

Cryoneurolyse: principes et applications cliniques en douleur chronique

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Plan de la présentation



Concepts de base



Publications
chez l'humain

Névralgies périphériques
Syndromes
musculosquelettiques
Douleur cancéreuse



Complications

Concepts de base

Historique

THE HISTORY OF CRYOANALGESIA



An Anglo-Saxon monk uses cold as a local anesthetic.

1050



Dr. Irving S. Cooper develops device with hollow tube to deliver pressurized nitrogen and achieve -190°C at the tip.

1961



Lloyd et al. proposes that cryoanalgesia is superior to other methods of peripheral nerve destruction.

1976



2013

The iovera® treatment system is launched. It delivers targeted cold to a peripheral nerve, immediately relieving pain.

400 BC

Hippocrates uses cold to relieve swelling, bleeding and pain.



1899

Campbell White is the first to employ refrigerants for medical use.



1967

Setrag Zacarian introduces a hand-held self-pressurized cryogen spray device.



<https://iovera.com/providers/>

Sonde de cryothérapie

- ▶ Extrémité étanche
- ▶ Gaz: N₂O ou CO₂
- ▶ Acheminement gaz 600-800 psi
- ▶ Canule interne d'évacuation 10-15 psi
- ▶ Effet Joule-Thomson

- ▶ Isolation électrique distale
- ▶ Neurostimulateur
- ▶ Thermistor

- ▶ Introducteur (ex. cathéter IV 12-16G)

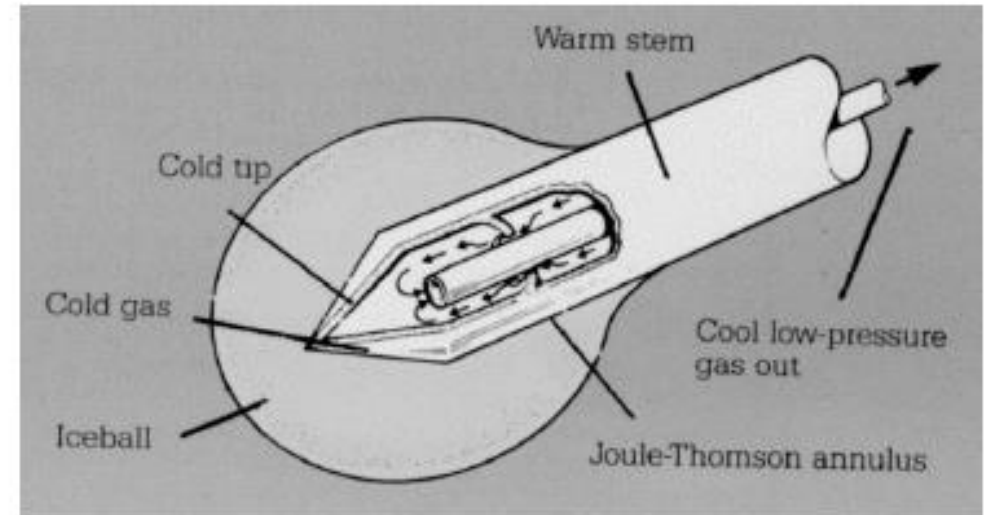


Figure 5. Joule-Thomson effect (image courtesy of Epimed).

Exemples de modèles de sondes

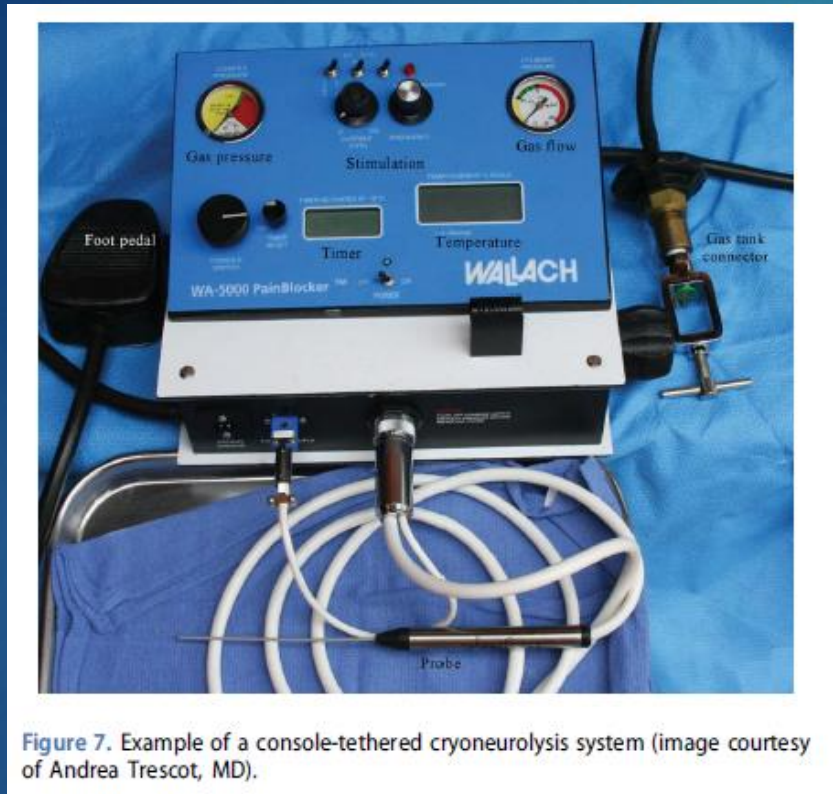


Table 2. Table of available cryoprobes for cryoneurolysis.

Cryoprobe diameter	Needle gauge	Ice ball size (mm)
Portable device [41]		
0.7 mm	22G	9.4 × 5.4 oval
0.4 mm	27G	5.7 × 7.8 oval
Console-tethered device [37]		
2.0 mm	14G	5.5 ball
1.4 mm	17G	3.5 ball

Physiopathologie de la cryoneurolyse

Formation de cristaux de glace intra-
et extracellulaires

Destruction des vasa nervorum

Œdème endoneural sévère dans les
90 minutes

Dégénéscence wallérienne (axone
et myéline)

Anatomie d'un nerf périphérique

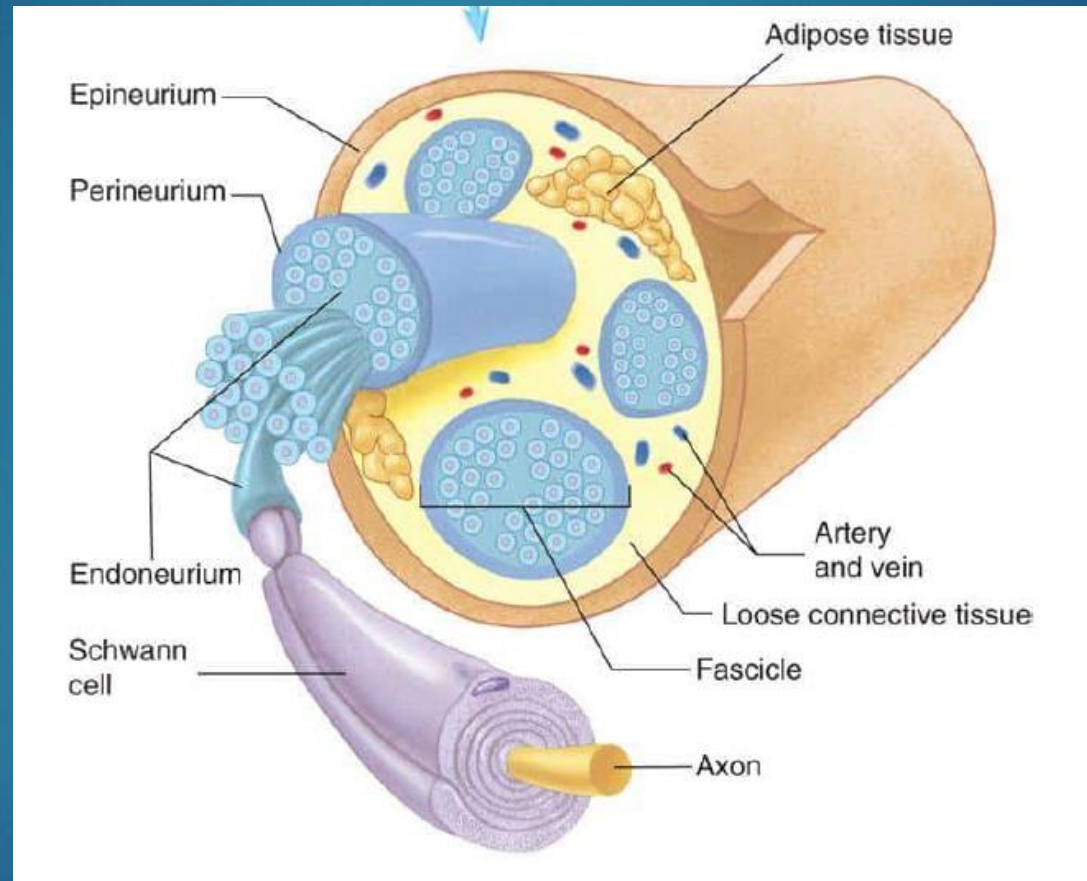


Table 1. Nerve injury as a function of cold [5,7].

Reversible	
First degree Neuropraxia – interruption of conduction; short recovery time	+10 to -20°C
Second degree Axonotmesis – Loss of axon continuity; Wallerian degeneration; preservation of endoneurium, perineurium and epineurium	-20°C to -100°C
Nonreversible	
Third/Fourth degree Neurotmesis – loss of axon continuity; some loss of continuity of endoneurium and perineurium	-140°C and colder
Fifth degree Transection (severe neurotmesis) – gross loss of continuity	Not possible with cryoneurolysis

Classification de Sunderland

Mécanismes complémentaires

- ▶ Analgésie fréquemment prolongée par rapport à la régénérescence neurale
 - ▶ Activation des voies descendantes inhibitrices
 - ▶ Blocage des neurotransmetteurs excitatoires
 - ▶ Blocage des canaux sodiques
 - ▶ Réhabilitation physique facilitée dans l'intervalle

Déterminants d'une lésion efficace



Bloc
diagnostique
méticuleux



Proximité du nerf
ciblé



Calibre de la
sonde



Taille de la
sphère de glace



Vitesse de gel et
de dégel



Durée de la
cryoneurolyse



Température des
tissus avoisinants
(*local heat sink*)



3-6 mm de
longueur de
lésion

Déroulement de la procédure

Lésion-type:
2-3 cycles de
2-4 minutes,
avec 30
secondes de
dégel

Inconfort ad
30 secondes,
soulagement
subséquent

Douleur
persistante:
via fibres non-
myélinisées
(trop loin du
nerf)

Ne jamais
mobiliser la
sonde avant
le dégel!

Avantages vs. thermolésion /transsection /neurolyse chimique

- ▶ Périnèvre et épinèvre préservés
- ▶ Membrane basale des cellules de Schwann
- ▶ Structure guidant la régénéscence axonale (1-4 mm / jour)
- ▶ Régénéscence malgré lésions répétées
- ▶ Théoriquement, absence de formation de névrome

- ▶ Peu de cascade inflammatoire

- ▶ Maintien des tissus conjonctifs, musculaires et vasculaires

- ▶ Point d'ébullition des gaz = plancher thermique
 - ▶ N2O -88 Celsius et CO2 -79 Celsius

Contre-indications



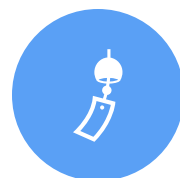
REFUS DU
PATIENT



TROUBLE DE
L'HÉMOSTASE



INFECTION



RAYNAUD



CRYO-
GLOBULINÉMIE



URTICAIRE AU
FROID



RELATIF; VISAGE
(ESTHÉTIQUE)

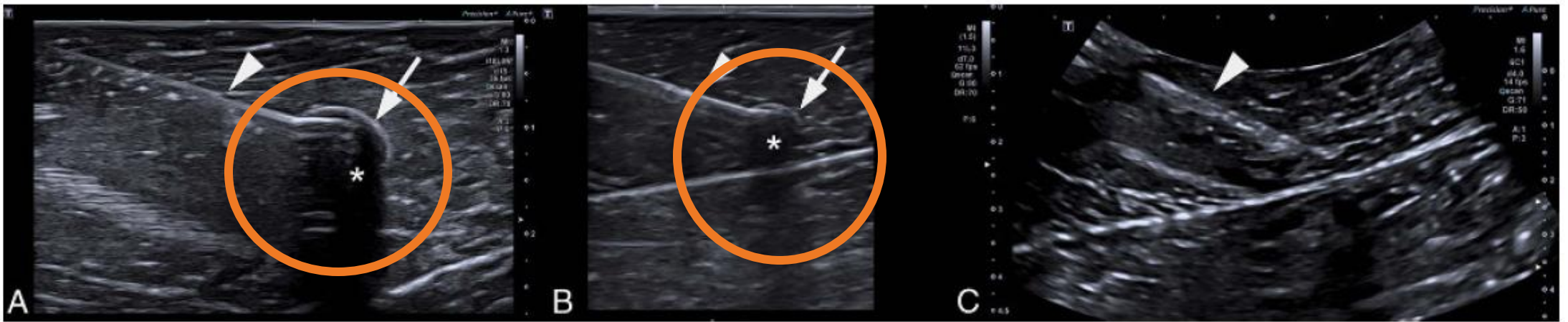
Modèles in vitro

Wolter 2017: bain de NaCl 0,9% et os de mouton

- Passer de -50 à -70 Celsius double la taille de la sphère de glace
- Allonger la durée de 30 à 120 sec.: 161%
- Augmenter le calibre de la sonde: 400 %
- Peu d'impact de l'angulation (sonde / os)

Birkenmaier 2010: boîte de gel agar

- Comparaison éventuelle de thermo- et cryolésion(s)



Modèle ex-vivo

Kastler A. et al., Reg Anesth Pain Med 43(6): 631-633.

Modèle animal



Nerf sciatique du rat Sprague-Dawley



**Laboratoire de Dartmouth
(1991-1995)**

Modèle comportemental de douleur
neuropathique
Aucune composante sympathique



***Nerve growth factor* augmenté dans
la corne dorsale (Ju et al, 2012)**

Publications chez l'humain

Quelques bémols



Peu ou pas de données randomisées



Données rétrospectives



Séries de cas



Case reports



Avis d'experts

Syndromes douloureux

Névralgies périphériques

Syndromes
musculosquelettiques

Douleur cancéreuse

Névralgies périphériques



Névralgie occipitale



Figure 7. Cryo probe placement **from midline to lateral**, in-plane approach. The ultrasound probe used for visualization has been removed for better view of the area. Image courtesy of Agnes Stogicza, MD.

Auteur et date	Approche	Nombre de patients	Diminution Intensité dlr	Durée
Kim 2015	Repères de surface (ridge)	38	57,9%	6,1 mois
Kastler 2017	CT-scan (C2)	6	Plus de 50%	7 jrs-3 mois
Stogicza 2019	Échoguidage (C2)	50	Non spécifiée	Non spécifiée

Névralgie du trijumeau

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Nally 1984	Ouverte	62	Non spécifiée	"Early" - 2,5 ans
Zakrzewska 1991	Ouverte	145	Non spécifiée	6 mois

Névralgie intercostale

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Jones 1987	Fluoroscopie	70	Aucune à totale (pire avec NPH)	1 sem-12 mois
Green 2002	Repères de surface	43	Significative chez la moitié	3 mois
Byas-Smith 2006	Échoguidage	1	100 %	2 mois
Moore 2010	CT-scan	18	45 %	Non spécifiée
Hunt 2010	VATS	1	100 %	9 mois
Connelly 2013	Échoguidage	3	85-100 %	2-9 mois
Koethe 2014	CT-scan	1	Non spécifiée	8 semaines



#cryoneurolysis



À la une

Récent

Personnes

Photos

Vidéos



Samer Narouze, MD, PhD @NarouzeMD · 13 avr.

#Ultrasound-Guided Percutaneous #Cryoneurolysis Decreasing #Opioid Consumption and Facilitating Extubation in a Patient with Traumatic Rib Fractures. #ASRASpring19 abstract by Margaret J. Chiu et al. @UCSDHealth



A parasagittal ultrasound view of T5-T8 intercostal nerves with labels of procedure. of cryoneurolysis probe.

<https://twitter.com/NarouzeMD/status/1117240882217005056> (accès le 2019.12.14)

Névralgies inguinales (nerf ilioinguinal et nerf génitofémoral)

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Fanelli 2003	Ouverte	10	77,5 %	Non spécifiée
Campos 2009	Échoguidée	1	50 %	3 mois

Méralgie paresthésique

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Johnson 2019	Échoguidage	1	Plus de 50 %	3 mois

Névromes post-amputation

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Moesker 2012	Repères de surface et neurostimulation	5	20-100 %	2,5 – 5 ans
Friedman 2012	Échoguidage	12	<i>None to marked relief</i>	6 sem-3 ans
Ramsook 2016	Échoguidage	1	100 %	6 mois
Prologo 2017	CT-scan ou échoguidage	21	Environ 66 %	5-7 mois

Névralgie infrapatellaire

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Trescot 2013	Repères de surface	1	"Sustained good relief"	1 an

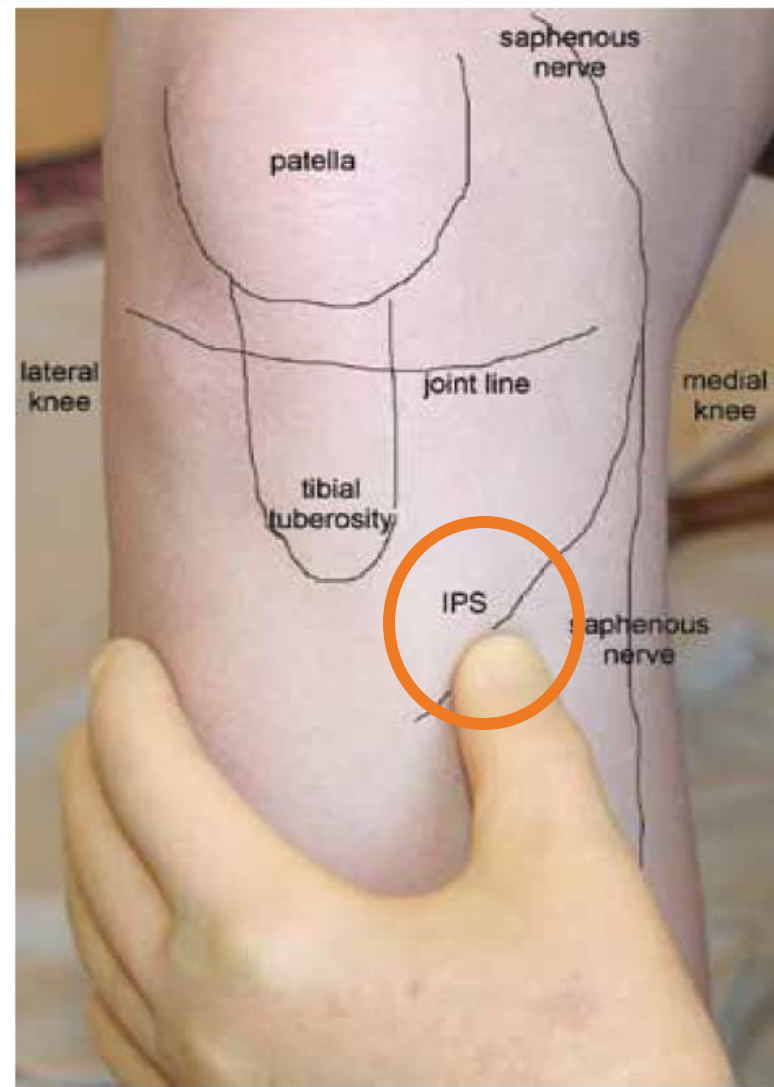


Fig. 5. Surface landmarks of the IPS .

Schwannomes névralgiques

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Martell 2014	CT-scan Branche proximale antérieure du nerf obturateur	1	100 %	6 mois
Mavrovi 2016	IRM Branche latérale cutanée du nerf iliohypogastrique	2	Aucun analgésique Lésions disparues	6 mois

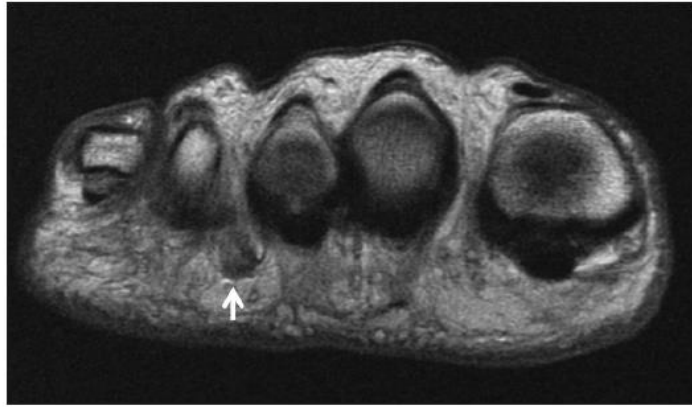
Névralgie surale

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Rhame 2011	Échoguidage	1	100 %	Q 3 mois
Bonham 2014	IRM	1	Environ 85 %	5 mois

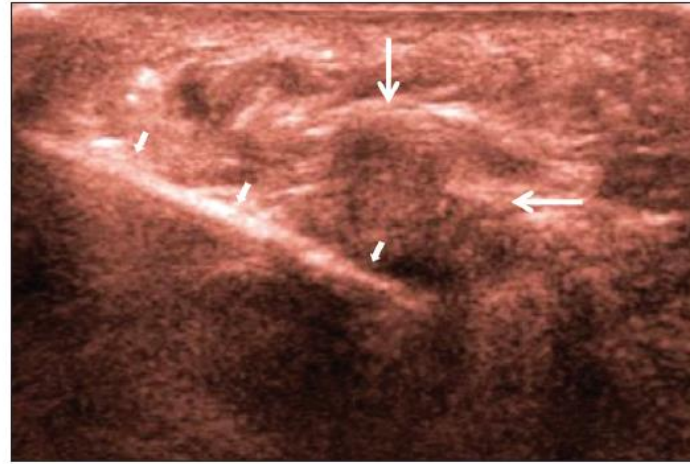
Névrome de Morton

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Hodor 1997	Repères de surface	1	100 %	6 mois
Caporusso 2002	Repères de surface	20	0-100 %	11 mois
Friedman 2012	Échoguidage	5	"None to marked relief"	4 sem-14 mois
Cazzato 2016	IRM	20	NRS moyen 3/10	19,7 mois

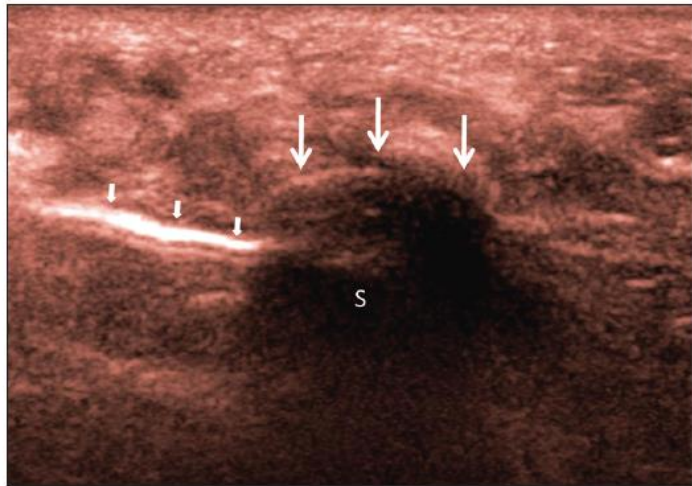
B



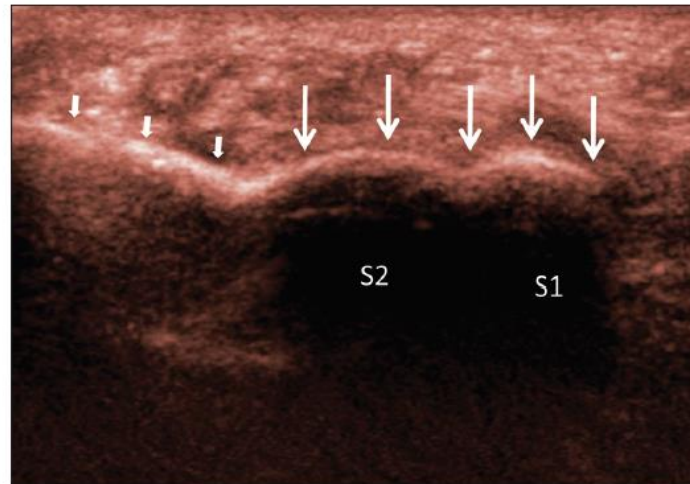
C



D



E



Névralgies périphériques diverses

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Yoon 2016	Échoguidage <ul style="list-style-type: none">• Digital• Ilioinguinal• Glutéal• Saphène• Gêniculé(s)• Tibial postérieur• Plantaire• Sural	22	Environ 75% Environ 40%	1 mois 6-12 mois

Névralgies diverses

Névralgies
faciales
(Barnard 1981)

Ulnaire et médian
(Wang 1985)

Obturateur
(Kim 1998)

Probable ACNES
(Weber 2002)

Fémoro-cutané
postérieur (Joshi
2017)

Pudendal
(Prologo 2015)

Nerf de Joplin
(Burke 2019)

Intercostobrachial
(Weber 2019)

Autres approches



Plexus brachial (Ramamurthy 1989)



Racines thoraciques (idem)



Racines sacrées (Evans 1981)

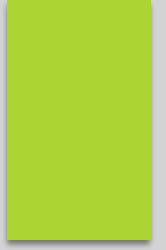


Ganglion impar (Loev 1998)



Vaporisateur cutané d'azote liquide – NPH
(Calandria 2011)

Syndromes musculo- squelettiques



Syndrome facettaire cervical

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Wolter 2018	CT-scan	5	"Adequate" (5/5)	Court terme

Éventuelle étude de non-infériorité vs. thermolésion

Syndrome facettaire lombaire

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Brechner 1981	Fluoroscopie	10	"Significatif" (9/10)	3 mois
Ross 1991	Fluoroscopie	23	"Complete"	6 mois-2 ans
Bärlocher 2003	Fluoroscopie	50	"Good response" 31/50	12 mois
Staender 2005	CT-scan	76	+50% (43/76)	6-14 mois
Birkenmaier 2007	Fluoroscopie	26	Environ 65%	6 mois
Birkenmaier 2007	Fluoroscopie	46	+50% (33/46)	6 sem-12 mois
Wolter 2011	CT-scan	91	35-45% (69/91)	1,7 an

Gonalgie

Auteur et date	Approche	Nombre de patients	Diminution intensité dlr	Durée
Radnovich 2017	Nerf infrapatellaire	180 Groupe sham OA lég/mod	50%	5 mois
Bellini 2015	?	4 (post-PTG)	50%	4 mois

Douleurs MSK diverses



Symphyse pubienne
(Glynn 1985)

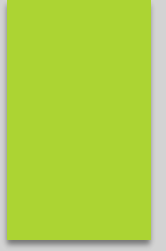


Arthralgie temporomandibulaire
(Sidebottom 2011)



Syndrome sacro-iliaque
(Bellini 2015)

Douleur cancéreuse



Mise en contexte



Expertise de radiologie interventionnelle



Cryoablation tumorale



Contexte palliatif



Publications émergentes



Séries de cas

Types de lésions néoplasiques

Revue systématique de Ferrer-Mileo, 2018

- ▶ Pancréas
 - ▶ Métastases hépatiques
 - ▶ Rectum
 - ▶ Métastases osseuses
-
- ▶ ORL (Dar 2012, Guenette 2017)
 - ▶ Mésenchymateuse paravertébrale (Li 2014)
 - ▶ Sarcome rétropéritonéal (Fan 2016)

Complications

Complications rapportées

Ecchymoses, œdème
localisé, erythème

Hypoesthésie
concordante

Alopécie

Hypo- et
hyperpigmentation

Engelure cutanée

Cas dispersés de névrite
(?effet préventif d'un
stéroïde)

Case
report: myonécrose du
vaste intermédiaire

Conclusion



Littérature surtout descriptive



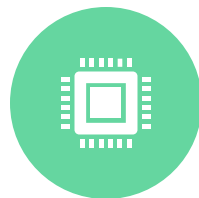
Large spectre d'indications potentielles



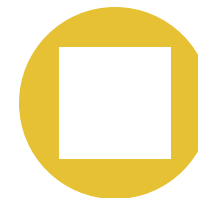
Faible incidence de complications sévères et/ou permanentes



Nouvelles sondes de cryoneurolyse





Évolution de la technologie échographique





Douleur aiguë et spasticité: nouveaux chapitres à suivre


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