

Medical Survey

OCCUPATIONAL ASPECTS OF RAYNAUD'S DISEASE¹ A CRITICAL HISTORICAL SURVEY

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The literature is reviewed beginning with the first descriptions of occupational Raynaud's disease in the second decade of this century. At the beginning of the fourth decade, the importance of vibration in the aetiology of the disease started to gain acceptance, and this idea solidified during this decade and the next to the extent that the disease is now called "vibration disease", or "vibration-induced white fingers", instead of "Raynaud's disease".

The writer maintains that vibration was accepted erroneously as an aetiological factor, and that the perpetuation of this error has confounded investigations into the aetiology of the disease ever since.

In the appendix, it is pointed out that certain occupational manifestations of Raynaud's disease have been recently described as a new disease named "occupational acro-osteolysis" and spurious aetiological factors have been postulated for it.

In 1862, Maurice Raynaud published his thesis describing the disease to which his name has been given.

Interested primarily in the rare and serious disease then known as spontaneous bilateral gangrene of the extremities, he maintained that this was connected by intermediate steps to the common and benign affliction known then as local syncope, and now referred to as "white fingers".

He stressed the importance of cold as an exciting cause of the attacks; but he did not include it in the predisposing causes. He attributed the disease to spasm of the blood vessels arising from vasomotor activity of the spinal cord, and in 1874 he published further observations in support of this hypothesis.

His theses were accepted by Thomas Barlow, a famous English physician, who translated them into English,³ and whose description of the disease in Allbutt's "System of Medicine" (1895)⁴ is classical.

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Unfortunately, Raynaud's work was not so well accepted by Jonathan Hutchison,⁵ another famous English physician, who called the malady "Raynaud's phenomenon", and not "Raynaud's disease" on the grounds that it included a large group of maladies which differed widely in their aetiology.

Hutchison's views on the aetiology of the malady are quite absurd when viewed in the light of present-day knowledge; yet his authority was sufficient to start a fashion which has persisted to this day. The fashion did not follow him in discarding "disease" for "phenomenon", but it has persistently asserted some fundamental difference between Raynaud's disease and Raynaud's phenomenon.

It is a foregone conclusion that any disease due to cold will have its occupational manifestations. Neither Raynaud nor Barlow saw any relation of the disease to occupation. In fact, Raynaud mentioned the idea only to dismiss it.

A certain number of patients had manual occupations such as washerwoman, chambermaid, burnisher, sculptor, etc. But as this circumstance was wanting in many other cases it appears to me that we cannot attach any importance to it.

Apparently it was first reported as an occupational disease in 1911 by Professor G. Loriga⁶ of Rome, who described its occurrence among operators of pneumatic tools.

In 1914, Bramwell⁷ of Scotland reported nine cases of scleroderma associated with Raynaud's disease, five of which involved stonemasons working with hammer and chisel, while one involved a coppersmith also using a hammer and chisel, and one involved a coal miner exposed to cold when cycling to and from work. He suggested that the relatively frequent occurrence of scleroderma among stonemasons was due to the holding of a chisel in the hand in cold weather.

The first large investigation was made by the U.S. Bureau of Labor Statistics and the U.S. Public Health Service⁸ as a result of complaints made by the President of the Journeymen Stone Cutters' Association of North America on December 28, 1916 — complaints of the injurious occupational effects of dust and of pneumatic tools on their members working in the Indiana limestone belt, resulting in tuberculosis and paralysis. The paralysis was not, in fact, such, but was Raynaud's disease.

The investigation was apparently set in motion by the report by Dr Miller of Chicago, on November 18, 1916, of Raynaud's disease in a stonecutter. Dr Miller related the operation of a pneumatic tool and conveyed this to the Stonecutters' Association.

The results of the investigation were published in the *Annals of the U.S. Bureau of Labor Statistics*, Number 147, July, 1918, under the title, "Effect of the Air Hammer on the Hands of Stonecutters", and includes reports by the following physicians: Alice Hamilton, of the Harvard Medical School, who was commissioned by the Bureau to investigate, and who was assisted by Thor Rothstein, a professor of nervous and mental diseases, who made a detailed clinical investigation of eight men; Major Cary, who examined eight soldiers who were formerly stonecutters; Dr Leake and Dr Edsall, of the U.S. Public Health Service; Dr Cottingham, who had examined seven men on behalf of the employees; and Dr Barnes, Dr Proctor and Dr Herring, on behalf of the employers.

Hamilton maintained that the trouble was not Raynaud's disease, and coined the term "spastic anæmia of the hands".

She found 34 of 38 limestone workers, 45 of 50 granite workers and 44 of 78 marble workers to be affected by it. She described how the blanching of the fingers usually developed early in the morning and passed off during work, how it developed after years of work and disappeared slowly after the sufferer left the trade. She considered that it seemed to be caused by three factors: cold, cramping of the fingers, and vibration, and recognized that the two last-mentioned factors would be hard to separate, because the tool that vibrated most would have to be held most tightly.

Leake stated categorically that, when the mills were visited soon after commencement of work, most of the operators showed blanching of the fingers. He thought cramping of the hand was more likely to be important than vibration. He recognized that it was not exclusive to pneumatic tool operators, and he mentioned the occurrence of the condition in a boilermaker who had never used such a tool.

Edsall confirmed the presence of symptoms at the commencement of work, and noted that sometimes the fingers were cyanosed instead of blanched. He recognized that men had suffered from the same trouble before the introduction of pneumatic tools, but thought that their introduction had increased the trouble considerably. He attached more importance to constriction of the grip than to vibration as a cause.

Barnes, perhaps, made the most pertinent observations of all. He clearly recognized that the condition existed before the introduction of air tools, and his comments are worth quoting verbatim:

That it is not due to the pneumatic hammer directly and primarily is proven by the fact that the condition was known to exist prior to the introduction of this tool. That the air hammer may have added somewhat to the frequency of its occurrence, as compared with the time when the chisel and mallet were used exclusively, is possible, but not proven. An extensive comparative study, which circumstances naturally made impossible, could alone settle this question.

Herring would not look further than cold as a cause of the condition and stated:

The condition which the men have termed "white-fingers" is simply a reaction of the skin and underlying blood vessels to the stimulation of the cold.

If we look at the investigation as a whole, it is surprising that none of the more serious manifestations of Raynaud's disease was found, and it is also surprising that a group of physicians, some so prominent, should fail to recognize that the malady had been described by Raynaud. They laboured under the misapprehension that Raynaud's disease was always a dread disease leading to gangrene. Even Alice Hamilton, the grandmother of occupational medicine in the U.S.A., made this mistake.

The consensus of the opinion of all the investigators was that this was a disease hitherto not known to medicine, always benign, for which cold was a necessary condition, and which was aggravated, perhaps, by interference with the circulation by the pressure of the grip and also, perhaps, by vibration.

In 1924, Dr Bridge and Dr Middleton, Medical Inspectors of Factories in Great Britain, together examined four masons with the complaint, and provisionally concluded that it was produced by two factors operating together: the pressure of the pneumatic tool impeding the circulation of the fingers, and the action of the cold.

Again in 1930, Dr Middleton⁸ investigated workers in the boot and shoe industry using pounding-up machines, and attributed their trouble to the pressure of grasping. He dismissed vibration as a factor of importance:

Vibration as such is not an important factor except in so far as it calls for an excess of static resistance in opposing the tendency to displacement of the object.

In the meantime, in 1925, Teleky⁹ of Vienna reported cases among iron foundry fettlers using pneumatic chisels; one had gangrene of the left little finger, and another had severe Raynaud's disease of the left hand.

In the late 1920's, a number of investigators in Germany reported cases occurring among operators using the pounding-up machines in boot factories. They showed that the incidence of the condition increased with years of work and decreased with the years after the cessation of work.

In 1931, Maria Seyring¹⁰ of Germany reported the results of an investigation of the disease among pneumatic tool operators — fettlers, riveters and moulders — in iron foundries.

Stating that her attention was first directed to the problem when she diagnosed a few cases of Raynaud's disease in fettlers, she made no further mention of Raynaud; but she recognized quite clearly that the disease she was dealing with was one fairly common in the general population.

She confirmed the fact that the incidence increased with years of employment, and she showed that it was most extensive in those whose work was hardest.

She knew that the exciting cause of each attack was cold, and realized, too, that the fingers of the fettlers were constantly exposed to a blast of cold air from the tool; yet she rejected this as a predisposing cause because the digits most subjected to the cold blast were not those most affected by the malady.

She also rejected pressure on the ulnar artery as a predisposing cause because this occurred in other trades,

and she argued, too, that, had it been the cause, the attacks would have occurred at work.

Having thus eliminated what she considered to be all other possibilities, she accepted vibration as the predisposing cause of the disease.

Important to her argument was her alleged finding that the attacks occurred as a rule outside working hours. This finding is at variance with that of the Indiana survey, and even with her own statement that "some fettlers reported that their white fingers became soft and warm again by working with the chisel as it became warm again during operation", which implied that the attack was present at work.

In 1934, Professor Loriga¹¹ of Rome published the first review on the subject under the title of "Pneumatic Tools" in the International Labour Office's "Occupation and Health". Although his report in 1911 had been the first to associate the disease with the use of pneumatic tools, Loriga's opinion in 1934 was that "vibration would not appear to have any particular significance".

Later, in 1938, Dr Teleky¹² of Vienna rewrote this article for the International Labour Office's "Occupation and Health" supplement. This review is neither critical nor profound.

Under the influence of Seyring, Teleky endeavoured to use the alleged general absence of attacks at work and their excitation by cold as devious argument in favour of vibration being the cause. The difficulties into which his logic leads him can be illustrated by his concluding remark:

To summarize, it may be said that vascular disturbances affecting chiefly the fingers of the hand holding the tool are of widespread occurrence; that these derangements occur more especially among workers working in a low temperature and that, if the workroom is heated, serious symptoms of the kind are of extremely rare occurrence. The vascular troubles are therefore a typical consequence of the shocks and vibrations to which these workers are subjected in the course of their occupation.

In the early 1930's, Raynaud's disease had been the subject of considerable clinical research in England, and, in 1934, Sir Thomas Lewis and G. W. Pickering¹³ published a review summarizing the results of their investigations. They followed Hutchison in fragmenting the disease into many separate entities, and set the pattern, followed to this day, of distinguishing between the "disease" and the "phenomenon". Under the heading "Raynaud's phenomenon following long continued vibration", they referred to attacks as being common in those using vibrating tools, and stated that the injurious factor had been proved by Seyring to be vibration. A few years later, Lewis incorporated these views into his book "Vascular Disorders of the Limbs".¹⁴

It cannot be said that the contribution of Lewis and Pickering was entirely negative. They did show that local chilling of a digit could induce an attack in that particular digit, and, conversely, that chilling of the body failed to produce an attack in a warmed hand.

They also produced the first estimate of the incidence of the disease among the general population, by questioning medical students and nurses and finding 28% of them to be affected.

Contemporarily with Lewis and Pickering, another Englishman, John Hunt, was investigating the disease clinically, and his findings were published as a critical review in 1936,¹⁵ and a few years later in the article on this disease in the "British Encyclopædia of Medical Practice".¹⁶ Hunt took it for granted that vibrating tools caused the disease, and yet he has this to say about cold:

The only factor which precipitates an attack is cold. Many of these men will say that vibration of the instrument itself will make their hands go pale and numb, but careful enquiry reveals that this is only on cold days.

His contributions were also not entirely negative, in that he did demonstrate that chilling of the body was necessary to produce an attack, as well as chilling of the hand.

After the work of these English investigators, there followed a decade of almost complete quiescence on the subject, due, no doubt, in part to the intervention of the Second World War.

The quiescence was broken by the first serious attempt to study the ætiology of the disease, which was undertaken by the Department of Research in Industrial Medicine of the Medical Research Council of the U.K. Their first paper was published in 1945 by Donald Hunter and others,¹⁷ and was followed by several others¹⁸⁻²⁰ in the next few years.

Although these writers admitted the importance of chilling as an exciting cause ("the symptoms were most pronounced and certainly aggravated by cold weather"), their study was rendered sterile by their gratuitous assumption that vibration was the more significant cause.

Their efforts were, therefore, mainly confined to a scrutiny of the parameters of vibration that might be relevant, and they advanced the hypothesis that the range of vibration frequency of between 2,000 and 5,000 per minute was the most dangerous.

Since that time, the number of published papers has been increasing exponentially year by year and has now reached astronomical proportions.

A recent interrogation of Medlars reveals that papers on the health aspects of exposure to vibration are now being published at the rate of about 50 per year.

It has not been possible for me to subject these papers to the close scrutiny to which I have subjected the earlier ones; yet I think it would be fair to comment that the underlying assumption of all of this later research has been that vibration was the cause of the condition.

These later investigators have been generally still willing to concede that attacks do not occur so frequently in warm weather; yet the parameters relating to vibration have usually been documented in detail, while those relating to temperature have been ignored.

Typical of modern attitudes is that revealed by Donald Hunter²¹ in his eight-page review of the subject under the heading "Effects of Vibration Tools" in his book "Diseases of Occupation" (1969). In this review, cold gets barely a mention.

DISCUSSION

One remarkable oversight which can be noted on reviewing the literature is the failure to perceive the interrelation of pressure of the grip and chilling of the fingers.

The interrelation of pressure of grip and intensity of vibration was realized by Hamilton as long ago as 1919,

but the obvious fact that pressure of the grip would interfere with the blood supply and thereby aggravate the effect of chilling seems to have escaped notice.

Perhaps the most significant point to be noted in reviewing the literature is the change that took place in attitudes to aetiology in about 1930. Earlier investigators, exemplified by Alice Hamilton, attached more importance to cold and cramping of the fingers than to vibration. Later investigators, exemplified by Lewis and Hunt in the mid 1930's, believed that vibration was all-important.

Apparently the change can be attributed to the work of Seyring in 1931. She was firmly convinced that vibration was the cause, and was apparently so successful in convincing others that this view has not been questioned to this day; but her work fell far short of the extensive comparative study that Barnes had suggested in 1919 as being necessary to establish any claim that vibration was an aetiological factor. It is apparent, therefore, that this change of opinion around 1930 attributable to Seyring was not scientifically validated and, furthermore, has not been validated to this day.

This being the case, it is fitting to ask what valid assumptions can be made in respect to the aetiology of this disease. It can be assumed that two conditions must be present for an attack to take place, and these are chilling of the body and chilling of the hands.

Furthermore, there is an occupational factor predisposing to attacks, the effect of which is cumulative over a period of years and persists for some years after removal of the factor.

It is quite clear that vibration is not a necessary predisposing factor, as attacks take place in persons who have not been exposed to it.

Surely the occupational factor that stands out as being the most likely predisposing cause is repeated chilling of the body and/or of the hands.

Until it has been shown, in a carefully controlled study, that more attacks occur with vibration and cold than just with cold alone, it cannot be claimed that vibration is a predisposing cause of the disease.

APPENDIX

Another occupational disorder which has been popularly associated with Raynaud's disease in recent years deserves a brief mention.

This time the aetiological factor is not sought in vibration but in exposure to some as yet unknown toxic chemical affecting persons handling freshly made polyvinyl chloride.

Like Alice Hamilton in 1919, the investigators have erred in believing that they have found a new disease, and they have given it the impressive title of "occupational acro-osteolysis". The acro-osteolysis refers to osteolytic changes

revealed radiologically in the terminal phalanges of the fingers.

Here the situation is worse than with "vibration disease", in that chilling is not mentioned, and there is no documentation whatsoever of parameters relating to temperature.

The occurrence of such osteolytic changes in Raynaud's disease was noted in a textbook as far back as 1934,²² and it has been documented many times since.²³ Need any more be said about "occupational acro-osteolysis"?

REFERENCES

- ¹RAYNAUD, M. (1862), "On Local Asphyxia and Symmetrical Gangrene of the Extremities", and RAYNAUD, M. (1874), "New Researches on the Nature and Treatment of Local Asphyxia of the Extremities", both translated by Barlow, T. (1888), "Collected Monographs", New Sydenham Society, London, 121: 1.
- ²BARLOW, T. (1899), "Raynaud's Disease", in "A System of Medicine", edited by Allbutt, T. C., Macmillan, London, Volume 6: 577.
- ³HUTCHISON, J. (1901), "Raynaud's Phenomena", *Med. Press*, 123: 403.
- ⁴LORIGA, G. (1911), "Il lavro degli scapellini col martelli pneumatici", quoted by Loriga, G. (1934).¹¹
- ⁵BRAMWELL, B. (1914), "Diffuse Scleroderma: Its Frequency; Its Occurrence in Stonemasons, etc.", *Edinb. med. J.*, 12: 387.
- ⁶ANONYMOUS (1918), "Effect of the Air Hammer on the Hands of Stonecutters", in "Bulletin of the U.S. Bureau of Labor Statistics", Number 236, Washington, D.C.
- ⁷ANONYMOUS (1925), "Annual Report of the Chief Inspector of Factories and Workshops for the Year 1924", H.M.S.O., London: 66.
- ⁸ANONYMOUS (1931), "Annual Report of the Chief Inspector of Factories and Workshops for the Year 1930", H.M.S.O., London: 119.
- ⁹TELEKY, L. (1927), quoted by Teleky, L. (1938), *loc. cit.*
- ¹⁰SEYRING, M. (1930), "Erkrankungen durch Arbeit mit Pressluftwerkzeugen", *Arch. Gewerbepath. Gewerbehyg.*, 1: 395.
- ¹¹LORIGA, G. (1934), "Pneumatic Tools", in "Occupation and Health", I.L.O., Geneva, Volume 2: 670.
- ¹²TELEKY, L. (1938), "Pneumatic Tools", in "Occupation and Health Supplement", September, 1938, I.L.O., Geneva.
- ¹³LEWIS, T., and PICKERING, G. W. (1933-4), "Observations upon Maladies in which the Blood Supply to the Digits Ceases Intermittently or Permanently, and upon Bilateral Gangrene of the Digits; Observations Relevant to So-called 'Raynaud's Disease'", *Clin. Sci.*, 1: 327.
- ¹⁴LEWIS, T. (1936), "Vascular Disorders of the Limbs", Macmillan, London.
- ¹⁵HUNT, J. H. (1936), "The Raynaud Phenomena: A Critical Review", *Quart. J. Med.*, 5: 399.
- ¹⁶HUNT, J. H. (1952), "Raynaud's Phenomenon", in "The British Encyclopaedia of Medical Practice", Butterworth, London: 532.
- ¹⁷HUNTER, D., McLAUGHLIN, A. I. G., and PERRY, K. M. A. (1945), "Clinical Effects of the Use of Pneumatic Tools", *Brit. J. Industr. Med.*, 2: 10.
- ¹⁸AGATE, J. N., DRUETT, H. A., and TOMBLESON, J. B. L. (1946), "Raynaud's Phenomenon in Grinders of Small Metal Castings", *Brit. J. Industr. Med.*, 3: 167.
- ¹⁹AGATE, J. N. (1949), "An Outbreak of Cases of Raynaud's Phenomenon of Occupational Origin", *Brit. J. Industr. Med.*, 6: 144.
- ²⁰HUNTER, D. (1969), "Effects of Vibrating Tools", in "The Diseases of Occupations", by Hunter, D., English Univ. Press, London: 885.
- ²¹BRAILS福德, J. F. (1934), "Radiology of Bones and Joints", Churchill, London: 27.
- ²²McLAREN, J. W. (1937), "Disability of Workers Using Pneumatic Drills with Special Reference to Radiological Changes", *Lancet*, 2: 1296.

The students in Law and Medicine of the University of Liege have invited the students of all Europe to attend a philanthropic congress for the discussion of various great social questions.—*Medical News, Lancet*, 1865, 2: 163 (August 5).

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