

## Section of Neurology

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### Raynaud's Phenomenon in Workmen using Vibrating Instruments

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PNEUMATIC instruments are now used for many purposes: in mining and quarrying, in roadmaking, in locomotive and other workshops, in shipbuilding and in the construction of all-metal aeroplanes, &c. Raynaud's phenomenon is liable to develop in the hands of men using them and it is of the utmost importance to both workmen and employers alike that its occurrence be prevented as far as is possible, and that, should it develop, it be recognized at once. This paper is merely a preliminary communication, as the work is unfinished and the problem not yet altogether solved.

The symptoms of which these workmen complain, and the signs one finds on examining their hands, correspond to those described by Raynaud in other diseases [21, 22]. "Raynaud's phenomenon" may be defined as "Intermittent pallor or cyanosis of the extremities, precipitated by exposure to cold, without clinical evidence of blockage of the large peripheral vessels and with nutritional lesions, if present at all, limited to the skin" [12]. In other words, "Attacks of 'dead' fingers or toes, brought on by cold, without marked changes in the pulse or massive gangrene." It is found in some fifteen different diseases, seven of which appeared in Raynaud's thesis. Of these fifteen only one should now, I believe, be called "Raynaud's disease". The phenomenon as it occurs in workmen using vibrating instruments, Raynaud did not know, but for the past thirty years such intermittent attacks of pallor or cyanosis of the fingers have been found to occur in men working with pneumatic chisels, hammers, riveters or road-drills, and also in shoemakers using pounding and lasting machines. From America and from the Continent descriptions of the condition have appeared from time to time, but in this country it has received scant notice in medical literature except from Sir Thomas Lewis [16, 17].

During the past year, in Dr. Hinds Howell's Neurological Clinic at St. Bartholomew's Hospital, I have come into contact with a group of riveters from a locomotive workshop. Through the courtesy of their Works Manager, I have been able to examine seven of these men, whose symptoms correspond closely with those complained of by workers with pneumatic tools in other parts of the world. The job of these particular men is to rivet over the ends of cold copper stays in locomotive fire-boxes. The pneumatic riveter weighs about 13 lb. and works at about 2,300 strokes a minute. The workman, who is supposed to wear leather gauntlets, grasps the underside of the vibrating end of the instrument with his left hand (figs. 1, 2), and the index finger of this hand—that nearest the end of the machine—is always the first to be affected. A limestone cutter holds the chisel from

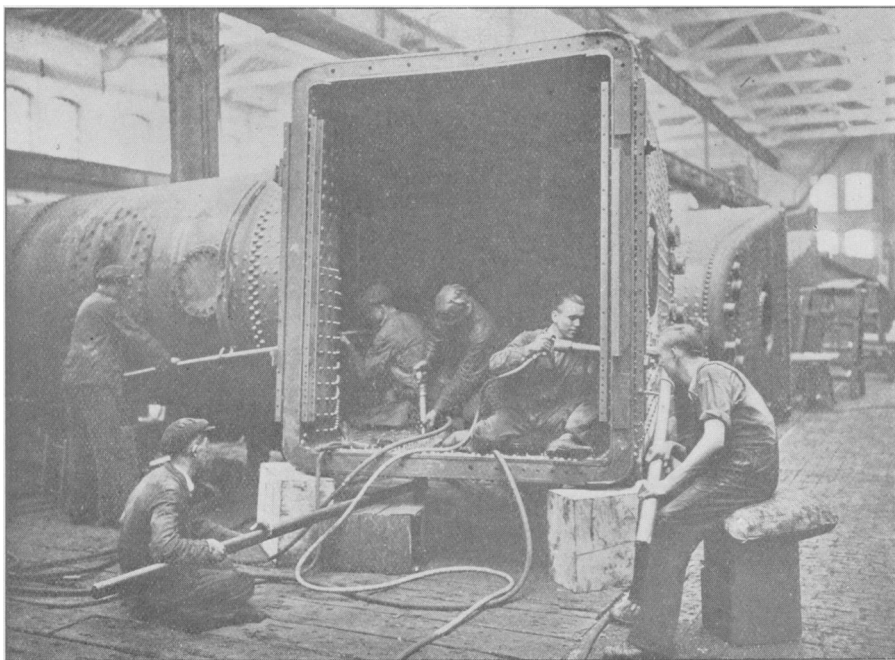


FIG. 1.—Pneumatic riveters at work.

above, with his little finger nearest the end, and in his case it is the little finger which first gives trouble. The cramped position in which the locomotive men work, together with the weight of the tool, forces them to change hands often, and although the fingers of the left hand are those affected first, all the fingers of both hands suffer in the end. It is the hardness and unyielding nature of the cold rivets which is partly responsible, I believe, for the symptoms of which these men complain, and which other riveters escape. Similar machines were used without ill-effects in building Lambeth Bridge, and also in the construction of the liner the *Queen Mary* (in which over ten million rivets were driven). In both these instances the rivets were of steel and were "hot": hot rivets are softer to work than cold rivets and I understand that untoward symptoms do not develop in this type of work.

## SYMPTOMS

The trouble in the circulation of the fingers first manifests itself when the men have been at cold riveting continuously for two years or more. Each man works about 250 stay-bolts a day, so that symptoms do not develop until about 200,000 have been fixed. Attacks of Raynaud's phenomenon then appear, at first only occasionally, in winter, but later more and more frequently and even in summer.



FIG. 2.—Another riveter.

They vary from a slight pallor of one finger-tip to cyanosis and numbness of all the fingers of both hands. The commonest finding is a pallor or slight cyanosis of one or two fingers of each hand, often symmetrical, but not necessarily so. The affected fingers are described by the men as "feeling cold", "going white", "waxy", "numb", or "dead". If the cyanosis lasts for more than half an hour the skin of the finger-tips becomes quite anæsthetic, and on cold mornings special difficulty is experienced in holding a razor, putting in studs, doing up buttons, &c. In few of

the published cases has the inconvenience been really severe, but many of the riveters whom I have seen have complained bitterly of their symptoms. In none of our patients were the hands "clammy". If a finger is cut during an attack it does not bleed, "only a little dark blood oozes out". The attack lasts as long as the hands and body remain cold. When warmth is applied in any form—hot water, hot air (as in front of a fire), or by friction—the fingers quickly recover their normal colour. During recovery the men may complain of "tingling" and "pins and needles" in the affected digits.

The attacks are brought on by cold—in cold air, when washing, holding a tumbler of cold water, or grasping a cold instrument at work, cycling in frosty weather, &c. An important factor is body temperature. When these men feel chilly in themselves their hands go blue on the slightest provocation—when sitting in a draught, or when walking outside in cold air for a few moments. When their bodies are really warm it is impossible to produce an attack, no matter how cold their hands are. It is early in the day, when they are shaving, dressing, or eating breakfast, that they experience the greatest inconvenience; this can be explained, I believe, by the fact that when getting up in the morning one's normal body temperature is 1° F. or more lower than it is in the evening.

There is no evidence that vibration by itself, without cold, can precipitate an attack. The pneumatic riveting machine I am describing is cold; cold air blows from the exhaust (which may be covered with ice) onto the hands and body of the workmen, and it is the coldness of this air which brings on those attacks which occur while at work. When the exhaust is made to blow elsewhere, and in those pneumatic machines which work "hot," attacks are not seen while the instruments are in use.

It has not been observed that emotion precipitates attacks in these men as it does in some other conditions associated with Raynaud's phenomenon.

#### SIGNS

General examination of these men, including investigation of the urine, blood-pressure, blood Wassermann and Sigma reactions, reveals nothing abnormal.

Their hands *when warm* show nothing unusual except for callosities over the thenar eminences caused by the rub of the instrument. The radial pulses are normal. There is no evidence of sclerodactyly or recurring whitlows. Nutritional changes in the finger-tips or finger-nails have not occurred in those men I have myself examined, but in two of Seyring's patients (men aged over 50, with arteriosclerosis) superficial necrosis is recorded [24]. Other complications sometimes described as arising from the use of pneumatic tools, are local atrophy of the muscles of the thenar or hypothenar eminences, and osteo-arthritis of the elbow and shoulder joints; these have not occurred in my group of riveters.

Their hands *when cold* reveal a typical Raynaud's phenomenon:—

Colour changes: With the hands at rest, below the level of the heart, the fingers become blue from the start. If the hands are lifted or the fingers moved, blood leaves the skin, and pallor—a yellowish white—results. The cyanosis passes through various depths, starting as a light bluish tint, "dusky", "a pale violet", and becoming a deeper blue, "slate blue", "leaden colour", "deep purple". It always starts at the finger-tips and spreads proximally up to the base of the fingers, perhaps to the palm. If the attack persists for a long time, a secondary waxy pallor replaces the cyanosis. The hands stay blue or pale until they are warmed. If warmed only slightly a stage is reached when the attack is, as it were, "in the balance"; during this stage warming the body alone may be enough to release the circulation. When the hands are warmed (40° C. for three minutes) the blueness begins to pass off and

irregular red blotches appear in its midst "like the spots on a plaice". Some of these appear, only to fade away, but in the end they coalesce until the whole dorsum of the hand and palm are fiery red or scarlet. Gradually this redness then spreads up each finger from base to tip, always in this direction. If any part of a finger is cyanosed, the distal portion is always cyanosed too. All the fingers do not recover at the same rate; some may be red throughout, while others still remain deep blue. After another hour or so this bright colour fades away, leaving the skin of the hand its natural tint.

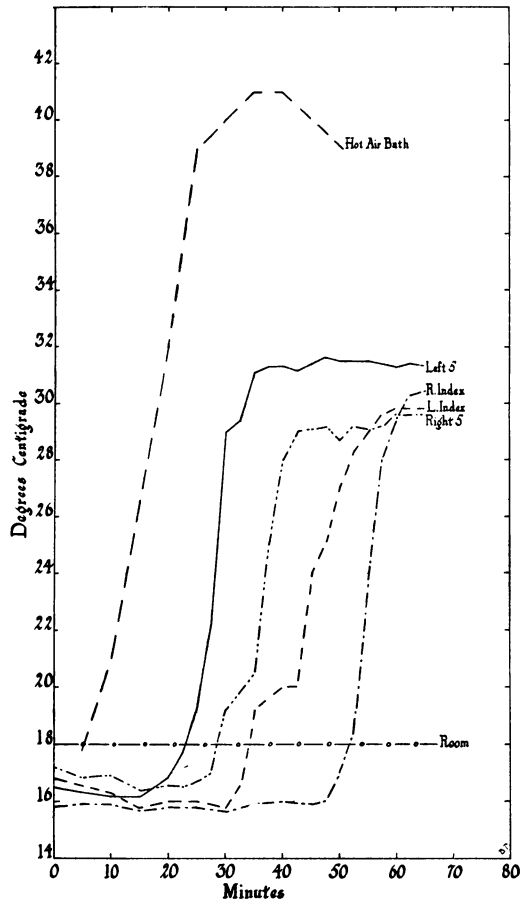


FIG. 3.—Temperature test. Release of the circulatory defect in the fingers (kept at room temperature) when the body is warmed in a hot-air bath.

Sensory changes: Every patient complains of his fingers feeling "numb" at the onset of an attack. Throughout the period of cyanosis some complain of "a tingling", some of an "uncomfortable sensation", some of a "slight pain". Severe pain is rare. On examination, a marked degree of hypo-aesthesia and hypo-algesia is found if the cyanosis has persisted for more than a few minutes: it spreads slowly upwards from the finger-tips to the palm. There is a short latent period between

the appearance of the cyanosis and the development of this sensory loss. During the phase of recovery, when the hands are being warmed, the men may complain of "pins and needles", "burning", or "discomfort".

Temperature changes: All the men complain that their fingers feel cold to the touch during the attacks, and this can be confirmed by an observer feeling the skin. Temperature tests reveal that the circulatory defect can be released by warming the body, without warming the hands, a release illustrated in figs. 3 and 4.

Sweating of the hands has not been noticed during attacks. Swelling of the fingers does not occur. In severe attacks local pressure on a finger leaves an indentation which takes longer to disappear than when the circulation is normal.

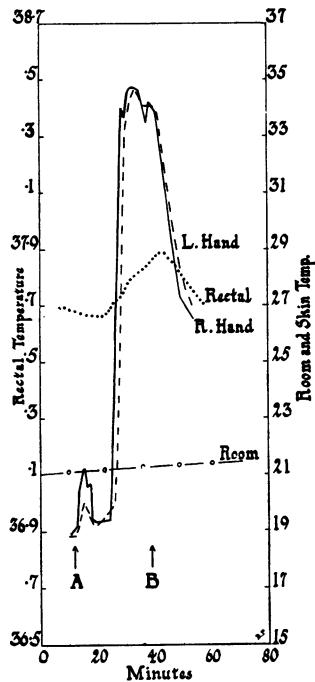


FIG. 4.—Temperature test. Release of circulatory defect in the fingers (kept at room temperature) as rectal temperature rises when the legs are placed in hot water.

The veins on the dorsum of the hands during an attack are small and the radial pulses are less easily palpable than when the hands are warm. If a finger is pricked during an attack it does not bleed. The nose, ears and feet of these men are normal and quite free from colour changes.

*X-ray photographs* of the hands of these men reveal changes which are being investigated more fully. The small areas of decalcification described by Brailsford [2] in workmen using compressed air drills can be seen in the bones of the hands of some of our riveters. Another change is an apparent periosteal overgrowth on the volar surfaces of the shafts of the phalanges. This sometimes occurs in normal healthy men [13] and further investigation into the X-ray appearances of the hands

of other manual workers is needed before one can say for certain whether or not this is abnormal, and vibration or other trauma plays any part in its production.

#### PROGNOSIS

When these men stop riveting-work their symptoms may improve a little but do not disappear. The residual circulatory defect causes considerable discomfort, and prognosis as to complete recovery is doubtful and usually poor.

#### TREATMENT

For those men who have already developed Raynaud's phenomenon in their fingers the best treatment is to keep the body and hands always warm, especially the body, and particularly in the mornings. If symptoms are really severe, physical therapy may be needed, and in elderly men with nutritional changes threatening sympathetic ganglionectomy or section of the sympathetic trunk may have to be considered.

#### PREVENTION

Several methods of tackling the problem have suggested themselves:—

(1) The rate of vibration of the instrument may be reduced below the critical level, which seems to be about 2,300 strokes a minute for this type of tool.

(2) Shock-absorbing pads of "Sorbo" rubber, perhaps  $\frac{1}{2}$  in. thick, could be incorporated in the palms of the leather gauntlets which these riveters wear.

(3) Similar pads might be fixed to the handle of the riveting machine itself; or a sleeve of the same material might be fixed around the barrel of the instrument, which the workman grips with his left hand—the site of most of the trouble. It is possible that some type of handle could be attached by a strong spring to this part of the machine, so that vibration on the palm of the hand is reduced to a minimum, without affecting the pressure which must of necessity be maintained on the end of the instrument.

(4) It seems that it is only when especially hard material is being worked, as in cold riveting, that attacks of Raynaud's phenomenon result, and then only after the men have been two or more years on the job; trouble may perhaps most easily be avoided by arranging the shifts of work so that no man does this particular type of riveting for more than a few months at a stretch.

(5) A completely different tool could be used—a so-called "fixed hammer" which is held against the rivet by a mechanical device, a cylinder containing compressed air. In this way vibration is absorbed before it reaches the man, but I understand that this apparatus is clumsy and inconvenient to work.

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