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Loss of Surround Inhibition and After Sensation as Diagnostic Parameters of Complex Regional Pain Syndrome

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Author(s)

Marie Wojcik Wolanin, Robert J. Schwartzman, Guillermo Alexander, John Grothusen

ABSTRACT

Complex Regional Pain Syndrome (CRPS) is a severe chronic pain condition. Patients with CRPS experience allodynia, hyperalgesia, autonomic dysfunction, movement difficulties and dystrophic changes. However other characteristics that may be unique to the pain in CRPS require further study. This study evaluated pain parameters in ninety five subjects composed of three groups: healthy pain free controls, patients with radiculopathy and CRPS patients. Healthy subjects were tested in all four extremities, whereas radiculopathy and CRPS patients were tested only on the most affected extremity. All subjects were tested for the following pain parameters: thermal allodynia, mechanical static and dynamic allodynia, windup, and a hyperalgesic mechanical stimulus. All subjects were also evaluated for autonomic dysfunction, movement disorder and dystrophic skin changes. Statistically significant differences were found between both pain groups and the healthy control subjects as well as between the two pain groups. The finding that statistically differentiated CRPS from radiculopathy and normal controls was pain spread following an algescic mechanical and cold stimulus as well as after sensations to these stimuli. The study demonstrated a simple bedside test that discriminated between CRPS, radiculopathy and healthy control subjects.

KEYWORDS

CRPS; Complex Regional Pain Syndrome; Radiculopathy; Pain; After Sensation; Spread; Chronic Pain

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References

- [1] R. N. Harden and S. Bruehl, " Diagnostic Criteria: The Statistical Derivation of the Four Criterion Factors," In: P. R. Wilson, M. D. Stanton-Hicks and R. N. Harden, Eds., *CRPS: Current Diagnosis and Therapy*, IASP Press, Seattle, 2005. pp. 45-58.
- [2] R. J. Schwartzman, K. L. Erwin and G. M. Alexander, " The Natural History of Complex Regional Pain Syndrome," *The Clinical Journal of Pain*, Vol. 25, No. 4, 2009, pp. 273-280. doi:10.1097/AJP.0b013e31818becea5
- [3] W. Janig and R. Baron, " Complex Regional Pain Syndrome: Mystery Explained?" *The Lancet Neurology*, Vol. 2, No. 11, 2003, pp. 687-697.
- [4] P. H. Veldman, H. M. Reynen, I. E. Arntz and R. J. Goris, " Signs and Symptoms of Reflex Sympathetic Dystrophy: Prospective Study of 829 Patients," *Lancet*, Vol. 342, No. 8878, 1993, pp. 1012-1016.
- [5] P. U. Dijkstra, J. W. Groothoff, H. J. ten Duis and J. H. Geertzen, " Incidence of Complex Regional Pain Syndrome Type I after Fractures of the Distal Radius," *European Journal of Pain*, Vol. 7, No. 5, 2003, pp. 457-462.
- [6] A. L. Oaklander and H. L. Fields, " Is Reflex Sympathetic Dystrophy/Complex Regional Pain Syndrome Type I a Small-Fiber Neuropathy?" *Annals of Neurology*, Vol. 65, No. 6, 2009, pp. 629-638. doi:10.1002/ana.21692

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- [7] P. Krause, S. Forderreuther and A. Straube, " TMS Motor Cortical Brain Mapping in Patients with Complex Regional Pain Syndrome Type I," *Clinical Neurophysiology*, Vol. 117, No. 1, 2006, pp. 169-176. doi: 10.1016/j.clinph.2005.09.012
- [8] B. Pleger, P. Ragert, P. Schwenkreis, A. F. Forster, C. Wilimzig and H. Dinse, et al., " Patterns of Cortical Reorganization Parallel Impaired Tactile Discrimination and Pain Intensity in Complex Regional Pain Syndrome," *Neuroimage*, Vol. 32, No. 2, 2006, pp. 503-510. doi: 10.1016/j.neuroimage.2006.03.045
- [9] C. Maihofner, B. Neundorfer, F. Birklein and H. O. Handwerker, " Mislocalization of Tactile Stimulation in Patients with Complex Regional Pain Syndrome," *Journal of Neurology*, Vol. 253, No. 6, 2006, pp. 772-779. doi: 10.1007/s00415-006-0117-z
- [10] C. Maihofner, R. Baron, R. DeCol, A. Binder, F. Birklein, G. Deuschl, et al., " The Motor System Shows Adaptive Changes in Complex Regional Pain Syndrome," *Brain*, Vol. 130, No. 10, 2007, pp. 2671-2687. doi: 10.1093/brain/awm131
- [11] L. Becerra, R. J. Schwartzman, R. T. Kiefer, P. Rohr, E. A. Moulton, D. Wallin, et al., " CNS Measures of Pain Responses Preand Post-Anesthetic Ketamine in a Patient with Complex Regional Pain Syndrome," *Pain Medicine*, 25 February 2009. doi:10.1111/j.1526-4637.2009.00559.x
- [12] C. J. Woolf and M. W. Salter, " Neuronal Plasticity: Increasing the Gain in Pain," *Science*, Vol. 288, No. 5472, 2000, pp. 1765-1769.
- [13] S. S. Dhar and M. T. Wong-Riley, " Coupling of Energy Metabolism and Synaptic Transmission at the Transcriptional Level: Role of Nuclear Respiratory Factor 1 in Regulating Both Cytochrome C Oxidase and NMDA Glutamate Receptor Subunit Genes," *The Journal of Neuroscience*, Vol. 29, No. 2, 2009, pp. 483-492. doi:10.1523/JNEUROSCI.3704-08.2009
- [14] L. R. Watkins and S. F. Maier, " Immune Regulation of Central Nervous System Functions: From Sickness Responses to Pathological Pain," *Journal of Internal Medicine*, Vol. 257, No. 2, 2005, pp. 139-155. doi: 10.1111/j.1365-2796.2004.01443.x
- [15] F. Marchand, M. Perretti and S. B. McMahon, " Role of the Immune System in Chronic Pain," *Nature Reviews Neuroscience*, Vol. 6, No. 7, 2005, pp. 521-532. doi: 10.1038/nrn1700
- [16] G. M. Alexander, M. J. Perreault, E. R. Reichenberger and R. J. Schwartzman, " Changes in Immune and Glial Markers in the CSF of Patients with Complex Regional Pain Syndrome," *Brain, Behavior and Immunity*, Vol. 21, No. 5, 2007, pp. 668-676. doi: 10.1016/j.bbi.2006.10.009
- [17] J. Xu, H. Gu and T. J. Brennan, " Increased Sensitivity of Group III and Group IV Afferents from Incised Muscle in Vitro," *Pain*, Vol. 151, No. 3, 2010, pp. 744-755. doi: 10.1016/j.pain.2010.09.003
- [18] J. Xu and T. J. Brennan, " Guarding Pain and Spontaneous Activity of Nociceptors after Skin versus Skin Plus Deep Tissue Incision," *Anesthesiology*, Vol. 112, No. 1, 2010, pp. 153-164. doi: 10.1097/ALN.0b013e3181c2952e
- [19] B. Heppelmann, " Anatomy and Histology of Joint Innervation," *Journal of the Peripheral Nervous System*, Vol. 2, No. 1, 1997, pp. 5-16.
- [20] R. Rolke, W. Magerl, K. A. Campbell, C. Schalber, S. Caspari, F. Birklein, et al., " Quantitative Sensory Testing: A Comprehensive Protocol for Clinical Trials," *European Journal of Pain*, Vol. 10, No. 1, 2006, pp. 77-88. doi: 10.1016/j.ejpain.2005.02.003
- [21] G. F. Webster, R. V. Iozzo, R. J. Schwartzman, A. J. Tahmoush, R. L. Knobler and R. A. Jacoby, " Reflex Sympathetic Dystrophy: Occurrence of Chronic Edema and Nonimmune Bullous Skin Lesions," *Journal of the American Academy of Dermatology*, Vol. 28, No. 1, 1993, pp. 29-32.
- [22] M. de Mos, A. G. de Bruijn, F. J. Huygen, J. P. Dieleman, B. H. Stricker and M. C. Sturkenboom, " The Incidence of Complex Regional Pain Syndrome: A Population-Based Study," *Pain*, Vol. 129, No. 1-2, 2007, pp. 12-20. doi: 10.1016/j.pain.2006.09.008
- [23] C. J. Woolf and R. J. Mannion, " Neuropathic Pain: Aetiology, Symptoms, Mechanisms, and Management," *Lancet*, Vol. 353, No. 9168, 1999, pp. 1959-1964. doi: 10.1016/S0140-6736(99)01307-0
- [24] C. J. Woolf, " Windup and Central Sensitization Are Not Equivalent," *Pain*, Vol. 66, No. 2-3, 1996, pp. 105-108.

- [25] T. Graven-Nielsen and L. Arendt-Nielsen, " Assessment of Mechanisms in Localized and Widespread Musculoskeletal Pain," *Nature Reviews Rheumatology*, Vol. 6, No. 10, 2010, pp. 599-606. doi:10.1038/nrrheum.2010.107
- [26] S. Bruehl, " An Update on the Pathophysiology of Complex Regional Pain Syndrome," *Anesthesiology*, Vol. 113, No. 3, 2010, pp. 713-725. doi:10.1097/ALN.0b013e3181e3db38
- [27] D. F. Russell and D. K. Hartline, " Bursting Neural Networks: A Reexamination," *Science*, Vol. 200, No. 4340, 1978, pp. 453-456.
- [28] M. L. Sotgiu and G. Biella, " Spinal Expansion of Saphenous Afferents after Sciatic Nerve Constriction in Rats," *Neuroreport*, Vol. 6, No. 17, 1995, pp. 2305-2308.
- [29] M. L. Sotgiu and G. Biella, " Spinal Neuron Sensitization Facilitates Contralateral Input in Rats with Peripheral Mononeuropathy," *Neuroscience Letters*, Vol. 241, No. 2-3, 1998, pp. 127-130.
- [30] G. Guilbaud, J. M. Benoist, A. Levante, M. Gautron and J. C. Willer, " Primary Somatosensory Cortex in Rats with Pain-Related Behaviours Due to A Peripheral Mononeuropathy after Moderate Ligation of One Sciatic Nerve: Neuronal Responsivity to Somatic Stimulation," *Experimental Brain Research*, Vol. 92, No. 2, 1992, pp. 227-245.
- [31] V. Morisset and F. Nagy, " Plateau Potential-Dependent Windup of the Response to Primary Afferent Stimuli in Rat Dorsal Horn Neurons," *European Journal of Neuroscience*, Vol. 12, No. 9, 2000, pp. 3087-3095.
- [32] J. Palecek, V. Paleckova, P. M. Dougherty, S. M. Carlton and W. D. Willis, " Responses of Spinothalamic Tract Cells to Mechanical and Thermal Stimulation of Skin in Rats with Experimental Peripheral Neuropathy," *Journal of Neurophysiology*, Vol. 67, No. 6, 1992, pp. 1562-1573.
- [33] J. M. Laird and G. J. Bennett, " An Electrophysiological Study of Dorsal Horn Neurons in the Spinal Cord of Rats with an Experimental Peripheral Neuropathy," *Journal of Neurophysiology*, Vol. 69, No. 6, 1993, pp. 2072-2085.
- [34] I. Omana-Zapata, M. A. Khabbaz, J. C. Hunter and K. R. Bley, " QX-314 Inhibits Ectopic Nerve Activity Associated with Neuropathic Pain," *Brain Research*, Vol. 771, No. 2, 1997, pp. 228-237.
- [35] M. L. Sotgiu, M. Lacerenza and P. Marchettini, " Effect of Systemic Lidocaine on Dorsal Horn Neuron Hyperactivity Following Chronic Peripheral Nerve Injury in Rats," *Somatosensory and Motor Research*, Vol. 9, No. 3, 1992, pp. 227-233.
- [36] C. Monteiro, D. Lima and V. Galhardo, " Switching-On and -Off of Bistable Spontaneous Discharges in Rat Spinal Deep Dorsal Horn Neurons," *Neuroscience Letters*, Vol. 398, No. 3, 2006, pp. 258-263. doi:10.1016/j.neulet.2006.01.008
- [37] R. E. Russo and J. Hounsgaard, " Plateau-Generating Neurones in the Dorsal Horn in an in Vitro Preparation of the Turtle Spinal Cord," *The Journal of Physiology*, Vol. 493, No. 1, 1996, pp. 39-54.
- [38] V. Morisset and F. Nagy, " Modulation of Regenerative Membrane Properties by Stimulation of Metabotropic Glutamate Receptors in Rat Deep Dorsal Horn Neurons," *Journal of Neurophysiology*, Vol. 76, No. 4, 1996, pp. 2794-2798.
- [39] C. Reali and R. E. Russo, " An Integrated Spinal Cord-Hindlimbs Preparation for Studying the Role of Intrinsic Properties in Somatosensory Information Processing," *Journal of Neuroscience Methods*, Vol. 142, No. 2, 2005, pp. 317-326. doi:10.1016/j.jneumeth.2004.09.006
- [40] V. Morisset and F. Nagy, " Nociceptive Integration in the Rat Spinal Cord: Role of Non-Linear Membrane Properties of Deep Dorsal Horn Neurons," *European Journal of Neuroscience*, Vol. 10, No. 12, 1998, pp. 3642-3652.
- [41] A. Fuchs, M. Rigaud, C. D. Sarantopoulos, P. Filip and Q. H. Hogan, " Contribution of Calcium Channel Subtypes to the Intracellular Calcium Signal in Sensory Neurons: The Effect of Injury," *Anesthesiology*, Vol. 107, No. 1, 2007, pp. 117-127. doi:10.1097/01.anes.0000267511.21864.93
- [42] V. Morisset and F. Nagy, " Ionic Basis for Plateau Potentials in Deep Dorsal Horn Neurons of the Rat Spinal Cord," *The Journal of Neuroscience*, Vol. 19, No. 17, 1999, pp. 7309-7316.
- [43] D. Derjean, S. Bertrand, G. Le Masson, M. Landry, V. Morisset and F. Nagy, " Dynamic Balance of Metabotropic Inputs Causes Dorsal Horn Neurons to Switch Functional States," *Nature Neuroscience*, Vol. 6, No. 3, 2003, pp. 274-281.

- [44] C. J. Woolf and A. E. King, " Physiology and Morphology of Multireceptive Neurons with C-Afferent Fiber Inputs in the Deep Dorsal Horn of the Rat Lumbar Spinal Cord," *Journal of Neurophysiology*, Vol. 58, No. 3, 1987, pp. 460-479.
- [45] M. L. Sotgiu, G. Biella and L. Riva, " Poststimulus after Discharges of Spinal WDR and NS Units in Rats with Chronic Nerve Constriction," *Neuroreport*, Vol. 6, No. 7, 1995, pp. 1021-1024.
- [46] Q. H. Hogan, " Role of Decreased Sensory Neuron Membrane Calcium Currents in the Genesis of Neuropathic Pain," *Croatian Medical Journal*, Vol. 48, No. 1, 2007, pp. 9-21.
- [47] M. Rigaud, G. Gemes, P. D. Weyker, J. M. Cruikshank, T. Kawano, H. E. Wu, et al., " Axotomy Depletes Intracellular Calcium Stores in Primary Sensory Neurons," *Anesthesiology*, Vol. 111, No. 2, 2009, pp. 381-392. doi:10.1097/ALN.0b013e3181ae6212
- [48] A. Fuchs, M. Rigaud and Q. H. Hogan, " Painful Nerve Injury Shortens the Intracellular Ca²⁺ Signal in Axotomized Sensory Neurons of Rats," *Anesthesiology*, Vol. 107, No. 1, 2007, pp. 106-116. doi:10.1097/01.anes.0000267538.72900.68
- [49] R. J. Schwartzman, G. M. Alexander and J. Grothusen, " Pathophysiology of Complex Regional Pain Syndrome," *Expert Review of Neurotherapeutics*, Vol. 6, No. 5, 2006, pp. 669-681. doi:10.1586/14737175.6.5.669
- [50] L. Del Valle, R. J. Schwartzman and G. Alexander, " Spinal Cord Histopathological Alterations in a Patient with Longstanding Complex Regional Pain Syndrome," *Brain, Behavior and Immunity*, Vol. 23, No. 1, 2009, pp. 85-91. doi:10.1016/j.bbi.2008.08.004
- [51] A. B. Malmberg, C. Chen, S. Tonegawa and A. I. Basbaum, " Preserved Acute Pain and Reduced Neuropathic Pain in Mice Lacking PKC γ ," *Science*, Vol. 278, No. 5336, 1997, pp. 279-283.
- [52] W. J. Martin, A. B. Malmberg and A. I. Basbaum, " PKC-gamma Contributes to a Subset of the NMDA-Dependent Spinal Circuits that Underlie Injury-Induced Persistent Pain," *The Journal of Neuroscience*, Vol. 21, No. 14, 2001, pp. 5321-5327.
- [53] D. Fuchs, F. Birklein, P. W. Reeh and S. K. Sauer, " Sensitized Peripheral Nociception in Experimental Diabetes of the Rat," *Pain*, Vol. 151, No. 2, 2010, pp. 496-505. doi:10.1016/j.pain.2010.08.010
- [54] T. Yokota, N. Nishikawa and Y. Nishikawa, " Effects of Strychnine upon Different Classes of Trigeminal Subnucleus Caudalis Neurons," *Brain Research*, Vol. 168, No. 2, 1979, pp. 430-434.
- [55] T. Yokota and Y. Nishikawa, " Action of Picrotoxin upon Trigeminal Subnucleus Caudalis Neurons in the Monkey," *Brain Research*, Vol. 171, No. 2, 1979, pp. 369-373.
- [56] S. Steer, B. Lad, J. A. Grumley, G. H. Kingsley and S. A. Fisher, " Association of R602W in a Protein Tyrosine Phosphatase Gene with a High Risk of Rheumatoid Arthritis in a British Population: Evidence for an Early Onset/Disease Severity Effect," *Arthritis & Rheumatism*, Vol. 52, No. 1, 2005, pp. 358-360. doi:10.1002/art.20737
- [57] M. L. Sotgiu, M. Brambilla, M. Valente and G. E. Biella, " Contralateral Input Modulates the Excitability of Dorsal Horn Neurons Involved in Noxious Signal Processes. Potential Role in Neuronal Sensitization," *Somatosensory and Motor Research*, Vol. 21, No. 3-4, 2004, pp. 211-215. doi:10.1080/08990220400012539
- [58] L. S. Sorkin and M. S. Wallace, " Acute Pain Mechanisms," *Surgical Clinics of North America*, Vol. 79, No. 2, 1999, pp. 213-229.
- [59] M. H. Pitcher and F. Cervero, " Role of the NKCC1 Co-Transporter in Sensitization of Spinal Nociceptive Neurons," *Pain*, Vol. 151, No. 3, 2010, pp. 756-762. doi:10.1016/j.pain.2010.09.008
- [60] C. Maihofner, H. O. Handwerker, B. Neundorfer and F. Birklein, " Cortical Reorganization during Recovery from Complex Regional Pain Syndrome," *Neurology*, Vol. 63, No. 4, 2004, pp. 693-701.
- [61] G. L. Moseley, " Distorted Body Image in Complex Regional Pain Syndrome," *Neurology*, Vol. 65, No. 5, 2005, pp. 773. doi:10.1212/01.wnl.0000174515.07205.11
- [62] J. Scholz, A. Abele, C. Marian, A. Haussler, T. A. Herbert and C. J. Woolf, et al., " Low-Dose Methotrexate Reduces Peripheral Nerve Injury-Evoked Spinal Microglial Activation and Neuropathic Pain Behavior in Rats," *Pain*, Vol. 138, No. 1, 2008, pp. 130-142. doi:10.1016/j.pain.2007.11.019
- [63] C. Maihofner, H. O. Handwerker, B. Neundorfer and F. Birklein, " Patterns of Cortical Reorganization in Complex Regional Pain Syndrome," *Neurology*, Vol. 61, No. 12, 2003, pp. 1707-1715.

- [64] B. Pleger, M. Tegenthoff, P. Ragert, A. F. Forster, H. R. Dinse and P. Schwenkreis, et al., " Sensorimotor Retuning [Corrected] in Complex Regional Pain Syndrome Parallels Pain Reduction," *Annals of Neurology*, Vol. 57, No. 3, 2005, pp. 425-429. doi:10.1002/ana.20394
- [65] A. Lebel, L. Becerra, D. Wallin, E. A. Moulton, S. Morris, G. Pendse, et al., " FMRI Reveals Distinct CNS processing During Symptomatic and Recovered Complex Regional Pain Syndrome in Children," *Brain*, Vol. 131, No. 7, 2008, pp. 1854-1879. doi:10.1093/brain/awn123
- [66] P. J. Albrecht, S. Hines, E. Eisenberg, D. Pud, D. R. Finlay, M. K. Connolly, et al., " Pathologic Alterations of Cutaneous Innervation and Vasculature in Affected Limbs from Patients with Complex Regional Pain Syndrome," *Pain*, Vol. 120, No. 3, 2006, pp. 244-266. doi:10.1016/j.pain.2005.10.035
- [67] K. A. Moore, T. Kohno, L. A. Karchewski, J. Scholz, H. Baba and C. J. Woolf, " Partial Peripheral Nerve Injury Promotes a Selective Loss of GABAergic Inhibition in the Superficial Dorsal Horn of the Spinal Cord," *The Journal of Neuroscience*, Vol. 22, No. 15, 2002, pp. 6724-6731. doi:20026611
- [68] G. T. Whiteside and R. Munglani, " Cell Death in the Superficial Dorsal Horn in a Model of Neuropathic Pain," *The Journal of Neuroscience Research*, Vol. 64, No. 2, 2001, pp. 168-173
- [69] A. S. Malik, O. Boyko, N. Atkar and W. F. Young, " A Comparative Study of MR Imaging Profile of Titanium Pedicle Screws," *Acta Radiologica*, Vol. 42, No. 3, 2001, pp. 291-293. doi:10.1080/028418501127346846