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History of Neurology

Jules Tinel (1879–1952): Beyond the eponym, the man and his forgotten neurological contributions



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ABSTRACT

The trauma of World War I had a lasting impact on clinician and physiologist Jules Tinel (1879–1952). His treatment of peripheral nervous system injuries led him, in 1917, to describe the eponymous sign that he linked to activity of the sympathetic nervous system. Among the sequelae of nerve injuries, he was confronted with causalgia that he attributed, here again, to the autonomic nervous system, the main focus of his laboratory research throughout his career. Tinel's sign became so well known that it eclipsed the originality of his seminal descriptions of exertional headache and of hypertensive emergency caused by pheochromocytoma, which could also have been associated with his name. He was always able to marry his clinical practice of neurology and psychiatric consultations with his anatomicopathological, physiological and pathophysiological research, which was based on his daily practice as a physician. At the same time, he directed the work of numerous assistants in his research laboratory, which has since been unjustly forgotten. Several hundreds of scientific publications, including three seminal works, bear witness to his intense activity, which he combined with a genuine talent for teaching and making his findings accessible to a wider public. Those publications alone would fully justify the historical value of extending his renown beyond the existing eponym.

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1. A life dominated by medicine and world wars

To reduce a man to his eponym is to neglect the originality and diversity of a life's work. Most of the articles mentioning Jules Tinel (1879–1952; Fig. 1) or Tinel's sign (or test) offer only a concise summary of his life, career and work [1,2]. Here, for the first time, is presented an expanded biography, thus exhuming Tinel from the purgatory of oblivion, as justified by his full and varied career.

His grandfather, Jules Hélot (1814–1873), was a surgeon at the hospital in Rouen, and his father, Charles-Armand Tinel (1831–1914), was an anatomy professor at the Rouen medical school and a surgeon. Jules Tinel, born in Rouen on 13 October 1879, was the fifth generation of physicians in this Norman medical family [3]. After starting his medical studies in Rouen, he was ranked 321st out of 332 successful candidates (702 overall) in the competitive exam for *externes* at the Paris hospitals in 1900 [4]. He received his initial training in neurology from Louis Landouzy (1845–1917) at Hôpital Laennec in 1903, followed by Joseph Dejerine (1849–1917) at

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Fig. 1 – Jules Tinel in 1909 as an interne at La Salpêtrière. (Enlargement of a photo in the *Album photographique de l'internat*, BIU Santé Paris, public domain).

La Salpêtrière in 1904. Both teachers considered him an “excellent externe”. Ranking a brilliant third on the competitive *internat* exam in 1905, he chose to work as an *interne* (houseman) under these two teachers in 1908 and 1909 [4]. In 1910, Arnold Netter (1855–1936) trained him in infectious pathology and completed his apprenticeship in pathological anatomy. It was in Netter’s department that he met Louise-Marianne Giry-Wissembourg (1873–1914; Fig. 2), the first Frenchwoman to pass the exam for *internes*. He married her shortly thereafter¹ and helped her prepare her thesis on the first recognized widespread epidemic of poliomyelitis (Heine–Médis disease) in the spring of 1909 in Paris [5].

During his time as an *interne* under Dejerine, on 6 May 1909, he proposed a semiological innovation that made it possible to distinguish organic anesthetics from hysterical anesthetics, using two tuning forks (‘diapason’) vibrating at different frequencies. The first tuning fork produced a vibratory sensation, the second an auditory impression. He cited a case of complete anesthesia in one arm due to a traumatic lesion of the brachial plexus, where the vibrations of the tuning fork placed on a metacarpal were not perceived, but the sound transmitted by “bone conduction of sonic vibrations to the labyrinth” was [6]. In contrast, in the case of hysteria, nothing can be perceived [6].

Landouzy presided over the jury for Tinel’s own thesis [7]. The subject, ‘*Radiculitis and Tabes: Radicular lesions in meningitis, pathogenesis of tabes*’, was suggested by Dejerine, while Tinel (Fig. 3) proposed a pathophysiology for the symptomatology of

¹ Jean Tinel (1912–1999) was Jules Tinel’s son from this marriage. In 1916, Tinel married Marie-Juliette May and had three other children.



Fig. 2 – Tinel’s first wife, Louise-Marianne Giry-Wissembourg, was the only woman (back row) in this photo taken at Hôpital Saint-Antoine in 1908–1909. (From the *Album photographique de l'internat*, BIU Santé Paris, public domain).

tabes, continuing the work of Jean Nageotte (1866–1948) [8]: “Having encountered a certain number of these cases, which are rare and in which syphilitic radiculitis precedes or accompanies the progression of tabes, we have attempted the anatomical and experimental study of inflammatory processes of radicular sheaths” [7]. He considered these sheaths to be the initial localization of tabes, especially at the posterior roots, in the extension of the posterior columns. Tinel also insisted on the following: “The existence of an arachnoid sheath [around the roots] is a crucial point for us”; he viewed lesions during tuberculous or other types of meningitis and during tabes as being dependent on this. Concerning this point, he also remarked that there was a “very special accumulation from a kind of decantation of cerebrospinal fluid elements in these sorts of cisterns that constitute the lumbar and sacral radicular sheaths” [9]. But for him, gravity was not the only explanation, as he saw the same accumulations at the cervical roots. Sharing the opinion advanced by Nageotte, he considered “the radicular nerve and its membranes as an efferent pathway for lymphatic circulation of the central nervous system. It appears very probable that the cerebrospinal fluid flows slowly, filtered by the lymphatic interstices and fissures along or across the ganglion and continuing with the serous sheaths of nerves” [7]. This concept of diffuse peripheral absorption, mentioned by Tinel but then forgotten for decades, is once again now generating discussion 115 years later [10,11]. In 1911, Tinel autopsied a tuberculous patient treated by Landouzy and his *interne* Pierre Gastinel (1884–1963) for sciatica and found a tuberculous radiculoneuritis that, for him, confirmed the pathophysiological propositions in his thesis [12]. In 1912 [13] with Louis de Gonzague Sauvé (1881–1960) and in 1913 [14] with Dejerine, he arrived at the same conclusions to explain tabetic gastric attacks. On 28 May 1914 before the *Société de Neurologie*, Tinel described how he had obtained experimental confirmation of



Fig. 3 – ‘Internes’ at La Salpêtrière, 1909–1910. (From the *Album photographique de l'internat*, BIU Santé Paris, public domain).

the ideas in his thesis and other work: he had inoculated an attenuated tuberculous bacillus into the fourth ventricle of a rabbit, then observed, 40 days later, “the presence of voluminous lymphocytic infiltrations, which had accumulated at the terminal part of the radicular sheaths” [15]. As this example shows, throughout his career, Tinel never abandoned a clinical or experimental subject, taking up each case again and again over time. As we shall see, he also used this principle for nerve injuries.

In 1910, Tinel was *chef de clinique* (senior houseman) under Landouzy. He then returned to La Salpêtrière to hold the same position under Dejerine in 1911 and 1912. During 1912–1913, he served as head of the pathological anatomy laboratory at the Nervous Disease Clinic. He gave “weekly demonstrations of normal and pathological anatomy of the nervous system and classes on pathological anatomy techniques” [16]. By the end of 1913, Tinel had already authored more than 40 publications which, for the most part, were neurological and some of which followed oral presentations before the *Société de Biologie* and *Société de Neurologie*. He was elected a member of the latter in 1914 and became its president in 1936.

Mobilized as *médecin aide-major de deuxième classe* (military physician with the rank of second lieutenant) to the 18th regiment of the territorial infantry, he was promoted to *médecin aide-major de première classe* (rank of lieutenant) on 20 March 1917, then promoted to *médecin major de deuxième classe* with the rank of captain in 1919 [17]. In October 1914, he helped Augusta Dejerine-Klumpke (1869–1927) along with André Thomas (1867–1963), Joseph Jumentié (1879–1928), Gustave Clarac (1884–1917) and Joseph Levi-Valensi (1879–1943) to treat patients with multiple neurological injuries. Such patients were arriving in large numbers at La Salpêtrière, which had been turned into a military neurological center. In 1915, he was appointed head of the Neurology Centre of the Fourth Region in Le Mans. After being demobilized on 6 August 1919, he joined the department of Edouard Toulouse (1865–1947) at the Saint-Anne asylum before returning to La Salpêtrière as head of the laboratory for the department of Henri Claude

(1869–1945). However, he did not pursue a university career after completing the highly competitive *agrégation* examination in 1913, as it was thrown out on a technicality [18]. World War I blocked any opportunity to try again and delayed his nomination as hospital physician until 30 May 1922. He was then successively appointed *chef de service* (chief physician) at Hôpital de la Charité on 1 January 1928, Hôpital de la Rochefoucauld on 1 January 1932, Hôpital Beaujon on 1 January 1937 and Hôpital Boucicaut on 10 January 1941 before his retirement on 1 January 1945 [19].

2. Tinel’s sign

In the 7 October 1915 issue of *La Presse Médicale*, Tinel published an article on the ‘pins and needles’ sign in peripheral nerve lesions [20]. Basing his work on the difficult treatment of patients with multiple neurological injuries who were being sent to La Salpêtrière, Tinel sought to propose a more detailed semiological analysis to distinguish neural severing, compression and “nerve irritation”, and to monitor patients following a neuroma or nerve suture. “The pressure of an injured nerve trunk very often results in an impression of pins and needles exteriorized by the subject at the periphery of his nerve, and localized by him in a precise territory. This impression of pins and needles must be differentiated absolutely from the pain sometimes caused by the pressure of a traumatized nerve. Pain is the sign of neuritic excitation; pins and needles are the sign of regeneration or, to be more precise, pins and needles indicate the presence of young nerve fibres undergoing growth [...]. Regenerative pins and needles are not painful; patients often compare this vaguely disagreeable sensation with that caused by electricity. It is barely perceptible at the compressed point, and felt much more acutely in the corresponding cutaneous territory” [20]. Guided by his clinical perspicacity, Tinel succeeded in distinguishing a neuroma from regeneration according to its fixity over time and the relative size of the resulting zone of pins and needles.

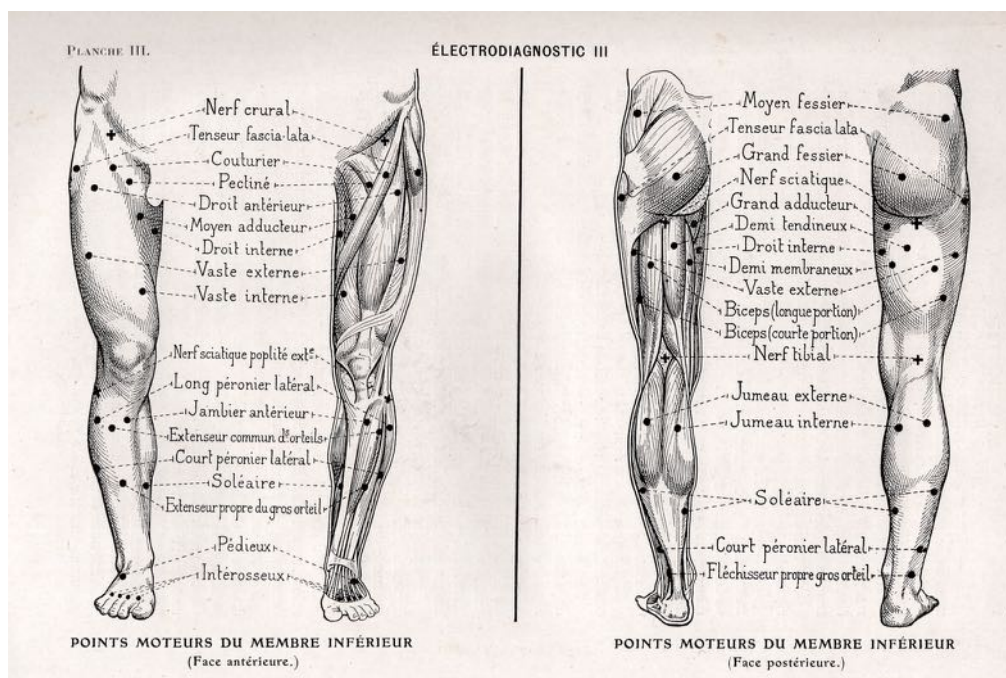


Fig. 4 – An illustration from page 43 of Tinel’s book, *Les blessures des nerfs. Sémiologie des lésions nerveuses périphériques par blessures de guerre*, published in 1916. (From the present author’s private collection).

He referred to examples involving the sciatic nerve in the thigh and radial nerve in victims of penetrating bullets. He concluded with modesty: “The resulting pins and needles do not constitute an absolutely constant sign that is fixed and always easy to interpret. Meticulous and repeated examination of the patient remains necessary. This sign is only valuable when associated with all of the other clinical signs. But despite all of these reservations, we consider pins and needles in some cases able to elucidate certain neurological diagnostic problems and provide precious indications for the prognosis and treatment of peripheral nerve lesions” [20].

While this description of the semiological sign played a large part in establishing Tinel’s fame, his 1916 book on nerve wounds also played a role, as attested by its British and American translations [21–23]. This work, already more detailed than that published at the same time by Chiriachitza Athanassio-Benisty (1885–1938) [24], another student of Dejerine, also included multiple high-quality drawings (Fig. 4) and covered all aspects of limb nerve anatomy, the semiology of various deficits and their progression, surgical treatment, and orthotics and assistive devices. Its findings were based on an astonishing 628 injury cases personally examined by Tinel. In 1927, Tinel revised much of this book’s content to address—along with the semiology of peripheral nerves, neuralgia and polyneuritis—traumatic injury to nerves in fascicle XXI of the *Nouveau Traité de Médecine* by Henri-Georges Roger (1860–1946), Fernand Widal (1862–1929) and Pierre-Joseph Teissier (1864–1932) [25].

As a result of the hostilities, Tinel was unaware that Paul Hoffmann (1884–1962) in Dorpat, Estonia, had published an article on outcomes with nerve sutures in Germany in March 1915, just before his own publication. Hoffmann described the same semiology in that paper [26] and, in a second article [27]

in August 1915, he added a description of percussion, mediated by the extended fingers of the examiner while using a reflex hammer, to trigger pins and needles. This was referred to as the ‘Klopfversuch’ or ‘tapping test’ and was not explicitly recommended by Tinel in his seminal article, although it is mentioned in the British translation of his book. (Had he read Hoffmann during the interval?). In fact, Hoffmann had added another detail not mentioned by Tinel: repeated percussions have a cumulative effect that sometimes triggers pins and needles where a single percussion triggers nothing. Nevertheless, the eponym remains ‘Tinel’s sign’ everywhere except in German-speaking regions, where it is known as “*das Hoffmannsche Klopfzeichen*” [1,2]. Etienne Feindel (1862–1930) gave a detailed account of the seminal article to readers of *La Revue neurologique* in November 1915, referring to the search for the pins and needles sign, but not employing the term ‘Tinel’s sign’ [28]. It appears that the use of the eponym can be attributed to British surgeon Cecil Augustus Joll (1885–1945) who, in 1915, served as chief surgeon at Hôpital Majestic² in Paris, where he probably met Tinel after overseeing the translation of his book. Tinel’s friend Jean Lhermitte (1877–1959) referred to Tinel’s description when he described ‘Lhermitte’s sign’ in multiple sclerosis in 1924 [29]: “The sensation of electrical discharge that so many patients with spinal concussion complain of has certain similarities with the

² The Hôpital Majestic, 19 avenue Kléber, Paris 16^e, opened its doors in 1908 and rapidly became a Paris landmark and the preferred hotel of Parisian high society during the Belle Époque—it was well known to Marcel Proust, for example. With its 400 rooms, it was requisitioned in 1915 to house a temporary British hospital. It became a hotel once again in 1916 and, in 2014, was renamed Hôpital Peninsula.

sensations provoked by percussion (Tinel's sign) or compression, or by elongation of slightly injured peripheral nerves; this has naturally led us to seek a common explanation." After the hostilities ended, the search for Tinel's sign, often poorly carried out and poorly interpreted, was apparently discredited for several years, and it was only after World War II that its significance was reevaluated by British neurologist Peter Wilfred Nathan (1914–2002) [30] in 1946 and American surgeon George S. Phalen (1911–1998) [31] in 1950. Both showed its relevance during a search for compression of a nerve trunk in a canal syndrome such as carpal tunnel syndrome. The writings of neither Tinel nor Hoffmann include examples in which pins and needles were related to non-traumatic mechanical compression.

At a meeting of the heads of the military neurological centers on 20 December 1917 at Hôpital Val de Grâce in Paris, Tinel presented, on behalf of the Neurology Centre of the Fourth Region (Le Mans), the results of the nerve sutures he recommended for injured patients and that he considered beneficial. However, as for "neural decompression", he found it unfortunate that the pins and needles sign was not sought: "Many decompressions that are considered to have produced excellent results are decompressions on nerves already undergoing healing. This evaluative error generally results from the fact that the early signs of nerve regeneration are not systematically sought and, in particular, the sign of pins and needles on percussion. This is the only sign that can easily detect, from the beginning, the slightest trace of nerve regeneration, then monitor progress step by step before any motor, electrical or sensory manifestation. This in turn makes it possible to avoid useless operations" [32]. In collaboration with René Delagenière (1884–1967), on 7 June 1917, Tinel reported on the beneficial result obtained in a patient in 1915 with a nerve graft of an 8 cm segment and clearly noted that he monitored the sensory recuperation "by the process of pins and needles on percussion" [33]. Tinel's test is now used widely, but its standardization is almost non-existent, its grading is seldom used and its reliability or validity is scarcely mentioned in the literature [34].

Tinel did not use elaborate electrical examinations for diagnostic purposes, but tested the persistence of conduction using faradic stimulation. His use of electricity was therapeutic, aimed at maintaining or recovering proper muscle trophicity; to this end, he employed "faradic baths or d'Arsonval cages" or "galvano-faradic currents" [32]. Also, he did not insist on the need to detect fraud and hysteria, as did Adolphe Zimmern (1871–1935) and Pierre Pérol (1880–?) in their electrodiagnostic manual [35,36].

3. From causalgia to autonomic nervous system function

In 1872, Silas Weir Mitchell (1829–1914) drew on his practice during the American Civil War (1861–1865) to describe a neuralgic syndrome characterized by its extreme intensity, its prolonged duration and its similarity to an intense burn [37,38]. There was no treatment at that time for the syndrome, which was referred to as 'causalgia' (from the Greek *kausis* for 'burning heat' and *algos* for 'pain'). Among the huge number of

patients with neurological injuries that Tinel treated, some developed this clinical picture of atrocious pain, involving "in particular the median and sciatic territories" and the hand or foot, appearing a few days to several weeks after injury. "What is even more curious, strong emotions and sensations cause violent exacerbations of the pain," added Tinel who, as early as 1917, noted that "the involvement of the sympathetic system in causalgia seems more and more obvious with each passing day" [39]. Struck by the importance of thermal, vasomotor, sudoral and trophic reactions "in a causalgic field", which was much more extensive than the actual territory of innervation of the affected nerve, Tinel proposed, as did Henry Meige (1866–1940), Chiriachitza Athanassio-Benisty [40] and René Leriche (1879–1955) [41] before him, the interpretation of causalgia "as an essentially sympathetic syndrome; it consists of a true sympathetic reflex arc, with painful centripetal excitation and centrifugal vasomotor, secretory and trophic reactions that maintain and exasperate the pain" [38]. Tinel returned several times to this theme and notably in 1918, when he proposed an alternative to Leriche's sympathectomy, comprising severing of the nerve in question followed by immediate suture [42].

All physicians had to deal with injured soldiers returning home after the war. In 1921, Tinel put forward a practical new name—"sympathetic algias"—for these war-related causalgias, which most physicians had never seen before. "Apparently the wound, most often minor, of a nerve trunk can provoke a special state of excitation of the corresponding sympathetic centers, simply by the pain it causes, or by excitation of the sympathetic fibers included in the damaged peripheral nerve. This excitation of the fibers causes the special pain in causalgia, which is so clearly sympathetic in nature; it is also the cause of the concomitant vasomotor and secretory disturbances" [43]. As no medical or surgical treatment proved effective, Tinel recommended "the indisputable influence of moral treatment [...]. It is by reassuring patients frightened and worried by their pain [...] that we provide the most effective therapy" [43]. However, at the 6 July 1933 session of the *Société de Neurologie*, he presented a case of causalgia in which he tried one of the first therapies involving three weeks of subcutaneous acetylcholine injections, "which provided remarkable relief" [44]. Currently known as 'complex regional pain syndrome (type II)', this clinical picture is still the subject of considerable debate as to its pathophysiology, which involves a hypothetical predisposition, an autonomic nervous system disorder and a psychological component. The variety of treatments prescribed is indicative that none is truly effective, as pointed out by a recent historical review, which omitted to mention Tinel at all [45,46]. For some neurologists, Tinel's wartime work was superseded by that of Jules Froment (1878–1946), who published in 1921 the *Traité de pathologie médicale et de thérapeutique appliquée* [47].

4. Autonomic nervous system and discovery of antihistamines

At the 5 June 1919 session of the *Société de Neurologie*, Tinel proposed an explanation for the paradoxical phenomenon of paresthesia, which developed within the first week of a nerve

suture in the corresponding dermatome. He highlighted the fact that the regeneration of neither nerve fibers nor “Schwann cells” could explain this exaggerated sensitivity. “In reality, the explanation for this phenomenon must be sought by exploring another paradigm. We believe that a rapid manifestation of sympathetic sensitivity is involved. This sensitivity is usually latent in the normal state. It depends on nerve pathways distinct from peripheral nerves and, at least in part, uses perivascular sympathetic pathways” [48].

Following his work on autonomic nervous system disorders in patients with war injuries, Tinel continued throughout his career to study this system, particularly in the context of mental illnesses. For example, he observed that during certain anxiety attacks “relating to periodic psychosis”, disorders of the autonomic nervous system occur, expressing vagal hyperactivity, whereas during neurotic attacks of anxiety, sympathetic hyperactivity arises. Based on these observations, he recommended this vegetative reactivity as a thesis subject to Daniel Santenoise (1897–1970) [49] and then extended his own studies to include mania and epilepsy [50]. Shortly thereafter, Santenoise became *chef de clinique* under Claude and then assistant to Charles Richet (1850–1935), before pursuing a career as a physiology professor in Nancy.

After practising at the Hôpital de la Charité, Tinel was sent, in 1932, to the Hospice de la Rochefoucauld, where he set up a nervous system physiology laboratory. A succession of *internes* worked there: Marcel Eck (1907–1989); future physiology professor Jean-Louis Parrot (1908–1991); [51] and Jean Brincourt (1907–1983). In addition to their technical innovations, Tinel and his team produced a vast number of publications concerning the autonomic nervous system. Tinel also completed numerous studies concerning aspects of many different topics, including the solar reflex of the autonomic nervous system, the oculocardiac reflex, “glycosuria and the autonomic nervous system”, anaphylactic shock [52], interpretation of “the white welt” (dermographism) and autonomic nervous system disturbances during the psychiatric conditions already mentioned [53]. He collated his theories and findings in a book published in 1930 with the (translated) title *General Conception of the Autonomic Nervous System and its Morbid Manifestations* [54]. This book covered in detail what was known at the time of the system’s anatomy, histology and physiology, with the aim of instructing general practitioners on the treatment of Raynaud’s disease (Maurice Raynaud, 1862–1881), among many others [55]. Tinel recommended examining the cutaneous capillaries at the base of the fingernails using low-power microscopy, an exploration first initiated by Herman Boerhaave (1668–1738), but not applied in clinical medicine until Otfried Müller (1873–1945) did so in 1922 in Tübingen, Germany [56].

Finally, it was in collaboration with Ernest Fourneau (1872–1949) at the Institut Pasteur that the Swiss pharmacologist Daniel Bovet (1907–1992),³ assisted by Georges Ungar (1906–1977) [57] and Anne-Marie Staub (1914–2012), worked at Tinel’s laboratory to uncover the antihistamine properties of a

derivative of benzodioxane (933F or piperoxan) [58], which led to their 1937 discovery of 1571F and 929F, two derivatives of diethylamine [59], thereby opening the way for our current antihistamine drugs.

5. First description of acute arterial hypertension indicating pheochromocytoma

Like his friend Lhermitte, Tinel’s medical practice was always based on a felicitous marriage of both neurology and endocrinology (with the latter gradually becoming independent of the former) with psychiatry. For example, he described his observation of a 28-year-old woman who was subject to repeated and extreme anxiety attacks as well as violent epigastric pain, with vomiting, profuse sweating, vasomotor disturbances of the face and extremities, persistent tachycardia and unstable arterial pressure with hypertensive crises (with values as high as 280/160 mmHg). During her third crisis, she died of acute pulmonary edema. The autopsy revealed a medulloadrenal tumour, “a true paraganglioma” [60]. Tinel explained this clinical picture as “an excess of adrenalin, exciting *par excellence* the sympathetic system” [60]. The term ‘pheochromocytoma’ was proposed by Ludwig Pick (1868–1944) in 1912 to describe the anatomical pathology of an adrenal tumour [61]. Later, during a discussion following the presentation of his case before the *Société médicale des hôpitaux de Paris*, Charles Aubertin (1876–1950) claimed to consider “this new syndrome of paroxysmal hypertension with adrenal origin [...] a seminal observation”. As a result, Tinel and his colleagues, Marcel Labbé (1870–1939) and Edouard Doumer (1891–1980), reported it on 23 June 1922 in a detailed clinical description along with its precise pathophysiology and pathological anatomy [60].

6. Seminal description of exertional headache

In 1932, Tinel added “to the vast group of headaches with a very special syndrome, highly characteristic and yet never before clearly isolated to our knowledge. This acute, violent, at times truly intolerable headache is brought about in certain subjects by any form of muscular effort and by any thoracic blockage involving cough, exclamation or singing—that is, by any cause liable to produce retrograde intracranial venous hypertension” [62]. This is how Tinel presented his seminal description of exertional headache. It is concise but, as with all of his publications, it combines a pathophysiological proposition with detailed clinical data. To validate his theory, he explained that he was able to trigger attacks by compressing the jugular vein: “this is what could be called the cervical tourniquet sign” [62]. It was not until 1956 that British neurologist Charles Putnam Symonds (1890–1978), using the overly restrictive term of “cough headache” [63], updated the differential diagnosis for this headache, associating it with a potential complication (aneurysm fissure). Then, in 1968, Edward Douglas Rooke (1912–2001) reevaluated this type of headache, minimizing the risk and severity [64]. The International Classification of Headache Disorders (ICHD)-3 distinguishes primary stabbing headache (4.1) and primary cough

³ Daniel Bovet isolated the first synthetic preparation of curare for use in humans, and was later awarded the 1957 Nobel Prize in Physiology or Medicine.

headache (4.2) from primary exertional headache (4.3) within “other primary headaches”. According to the current knowledge, around 40% of acute exertional headaches are symptomatic, and the first step is to look for a Chiari type-I craniocervical malformation [65].

7. Regulation of cerebral circulation

Tinel completed his study of cerebral arteriovenous reactivity with his 1936 proposition of an alternative to the generally accepted theory of an exclusively passive regulation. Using Ungar’s research results, he confirmed that cerebral vessels had sympathetic and parasympathetic innervations, which allowed reflex postural adaptations, and explained their sensitivity to pharmacodynamic agents such as adrenalin, acetylcholine and histamine; it also explained their sensitivity to increasing blood pressure in the posterior lobe of the pituitary gland which, at the time, was still poorly identified. There was also the effect of oxygen, which Ungar had demonstrated involved powerful vasoconstrictive activity [66]. With Marcel Eck, Tinel developed a technique for measuring arterial pressure in the central retinal artery and they studied, among other things, the effect in rabbits of sympatholytics (ergot derivatives), electrical stimulation of the cervical sympathetic trunks and severing of Hering’s nerve (the glossopharyngeal nerve branch to the carotid sinus). In conclusion, Tinel wrote: “We consider that the conception of cerebral vasomotor regulation, a result of the association of these diverse factors, is important both from a physiological and clinical point of view, and that it can reveal to us the various disturbances, in all their complexity, on which cerebral circulatory dysfunction seems to depend” [67]. However, it is now clear that Tinel’s interpretation of the phenomena regulating cerebral circulation was incomplete, based as it was on only vascular reactivity by extrinsic innervation of the intracranial arteries. He was unaware of the roles of, for instance, glucose consumption, cerebral venous pressure, partial pressure of oxygen (PaO₂) and partial pressure of carbon dioxide (PaCO₂). Tinel never referred to the first arteriographies performed by Egas Moniz (1874–1954), even though they were contemporaneous. Also, in his conception of cerebrovascular accidents, he overlooked the role of atheroma in extracranial arteries and the importance of collateral circulation [68].

8. Psychiatric studies

Tinel’s psychiatric studies are those of a psychobiological pioneer. Starting in 1925 and working with Claude and Santenoise, he applied the acquired pathophysiological data for the autonomic nervous system to treat anxiety and manic excitation. This led him to use intravenous phenobarbital, belladonna and adrenalin, arsenic and intravenous calcium chloride. The effect was favorable, provided that treatment was started as soon as symptoms set in: “In the absence of truly pathogenic medications, we consider these treatment methods to constitute significant progress.” Side-effects, however, were not mentioned in the article [69].

Tinel and Santenoise [69,70] attempted to highlight only the simple biological parameters to support their diagnostic use for mental illnesses. They spent long years studying variations in the leukocyte count in neurasthenia, mania and epilepsy, for example, before arriving at the conclusion that “the variations in the leukocyte count during mental illnesses faithfully reflect the various reactions of the autonomic system, and of the sympathetic system in particular” [69]. During these experiments, it occurred to Tinel to carry out his own blood count. Assuming his own good health, he was surprised to discover that his results corresponded to the agitated mania category. Realizing that he had smoked several cigarettes the day of the count, he carried out his analysis a second time after having stopped smoking for several days. As the results were then normal, he expanded his investigation to all his hospital personnel, becoming the first to describe the role of cigarette smoking in blood count variations [71].

In 1933, Tinel helped Elisabeth Jacob write her thesis, which sought to determine whether autonomic nervous system disorders were etiological or secondary to the onset of psychosomatic disturbances as well as during “ketosis and azotemia”. The thesis recommends “eserine salicylate”, pilocarpine or adrenalin treatment [72].

Working with Henri Baruk (1897–1999) in 1931, Tinel became interested in changes to the “flow of thoughts” (“courant de la pensée”) in a male patient subject to partial convulsive attacks with intracranial hypertension caused by a tumour [73]. He suffered from multisensory hallucinations alternating with extreme passivity, apathy, blunted affect, and profound generalized loss of self-motivation and conscious thought. Tinel used the term “mentisme” and described various affective states, notably dulling of thought (“engourdissement psychique”). What can be called ‘psychic akinesia’ is a rare neurological condition seemingly similar to what is now known as ‘athymhormic syndrome’ [74]. Tinel also reported fluctuations in intracranial pressure, which he brought on by applying pressure to a skull bone flap created during decompressive trepanation [73].

Finally, in 1941, he published a book “for practitioners”, aimed at helping them to diagnose and treat “neurasthenia” [75].

9. Endocrinology

After the discoveries of Claude Bernard (1813–1878), Brown-Séquard (1817–1894), Joseph Babiński (1857–1932), Pierre Marie (1853–1940), Walter Cannon (1871–1945), Harvey Cushing (1869–1939) and so many others, endocrinology gradually became independent of neurology at the beginning of the 20th century [76]. Tinel’s interest in autonomic equilibrium led him to focus on “glands with internal secretion”. In 1931, with family physicians in mind, he published the remarkable handbook *Précis clinique d’endocrinologie* — which attests to his vast knowledge of physiology and his talent for making it accessible — with the aim to provide information for physicians on recently developed treatments, including organotherapy [77].



Fig. 5 – In 1936, Jules Tinel was made President of the *Société de Neurologie* (BIU Santé Paris, public domain.).

10. A forgotten hero

In 1942, Tinel (Fig. 5) entered the French Resistance movement with his son Jacques, his second son from his second marriage. He gave shelter in his home to British and American aviators, whose planes were brought down in France. His son, who was helping them cross the Spanish border, was arrested in May 1943. Following imprisonment, he died during deportation to the Dora-Mittelbau concentration camp. Tinel himself spent three months in prison in 1943 in Bordeaux, and his wife spent a year in prison in Fresnes, in the southern suburbs of Paris [3].

Despite his retirement in 1945, he continued to see patients at Hôpital Boucicaut; the occupation of Hôpital Beaujon by the Germans forced this move in 1940. There he devoted himself to “the depressed, the anxiety-ridden and the phobic. He gave them sedative medications in which he believed firmly, but more importantly, he took the time to listen to them and gave unstintingly of himself to inspire them with hope for the future” [3].

Tinel died of a myocardial infarction on 4 March 1952. Brincourt concluded his fine eulogy this way: “His indefatigable devotion, his goodness and his selflessness were only known to his patients. His modesty and dislike of public gatherings prevented his work from having the dissemination it deserved. The medical corps was unaware of his merit” [3].

11. Conclusion

It was not possible to cover all the research areas in which Tinel worked, including, for example, epidemic neuritis during von Economo encephalitis, regulation of cerebrospinal fluid secretion, dementia praecox, and the viral origin (herpes zoster) of shingles, its contagiousness and the neuropathological techniques.

While Tinel remains well known because of the eponymous clinical sign, its validity has never been clearly established [78]. Nevertheless, physicians looking for nerve compression syndromes use it regularly because it is quick and easy, and relatively simple to interpret, yet Tinel never foresaw this application.

Although he was only one of the many researchers studying the autonomic nervous system at the time, his work is probably among the most relevant. Yet, his seminal descriptions of hypertensive emergency due to pheochromocytoma and of exertional headache failed to bring him the recognition he deserved. Our aim in the present article was to renew interest in his life’s work, which was arguably more significant than it might appear.

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