Acta Dermatovener (Stockholm) 53: 50–52, 1973

# CUTANEOUS MICROWAVE INJURY

## *A Report of Two Cases*

Roger H. Brodkin and Jacob Bleiberg

*From the Department of Medicine, Division of Dermatology, College of Medicine and Dentistry of N.J. at Newark, USA*

*Abstract.* Microwave ovens are becoming increasingly common in our environment. Two cases of presumed microwave injury which resulted in dystrophic changes of the fingernails are presented. The nature of microwaves and the design of the microwave oven is discussed. It is suggested that physicians be suspicious of exposure to microwaves in cases of nail plate dystrophies.

Microwave ovens have grown increasingly popular in commercial establishments and private homes in the past decade and show promise of soon becoming common fixtures in our environment. Cutaneous injury from the use of microwave ovens has not been previously reported. Since we have recently observed two patients with cutaneous injury presumably due to the use of a faulty microwave oven and because of the possibility that this new energy source may be the cause of more injury to patients in the future, we are herein reporting our observations on these two cases and presenting a brief discussion of the nature of microwaves and a description of the microwave oven.

## CASE REPORTS

*Case 1.* H. M. A 50-year-old white female who had operated a microwave oven in a department store snack bar for 4 years. Her job consisted of placing hamburgers, "hot dogs" and rolls, which she obtained from a refrigerator, into a microwave oven and cooking them for approximately 20 sec, controlled by an automatic timer on the oven. Approximately 5 months before presenting herself for examination, she first noted what she described as an "infection" on the index finger of the left hand, near the base of the nail. The appearance of this lesion coincided with what she alleged was a malfunction of the microwave oven, which resulted in burning of food. Within the next 4 weeks, this same process spread to involve three fingers of the right hand. She applied compresses to this area without benefit. Shortly after that, she began to notice transverse ridging and deformity of the nails which began at the nail base proximally. While operating the oven during the time of onset of her eruption, she noted no burning sensation in her fingers and very little pain or tenderness. She did no wet work in her job and denied ever having any other problem with her job. She had never had any previous difficulty with her fingers or fingernails and had had no previous dermatologic problems of any sort. Her general health had always been good and except for a ligation of the superficial veins of a leg in 1971, had never had any significant illnesses or operations. There was no family history of diabetes.

On complete physical examination, the positive physical findings were limited to the nails alone. Examination of the nail plates revealed transverse dystrophic ridging of the thumb and little finger of the right hand. The index finger of the left hand showed even more extreme transverse dystrophic ridges with partial separation of the nail plate from the nail bed (Fig. 1). The paronychial areas were normal.

Laboratory studies revealed a normal complete blood count and urinalysis, Also normal were the ESR, FBS, BUN, cholesterol, uric acid, serum bilirubin, total proteins, serum albumin, alkaline phosphatase, SGOT, and SGPT. X-rays of the fingers revealed no demonstrable soft tissue or bone abnormalities. The patient was started on treatment with a topical steroid cream and follow-up over a 6 week period has resulted in gradual improvement of this condition as the dystrophic changes have continued to grow distally and normal nail to form proximally.

*Case 2.* A. R. A 56-year-old white female who had been employed at the same snack bar, operating the same microwave oven for 1 $^1/_2$ years. Her history, as in the previous patient, was completely unrevealing except for her nail problem which she describes as her nails starting to become deformed at approximately the same time as patient No. 1. She had tried no therapy whatsoever. She denied any pre-existing dermatologic problems, paronychia, nail diseases or diabetes. Complete physical examination again was non-revealing except for

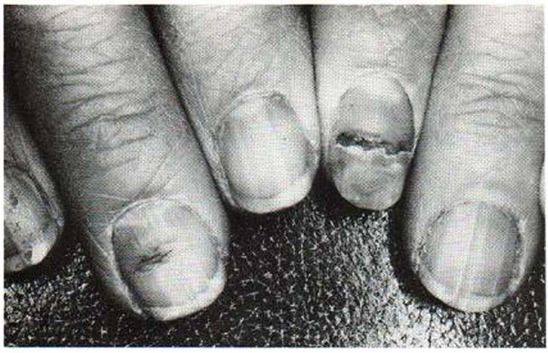

*Fig. 1.* Fingernail plates, Patients no. 1, showing varying degrees of transverse dystrophic ridging.

the findings of the nail plate which presented a similar severe transverse ridged dystrophy of the middle finger of the right hand and the index finger of the left hand (Fig. 2). Laboratory investigation revealed a normal complete blood count and urinalysis. The corrected ESR was 32 mm in 1 hour. FBS, BUN, cholesterol, uric acid, serum bilirubin, total protein, serum albumin, alkaline phosphatase, SGOT and SGPT were all within normal limits. The serum uric acid was 7.2 (normal 2–7). X-ray examination of the fingers revealed the bony structures and soft tissues to be within normal limits.

## COMMENT

Microwaves include a portion of the magnetic spectrum between very high frequency radio waves and infra-red waves, from 10 to 100 000 megacycles per second. Molecular structure of the target suhstances determines whether microwave energy of a particular wave length is transmitted (air, glass), reflected (metal), or absorbed (foods, human tissue). When absorbed, microwaves produce thermal, electrical and magnetic effects. The biological effects produced result primarily from the heating of tissues. These effects depend upon the frequency and intensity of the beam, the length of exposure and the conductance of the tissues (1, 3, 6, 7, 8). Wavelengths between 150 and 1 000 megacycles per second are absorbed only in the deeper tissues and are not perceived as heat (9). Up to 10 000 megacycles per second, the more superficial tissues absorb the energy and above 10 000 megacycles per second, heat is perceived in the cutaneous receptors.

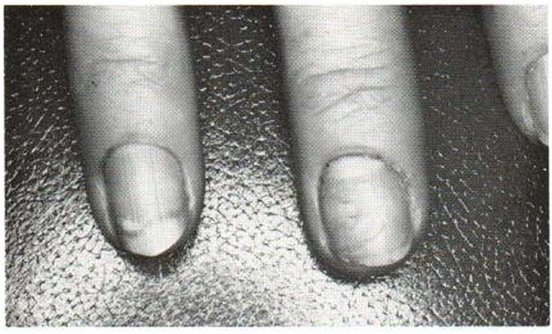

*Fig. 2.* Fingernail plates, Patient no. 2, showing varying degrees of transverse dystrophic ridging.

The lens of the eye has been observed to be the tissue most susceptible to microwave damage, both in occupational exposure to man and in laboratory animals (5). The testes also appear to be susceptible. Other reported effects include bradycardia, endocrinopathy, hypotension, elevated blood histamine and CNS symptoms consisting of headache, irritability, fatigability and disturbed sense of smell. Many of these were noted to be reversible (9).

The microwave oven consists of a generator and a horn which feeds the radiation into a cooking cavity. Most microwave ovens generate radiation of 2 450 megacycles per second. Thus damage from heat may result in human tissues without being perceived by the operator. The microwaves are evenly distributed throughout the cooking cavity by being reflected off rotating metal blades. Hinges and doors are carefully designed and built to minimize leakage. Interlocks are used to insure secure closure of the door while the unit is operating (2, 4, 10).

Disagreement exists on "safe" limits of exposure to microwaves. For practical purposes, the dose received by an individual varies with the time of exposure. It has been established that leakage occurs in the microwave ovens now in use varying from 2–92 % of ovens tested, depending upon the technique of testing (4).

When the two patients complained to their employer, and before they were seen by us, the microwave oven was removed and returned to the manufacturer. We could obtain no information regarding leakage or functional integrity of this unit from either the employer or the manufacturer.

The evidence suggesting that the microwave oven was cause of the cutaneous injury in these two patients seems impressive. 1) Only the two

persons operating the oven developed lesions, in spite of the fact that there were other people employed in the snack bar. 2) They both developed similar lesions. 3) The lesions occurred at approximately the same time in both patients. 4) There were no previous similar lesions in these individuals, nor was there any apparent underlying or other environmental cause. 5) They were both doing this same job for a prolonged period of time prior to this injury, without any problem. 6) The lesions began to improve when the unit was removed. 7) Microwave ovens generate radiation which has the capacity to produce thermal injuries in tissue without providing a sensation of heat to the individual. 8) Since the structures from which the nail plate originate lie beneath the skin surface and microwaves can produce thermal injury in deeper structures, the lesions produced in the nail plate are compatible with the type of injury which microwaves might produce.

It would seem that since microwave ovens are now in common use and since dystrophic changes of the nail plate are common lesions, that patients and dermatologists might not be alerted to the possible association and might not be sufficiently suspicious to make this diagnosis when confronted with the problem. It is the fact that there were two patients with the same exposure to microwaves at the same time, who developed the same lesions, that makes the chain of circumstances so convincing that the clinician now must be suspicious of microwave injury in dystrophic changes of the nails.

## REFERENCES

1. Boysen, J. E.: USAF experience with microwave exposure. J Occup Med *4:* 192, 1962.
2. Cleary, S. F.: Considerations in the evaluation of the biological effects of exposure to microwave radiation. Amer Indust Hyg Ass J *31:* 52, 1970.
3. Deichmann, W. B. & Stephens, F. H., Jr: Microwave radiation of 10 mw/cm and factors that influence biological effects at various power densities. Industr Med Surg *30:* 221, 1961.
4. Gilbert, H.: A study of microwave radiation leakage from microwave ovens. Amer Ind Hyg Assoc J *31:* 772, 1970.
5. Letavet, A. A. & Gordon, Z. V.: The biological action of ultrahigh frequencies. Acad Med Sci U.S.S.R. Moscow (1960). (Translation by U.S. Joint Publ. Research Service. 12471, 1962.)
6. Morgan, W. E.: Microwave radiation hazards. Arch Industr Health *21:* 570, 1960.
7. Peyton, M. F. (ed.): Proceedings of the Fourth Annual Tri-Service Conference on the Biological Effects of Microwave Radiation, New York, Vol. 1. Phenamun Press, 1966.
8. Suroviec, H. J.: Microwave ovens radiation hazards in food vending establishments. Arch Environ Health *14:* 469, 1967.
9. Terrill, J. G., Jr: Microwave lasers and X-rays, adverse reactions due to occupational exposure. Arch Envir Health *19:* 265, 1969.
10. — Testimony on "Radiation Control for Health and Safety Act of 1967" before the Committee on Commerce, United States Senate, Part 2, Serial No. 90-49, P. 517, (May) 1968.

*Received May 26, 1972*

Roger H. Brodkin, M.D.
40 Union Avenue
Irvington, N.J. 07111
USA