

# Case Study on Chronic Pain Management with Millimetric Waves: A One-Year Follow-Up on Allodynia

Debouzy JC<sup>1</sup>, Guillemin F<sup>2</sup>, Crouzier D<sup>3</sup>

<sup>1</sup>7e centre Médical des armées, Quartier Reyniès, 38760 Varcès,  
Corresponding Author Email: [jcddebouzy\[at\]gmail.com](mailto:jcddebouzy[at]gmail.com)

<sup>2</sup>IG, av de la falaise 38360 Sassenage, France  
Email: [i.guillemin68\[at\]gmail.com](mailto:i.guillemin68[at]gmail.com)

<sup>3</sup>Remedee Labs, chemin de l'étoile, 38330 Montbonnot, France  
Email: [david.crouzier\[at\]wanadoo.fr](mailto:david.crouzier[at]wanadoo.fr)

**Abstract:** *This communication aims to illustrate the complexity of healthcare in the context of chronic pain pathologies based on our previous publications. Hence, Armstrong and colleagues, and IASP [1, 2], clearly distinguish three main modes of pain: nociceptive, neuropathic, and nociplastic. In health care, etiological treatment of any lesion is the obvious effective approach, especially for nociceptive and/or neuropathic pain, where the support of the injury, whether it is anatomical tissue or nerve, is generally known. As regards the third type of pain - nociplastic, where the multifocal painful context (the usual hyperesthesia, among others) is in the foreground, the response to "pharmacological" therapies is disappointing, leading to a chronic evolution and to psychological and social consequences. Besides, non-pharmacological therapies (e.g. physical, acupuncture, TENS...) have provided good results in the care of chronic pain. Since 2015, miniaturized solutions have allowed the personal use of well-recognized analgesic properties of millimeter waves (MMW) - outside medical structures- in the management of chronic pain, and in particular neuroplastic or nociplastic pain, independently of any etiology. This case study explores the use of millimetric waves MMW in managing chronic pain, specifically in a patient suffering from allodynia following an acute trauma. Over a one-year weekly follow-up, the patient utilized a portable MMW-emitting wristband, leading to notable improvements in pain management, sleep quality, and overall quality of life. A special attention was paid to 1. Quality of life (PSQI, SF36), including environmental professional and personal factors and constraints-; 2. Pain (VAS and SF36), sleep quality (PSQI), and all-day life conditions (FIQc, PSQI, SF36). These scores were recorded at the beginning and the end of the observation period. The findings suggest that MMW therapy can be a viable non-pharmacological treatment for chronic neuroplastic pain, with significant implications for future research and clinical practice. This communication should be considered as an illustrative case report, this completing our other previous works mentioned in the bibliography (e.g. ref 9,11, 28-34). Thus, several parts in the present introduction section are close to those of previous papers.*

**Keywords:** millimetric waves, chronic pain care, nociplastic, fibromyalgia

## 1. Introduction

Activation of normal nociceptors, neuropathic (lesion or disease affecting the somatosensory system), and neuroplastic pain (linked to alterations in nociception) can play roles of different degrees, depending on the etiology, whether curable or not, the neurological consequences, and the automation of pain by maladaptation (exaggeration) of the pain response [3]. Regarding nociplastic pain (fibromyalgia, allodynia, etc.), pharmacological care exists, at the cost of limited and temporary responses, and side effects often leading to withdrawal of the treatment; this is why non-pharmacological treatments have also been proposed (generally physical agents, e.g., acupuncture, physiotherapy, sports activities) which are generally, if not completely effective, have the merit of having little side effects or toxicity. Among them, Millimeter wave (MMW) therapy was discovered in the 1970s in USSR countries and used clinically for their hypoalgesia properties in various pain pathologies [4, 5]. Subsequently, these hypoalgesia properties were related to a central nervous system response following peripheral stimulation, mainly involving the secretion of endorphins, as well as other neurotransmitters such as parasympathetic, DOPA, etc, [6, 7]. After 2010, the

development of miniaturized solutions allowed the personal use of MMWs -outside medical structures- in the management of chronic pain, and in particular neuroplastic or nociplastic pain, independently of any etiology [8, 9]. We report here a case of chronic pain, related both to fibromyalgia/allodynia and probably neuropathic contributions (Arnold-like looking pains) after initial pain due to a car accident. The patients experienced the use of a portable, wristband designed, MMW system (This device was first intended for wellness or stress relief purposes). The purpose of this article is to evaluate the effectiveness of millimetric waves MMW as a non-pharmacological treatment for chronic pain, illustrated through a case study of a patient with allodynia.

## 2. Materiel and methods

Our patient, a woman born in 1968, tried out the MMW transmitter bracelets available on the internet and initially intended to improve well-being and sleep, and to relieve stress [10, 11]. The basic principle of this system uses the analgesic properties of millimeter waves (in the 30-90 GHz bands), widely described in the last decade of the 20th century, and more recently reviewed in some recent studies

and reports [12]. As described in former papers [11], the basic mechanism relies on endorphin secretions from the Central Nervous System, which in turn is triggered by a peripheral stimulus (i.e., MMW) applied to the cutaneous receptors of the wrist. In practice, as described elsewhere [12], the miniaturized transmitter is mounted on a bracelet and worn like a watch: this device emits a continuous electromagnetic wave of 60 GHz at a power density of 14mW/cm<sup>2</sup> on 2cm<sup>2</sup> in contact with skin surface (3 sessions of 30 or 37 minutes per day) on the palmar side of the wrist, i.e., in very close contact with the median nerve. We report here on the time course of the patient’s pain management, quality of life, and autonomy. To achieve these goals, various specific questionnaires were fulfilled at the beginning and the end of the observation period (covering 1 year), to investigate: VAS [13]: Visual Analogue Scale (VAS) is a measurement instrument that tries to measure a characteristic or attitude that is believed to range across a continuum of values, not discrete values [14]. SF36, Short Form Survey (SF-36)[15, 16] Scoring, which derived calculations allow to estimate physical functioning, role limitations due to physical health, role limitations due to emotional problems, energy/fatigue, emotional well-being, social functioning, pain, and general health; FIQ-C Fibromyalgia Impact Questionnaire [17] of 10 items leading to a numeric scoring with 3 classes (normal, to survey, to consult medical staff); PGIC, Patients’ Global Impression of Change (PGIC)[18] scale, to describe changes -if any- in activity limitations, symptoms, quality of life related to pain. PSQI, Pittsburgh Sleep Quality Index [19], scoring the usual sleep habits during the past month only. Besides, the brief weekly feedback was collected over the same period, including pain evaluation and localization (VAS), pharmaceutical care, MMW use (sessions per day), sleep, stress, and other intercurrent events.

### 3. Case description

The initial event is a public road accident (2015), involving a rear impact and “whiplash”. During the following period, she manifested vestibular signs, mainly left, in particular sensations of seasickness and dizziness, at the time related to dysfunctions of the otoliths. As considered like vestibular dysfunction (cranial pair VIII) physiotherapist and orthoptist, care and re-education were realized, unsuccessfully. Arnold’s neuralgia was initially evoked from the clinical context (from a headache involving the scalp, dizziness, sleep disturbances, history of car accident). The numerous neurologic and vestibular explorations eliminated Arnold’s neuralgia (period 2015-2016), whereas no definitive diagnosis was established; However, chronic pain set up progressively until 2020. As soon as 2019, staged uncinat disc arthrosis C4-C5, C5-C6, C6-C7 was observed by MRI, and herniated discs identified from 2020. Conversely, electromyographic recording were found normal. Finally, such hyperesthesia was identified as allodynia, with special localization to the C2 C3 nerve roots, and symmetrical irradiations in the trigeminal (V2,3) and facial (VII) territories, and towards the vault. Since 2020, pain was particularly provoked by simple touch (e.g., wearing glasses or setting in headrest position), with hours pain duration. Dizziness and pain were also enhanced during the week preceding the menstrual cycle, at night and before daily work. Also, falling asleep and sleep quality were also strongly altered. As a professional consequence, her health

status required an adapted workstation for the disabled, and special PC screens. Medical care first consisted of several local peripheral infiltrations only resulted in temporary partial pain relief. Besides, current care consisted of tense applications and analgesic (paracetamol) and antidepressant / non-selective monoamine reuptake inhibitor (Laroxyl: Amitriptyline). When the observation period (July 2022) began, allodynia was present, with headaches and various pain localizations (cervical, shoulders, hips, and elbows). Sleep was deeply altered (80%); current VAS was 3, with throbbing pain (see tables). She started to wear the watch-designed, millimetric emitting device, first intended for wellness or stress relief purposes [20]. Initially, use consisted of 3 sequences of 30 min a day, while later (6 months), she adapted the use to 4 sequences of less power and longer durations (37min). In between, she had withdrawn any pharmaceutical treatment. The results, noted for headache, pain, sleep, recovery after exercise were mild, but real even if inconstant.

**Table I:** Scores evolution

	Initial	Final	Comments
VAS	Mean 3; in crisis 8-9	-1 in intensity and duration	
FIQ-R• All day life	12	7	
Symptoms	31	24	
Total (21)	43	31	35: nearly normal 50: care required
PSQI	15	15	Due to Snoring, pain
PGIC (18)	--	3	A little better, but no noticeable change

Importance of physical activity and sleep perturbations

The latter was specially related with professional constraints and threats, and to various stress (periods, intense exercises or works, vibration in transport, wearing a helmet, full moon...) that deteriorated the general condition, or with holidays, resting period, that improved the overall signs. Subsequently, the neurologist prescribed her duloxetine (30 to 60 mg, classical daily doses) and pregabalin (up to 75mg) was proposed after electromyographic results. No noticeable clinical change was obtained. As important side effects were observed (headache, dizziness, drowsiness, digestive (nausea-constipation), weight gain, and mood disorders), this treatment was finally withdrawn. The scores at the end of the observation period are presented on tables I and II.

**Table II:** Calculated SF36 score before and after 1-year MMW trial.

SF36	Initial	Final
a) Physical functioning	75	80+
b) Role limitation due to physical health	100	100
c) Role limitation due to emotional problems	66	33
d) Energy/fatigue	45	35
e) Emotional well-being	44	56
f) Social functioning	61	75+
g) Pain	45	45
h) General health	75	80

### Scores from questionnaires Final / vs Initial (tables I and II)

**Pain:** was addressed directly by VAS evaluation and from 2 items in SF36 form. Whereas the latter failed to detect any difference item g, VAS=4-5), overall evaluation noticed average improvement, even if slight (1 point, table I). It is noticeable that this feature must be modulated by the great variability in time and following the environmental circumstances. For instance, professional constraints led to increased pain; besides, atypical headache is present from time to time, -up to become insupportable-. these features are still present.

**Physical performances and functioning.** Physical limitations (SF36-b) were not clearly improved, except for long ballads during holidays. Note that the willingness of the patient was determining, and similarly role limitations related with emotion (SF36-c), and all-day life (FIQ) evidenced some improvements.

**Sleep (PSQI):** despite several periods of better sleep (up to a whole calm night) were noted, they were both inconstant and heterogeneous in intensity and with time. Causing features were more or less related to snoring or pain.

**Impact of fibromyalgia (FIQ-r):** Impact of fibromyalgia (FIQ-r): for the same reasons, the whole score was not dramatically enhanced (from 43, to control to 35, subnormal). This is all in agreement with the limited enhancement calculated on SF36-h, general health, raised from 75 to 80.

## 4. Discussion and Conclusion

In the field of chronic post-surgical or post-traumatic chronic pain, there is frequently a dissociation between pain, discomfort, and structural/medical support. This disconnect was related by Ossipov [22] to neuroplastic changes occurring in the peripheral and central nervous systems. Even if a possible triggering factor exists (trauma...), the initial organic context does not explain the transition to chronicity. Gatchel et al. [23] mentioned that "patient exhibits a vulnerability to dysregulation of central feedback circuits that control sympathetic tone, inflammation, circadian rhythms (central and peripheral clocks), gut microbiome, metabolic redox and whole joint pathology". The consequences are a loss of autonomy, the limitation of daily physical activities, dissociation, etc., especially since long-term drug treatment is generally disappointing. In the case reported here neuroplastic processes lead to an imbalance of the inhibitory systems and of a sensitization mechanism.

Faced with the limited effectiveness of therapeutic solutions not devoid of side effects, the search for non-invasive, non-drug solutions meets a growing expectation of patients, especially if they are effective and ambulatory. The first non-drug treatment recommended for patients suffering from chronic pain is "physical exercise" [24], but it is extremely difficult for sufferers to exercise when even simple everyday actions are painful. Physical stimulations of the peripheral nervous system have also been proposed [25]: treatments such as massages, spa treatments, acupuncture, cryotherapy, or even electrical stimulation (CTMs). These solutions, although effective, require significant expenditure of time

and money. Among these methods, local exposure to low-intensity millimeter waves, appears as a reasonably conceivable method of central production of endorphins, devoid of side effects. Recently, the advanced miniaturization of the system makes it ambulatory, and even portable (by integration for example in a bracelet, marketed as a non-medical well-being source device) and self-manageable by the patient, all constituting a considerable advantage. The National Center for Complementary and Alternative Medicine (NCCAM, USA) [26] had also identified "this form of treatment (MMW) as one of the main fields of complementary and alternative medicine in terms of 'analgesia', following the identification of so-called nociplastic pain, including fibromyalgia". This similarly applies to allodynia generally more or less associated to fibromyalgia. From classical works and literature review [27, 28], and from results obtained from our own experimental and clinical results, [29, 30], response to MMW could be coarsely separated into three classes: Immediate [31] or very short term [32, 33], dramatic improvement of health status, pain and functions; this class does not probably exceed 10-15 % of the patients; Conversely, about 20% of patients found no improvement in their overall pain or quality of life, for instance. These "non-responders" patients are generally also non-responders to other peripheral stimulations, e.g. TENS or acupuncture (unpublished data). Most of the population experienced mixed, slight, and often inconstant results, as here, especially when other contributions to pain were intricate (somatic or neuropathic). Besides, a placebo effect probably also exists, making the interpretation almost puzzling. Objectively, in the present case, whereas headaches were still frequently present, vertebral vascular contribution was not definitively excluded (MRI examination showed several cervical disc herniation with early osteoarthritis). Hence, after the initial trauma, neuropathic contribution was highly probable, leading to chronic pain and imbalance in pain regulation. It was noted that acute events occurred after activities, especially homework (e.g. tiling, carrying loads or maintenance) of significant duration where all body and especially neck mobility was systematically involved. Such features would also -at least- partially explain the irregularity in the response to MMW. However, whereas sleep was still of inconstant quality, mean pain (-1, table I), pain intensity and duration in crisis (-1) and quality of life lightly were somehow improved. Also, physical activity was enhanced. Besides, no adverse effect was present, rather limitations of side effects of other medications (Duloxetine). It is worth to note that, as the survey/weekly reports lasted more than 1 year after the experimental period described here, late features occurred: the MMW system crashed due to a battery issue. As several weeks passed before the device was replaced, the patient experimented with a "treatment-free" period: clinical symptoms reappeared both in frequency and intensity (headache, dizziness, sleep disorder...). This pointed to her the significant effect of the device, as because she had become accustomed to the improvement in everyday life. Moreover, after MMW system replacement, she noted sleep was improved again (both in quality and in frequency of awakening events). This was also the case for recovery after physical exertion, and also for pain (whereas the same response heterogeneity was noted as during the observation period). This latter feature might be the cause of a bias in the interpretation of the results (VAS, SF36 pain...). Obviously,

if one expects an important pain relief over a long running time, etiological treatment of nociceptive and neuropathic components of pain are the points to satisfy. In conclusion, this case study demonstrates that millimetric wave therapy can be an effective, non-invasive treatment for chronic pain, particularly for conditions like allodynia and fibromyalgia. The therapy showed improvements in pain management and quality of life, suggesting its potential as an alternative to traditional pharmacological treatments. Further clinical trials are recommended to validate these findings and explore the broader applicability of this treatment modality.

**COI:** Dr Crouzier works presently for Remedee Labs.

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## Author Profile



**Jean-Claude DEBOUZY**, Professor, MD, PhD, First worked as a medical doctor before moving towards research in biophysics (NMR), then electromagnetic waves (OEM). He is OEM referent for the army health service in France and continues his work on the biological effects of millimetre waves, and medical practising.