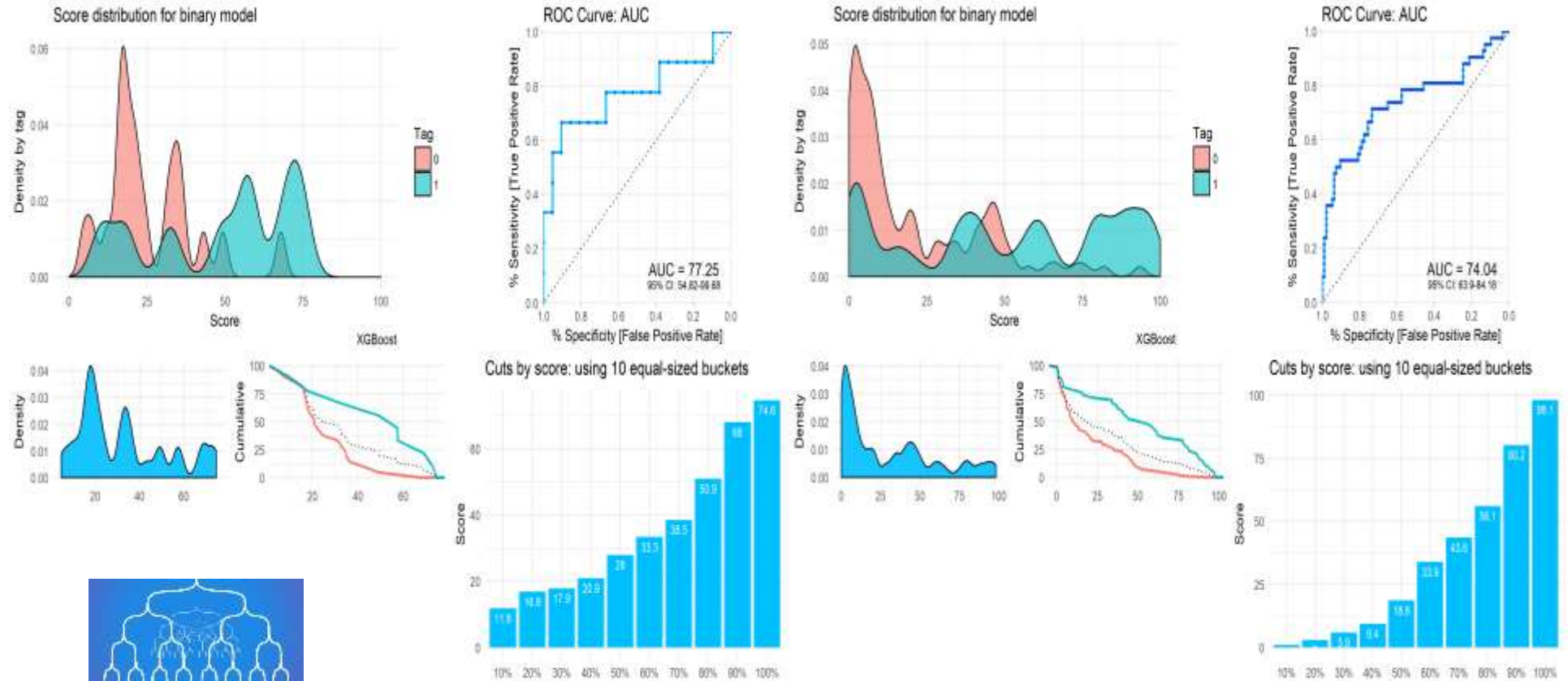
Learning
N=106

Validation
N=30

Model evaluation measures:
ROC curve, AUC, density by target, cumulative scores plot



Comparison and diagnosis of different classification algorithms



Test set

XGBoost

Train set

Clinical case : Mr G.

- 40 years old – former police officer
- Pain onset following a violent aggression
- Patient had nightmares due to the incident lacked engagement (feeling of injustice)
- Patient oriented towards a psychiatrist

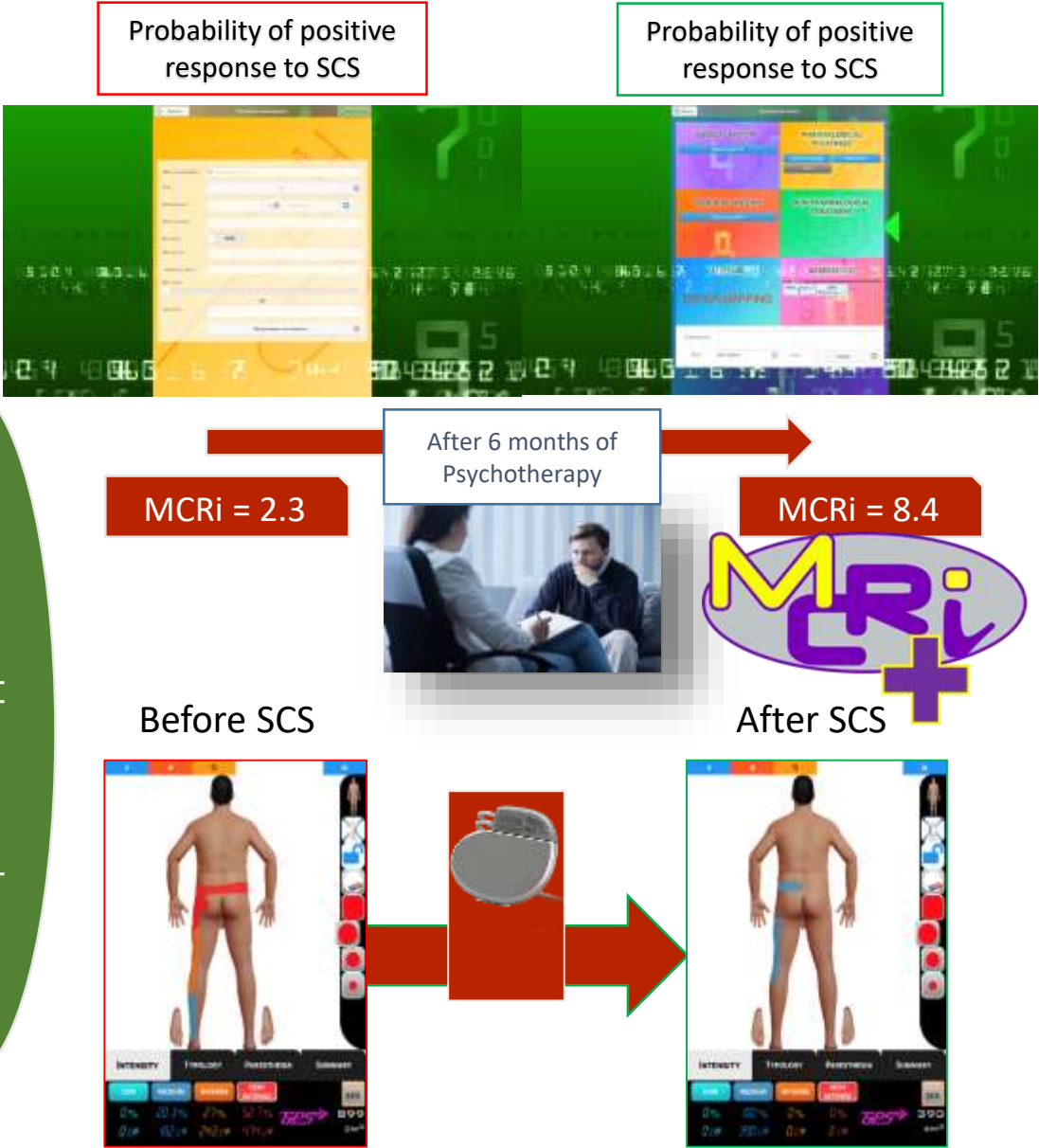
SCS e-tool

Psychosocial factors

Presence and degree of compromising factors

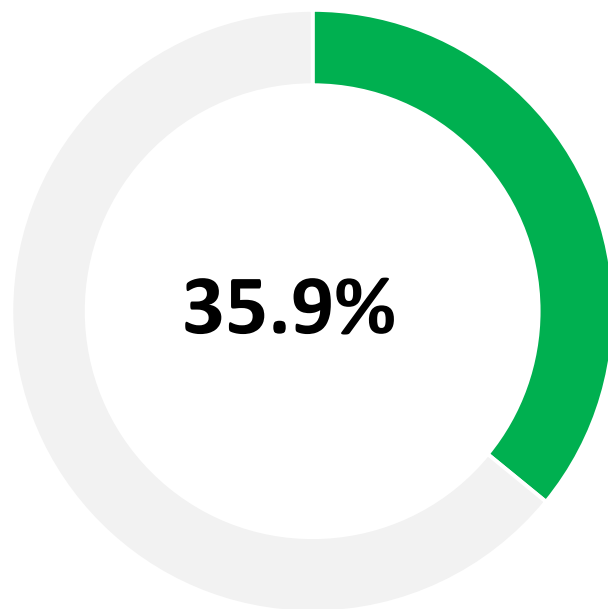
	No	Partly	Total
1 Lack of engagement			
1 Dysfunctional coping	No or mild	Moderate - severe	
1 Unrealistic expectations	No or mild	Moderate - severe	
1 Inadequate daily activity level	No or mild	Moderate - severe	
1 Problematic social support	No or mild	Moderate - severe	
1 Secondary gain	No	Probably - very likely	
1 Psychological distress / mental health problems	No or mild	Moderate - severe	
1 Unwilling to reduce high-dose opioids	No, not applicable	Probably - very likely	

Machine learning response prediction approach

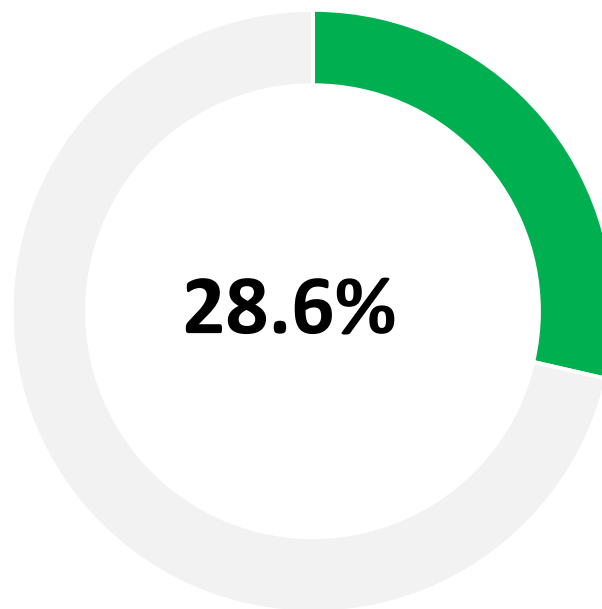


Résultats

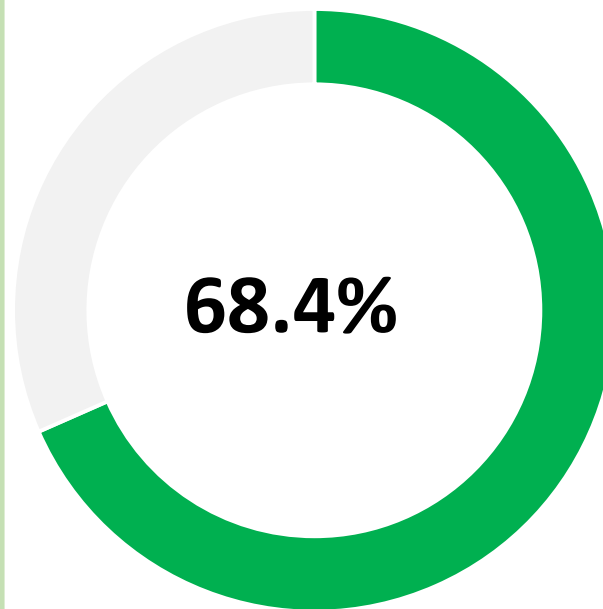
Percentage of responders to OMM
(n=174)



Percentage of responders to spinal reoperation
(n=7)



Percentage of responders to SCS
(n=19)





Ingredients for the moussaka:

250 g of minced meat

4 eggplants.

4 tomatoes.

1/2 garlic clove.

A few sprigs of chives.

Olive oil.

1/4 l of water.....

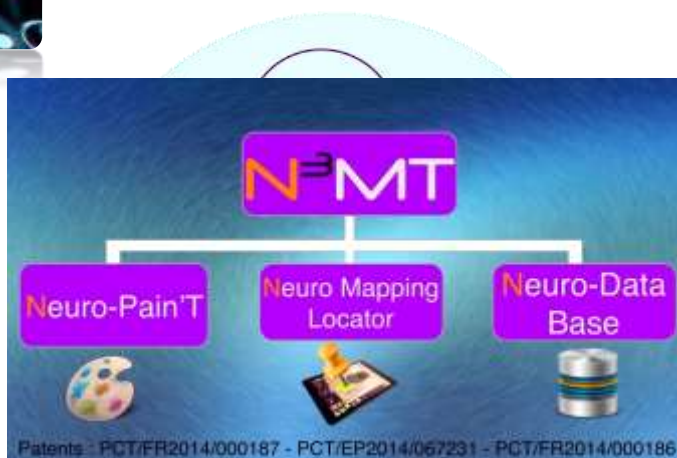
STEP 3: Data / Medico-economic analyses

Value
Based
Health
Care



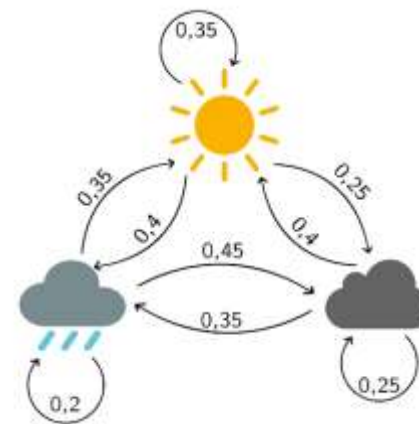
Data

Patient
Reported
Outcomes



Analysis

Markov Models / Cost-effectiveness analyses



Strategy



Consultation multidisciplinaire : travail collectif





Philippe RIGOARD



Maxime BILLOT



Manuel ROULAUD



Amine OUNAJIM



Kévin NIVOLE



Mathilde MANY



Nihel ADJALI



Bertille LORGEUX



Sandrine BARON



Elodie CHARRIER



Bénédicte BOUCHE



Nelly GRIMAUD



Romain DAVID



Lorraine MISBERT



Philippe PAGE



Géraldine
De MONTGAZON



Aline ROY-MOREAU



Chantal WOOD



Delphine RANNOU

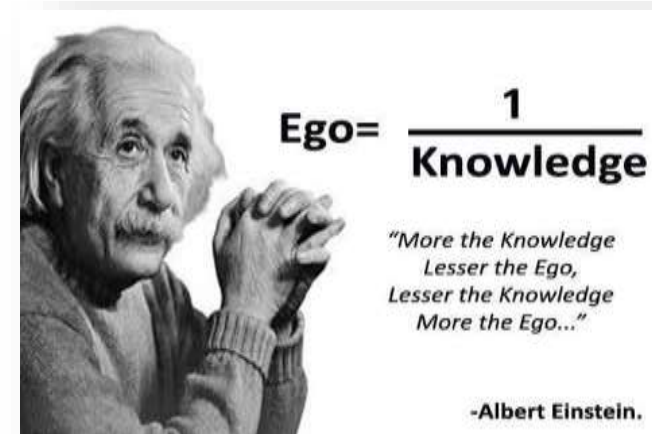


Laure POUPIN



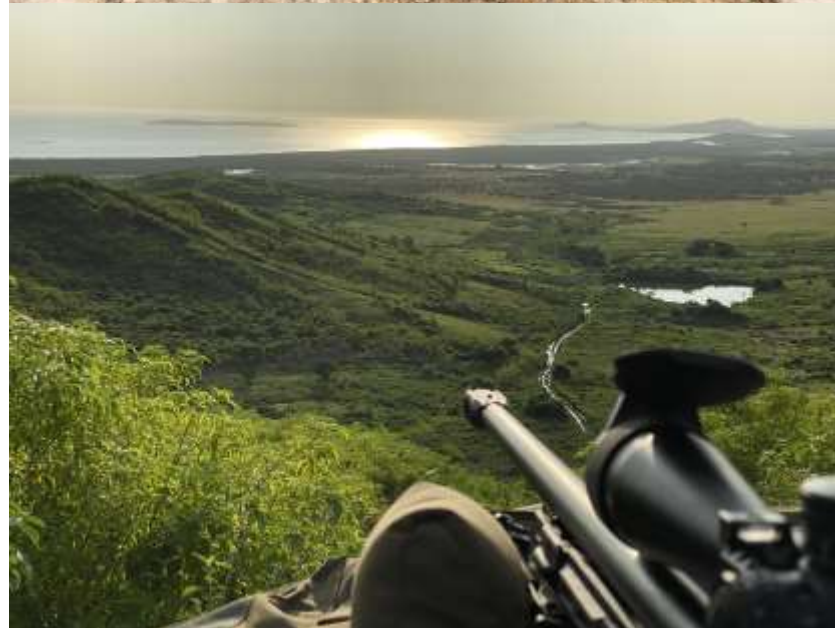
Nazem ABBAZED

Tout est une question d'équipe !





**Une Histoire de Patients,
Une Histoire de Rencontres,
Une Histoire d'Amitié...**



MERCI !