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Atlas of Current Roentgenographic Findings in the New Jersey Radium Cases

U. S. Atomic Energy Commission

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Radium Research Project
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ATLAS OF CURRENT ROENTGENOGRAPHIC FINDINGS
IN THE NEW JERSEY RADIUM CASES

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October 1963

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ABSTRACT

Presented are annotated roentgenograms of bone which are illustrative of the bone changes currently encountered and of the terminology used to describe these changes in a study of individuals under investigation by the Radium Research Project of the New Jersey State Department of Health in the course of its epidemiological follow-up of radium cases.

The bone changes illustrated are representative of findings currently observed and include destruction of bone; disturbance of articular aspect; cortical, trabecular, and periosteal changes; sclerosis; discrete radiolucencies; fractures.

With thorough clinical and laboratory studies, specific etiologies for these bone changes, other than radium or aging, have been excluded.

PREFACE

This is one of a series of reports on the epidemiological follow-up of a group of individuals with body burdens of Radium-226 and Radium-228 (mesothorium).

Since only a portion of the examinations anticipated in the entire study has been completed, and since only certain selected films have been presented, it must not be presumed that these are generalized findings or that the findings are the predictable results of the exposure to internal body burdens of radium.

This report contains reproductions of selected films collected to date. Subsequent films, with substantiating findings of studies, (including histopathology, microautoradiography and microradiology) will be published periodically.

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7 - Discrete Radiolucency	4, 6, 7, 8, 9, 14, 16, 17, 18, 19, 20, 21, 22, 23, 26, 28, 29, 30
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INTRODUCTION

Annotated roentgenograms of bone are presented which are illustrative of the bone changes currently encountered and of the terminology used to describe these changes in a study of individuals under investigation by the Radium Research Project of the New Jersey State Department of Health in the course of its epidemiological follow-up of radium cases.

This report has been prepared for the primary purposes of making available examples of roentgenographic changes in bone to those interested in the effects of radiation on man and of illustrating the terminology used by this Project in describing these changes.

Included in the selection of films are three reproductions of historical importance. Plates 1A and 1B were taken by Dr. Theodor Blum, the one who first related the occupational exposure of persons in the radium dial painting industry to a specific pathological effect. These films were used by him as a basis for his original statement concerning "radium jaw" in 1924. Plate 2 was taken for Dr. Harrison Martland Sr. and used by him in his initial investigations of the radium dial painters.

The bone changes currently encountered and illustrated herein, which may be entirely or partially related to the long-term deposition of radium, are described by the use of suitable terminology. It reflects practice in roentgenology and was selected so that it could be used by both the general radiologist and the oral radiologist. This

terminology is not intended to be suitable for all purposes of diagnostic roentgenology, but it is expected that persons accustomed to reading films will have no difficulty in using the terms. The aim was to establish a terminology which could be used with consistency throughout these studies of the effects of radium on man. The terminology used in this report is as follows:

- 1 - Destruction (not limited to anatomical site)
- 2 - Change of Articular Aspect
- 3 - Cortical Change
 - A - Irregular
 - B - Thickened
 - C - Thinned
 - D - Laminated
- 4 - Sclerosis
 - A - Diffuse
 - B - Patchy
 - C - Phalangeal tufts
- 5 - Trabecular Change
 - A - Calcification
 - 1 - Increased density
 - 2 - Decreased density
 - B - Pattern
 - 1 - Lost
 - 2 - Blurred
 - 3 - Coarsened
 - C - Configuration altered
- 6 - Fracture
- 7 - Discrete Radiolucency
- 8 - Periosteal Change

It is realized that many classifications, listings or indices of roentgenographic findings in bone exist. It was felt, however, that the terminology finally selected is most suitable for its designed purpose and consists of regularly used terms. An attempt was made to avoid the use of diagnostic terms, since substantiating histopathology has not yet been completed for each of the findings presented. It was based, instead, on descriptive terms of the areas of bone described, realizing that, although a uniform terminology can be used to describe visible changes in the films, the etiology of the described change may vary from individual to individual, from bone to bone, and from area to area within the same bone.

It should be noted that this report does not include a method of indicating degrees of severity of change. Various scoring systems have been reviewed and found to be lacking in ability to express the true roentgenographic image and interpretation of the individual bone or the entire skeletal system.

In order to express degrees of change, it is thought that a statistically valid scoring system must establish criteria for size and type of change, as well as for location and frequency of occurrence. It is anticipated that a subsequent report will include a scoring system currently being evaluated by this Project.

Although the bone changes illustrated may be found in persons who never worked with or were otherwise exposed to radium, insofar as possible specific etiologies for these bone changes, other than radium or aging, have been excluded by thorough clinical and laboratory studies.

It should be understood that every finding in every film has **not** been indicated, but just those needed for illustration purposes. Data given with each film include case number as listed by Radium Research Project, sex and age of the individual at the time the film was taken, at the time of surgery, or at the time of death for those films taken of specimens.

Since one of the objectives of this report was to present accurate and reliable illustrations of roentgenographic findings, an attempt has been made to minimize any changes in contrast between the film and the illustration and to preserve the detailed

structure of the bone. Furthermore, to avoid any tendency to enhance, highlight, or exaggerate various findings, none of the films were staged (outlined).

Since only a portion of the examinations anticipated in the entire study has been completed, and since only certain selected films have been presented, it must not yet be presumed that these are generalized findings nor that the findings are the predictable results of the exposure to internal body burdens of radium.

Subsequent films, with substantiating findings of studies (which include histopathology, microautoradiography, and microradiology) and estimates of the body burden of radium, will be published periodically.

June 4, 1924

"There came under my observation a case of osteomyelitis of the mandible and maxilla, somewhat similar to phosphorus necrosis; which, however, was caused by some radioactive substance used in the manufacture of luminous dials for watches. The condition has been termed "radium jaw."

Plate 1A

Blum, Theodor. "Osteomyelitis of the Mandible and Maxilla,"
The Journal of the American Dental Association (September, 1924).

X-ray Plates

June
1924

THEODOR BLUM
RIGHT

"Roentgenogram of the right maxilla and mandible. Note the loss of the maxillary teeth and bone and the peculiar bone structure of the mandible."

Theodor Blum, D.D.S., M.D., "Radium Necrosis"
Archives of Clinical Oral Pathology, Volume I,
Number 4 (December, 1937)

Plate 1B

Roentgenogram taken at the request of Dr. Harrison S. Martland in his original study of the radium workers.

Osteosarcoma of the femur in a young female radium dial painter. The pelvic bones appear relatively normal. It was the discovery of lesions of this type in individuals exposed to radium that led Dr. Harrison S. Martland to confirm Blum's original suspicions and establish the occurrence of changes in bone following radium deposition and retention.

Case 5281 - Female, Age 58

The diagnosis following biopsy of the tumor of the distal tibia was osteogenic sarcoma.

Plate 3

Plate 4

Case 5215 – Female, Age 74

Plates 4 and 5 illustrate three stages in the development and growth of an osteosarcoma of the tibia over an eight month period. The multiple changes due to radium are well seen on the amputation specimen, (Plate 6).

Plate 4

Destruction (not
limited to
anatomical site)

Lat

9/8/60

AP

Plate 5

Case 5215 - Female, Age 74

Plate 5

Plate 6

Case 5215 — Female, Age 74
(Amputation Specimen)

Plate 6

Plate 7

Case 5281 – Female, Age 58

There is irregularity of the proximal extremity of the humerus. In the chest film, Plate 7A (taken five years previously), the changes were less evident.

Plate 7

Plate 8

Case 5047 - Female, Age 71

Multiple articular and subarticular areas of destruction causing irregularity of articular surface of femoral head. It is possible that these resorption areas could result in destruction of the articular process by confluence and weakening of the bone structure.

Plate 8

Plate 9

Case 5023 - Female, Age 61

Plate 9

Plate 10

Case 5276 — Female, Age 54

Plate 10

Plate 11

Case 5900 – Female, Age 43

The changes are symmetrical and bilateral.

Plate 11

Plate 12

Case 5284 – Female, Age 61

Varying degrees of irregular sclerosis in the same individual. The appearance is that of infarction.

Plate 12

Plate 13

Case 5048 - Female, Age 58

Plate 13

Plate 14

Case 5014 - Female, Age 60

Plate 14

Plate 15

Case 5284 - Female, Age 61

Plate 15

Plate 16

Case 5047 – Female, Age 71

Fracture occurred without history of adequate trauma at approximately 50 years of age.

Plate 16

Plate 17

Case 5215 - Female, Age 74

Plate 17

Plate 18

Case 5204 – Male, Age 81

Irregularities of bone pattern (compare with Plate 19 specimen films).

Plate 18

Plate 19

Case 5204 – Male, Age 81

Abnormal areas that were difficult to define during life became more apparent when the soft parts were removed (compare with plate 18).

Plate 19

Plate 20

Case 5281 — Female, Age 63

Numerous areas of discrete radiolucencies throughout the calvarium. Changes of decreasing degree of severity can be seen in the following four individuals (see Plates 20, 21, 22 and 23).

Plate 20

Plate 21

Case 5014 — Female, Age 60

Plate 21

Plate 22

Case 5127 - Male, Age 67

Plate 22

Plate 23

Case 5276 - Female, Age 54

When only a few discrete radiolucencies are present, it may be difficult to differentiate them from the normally occurring pachionian depressions or blood lakes.

Plate 23

Plate 24

Case 5251 — Female, Age 64

Sclerotic patches in tips of phalangeal tufts. Occasionally they are present in the central portions of the tufts.

Plate 24

Patchy
Sclerosis

Plate 25

Case 5276 - Female, Age 54

Plate 26

Case 5047 — Female, Age 71

Generalized disturbance of trabecular calcification and pattern (see Plate 29A).

Change of Trabecular
Calcification-Increased
Density With Loss of Pattern

Patchy
Sclerosis

Irregular and
Thickened Cortex

Plate 27

Case 5048 - Female, Age 58
(See plate 29B)

Plate 27

Plate 28

Case 5002 – Female, Age 56

Plate 28

Plate 29A

Plate 29B

Plate 29C

Plate 29D

Plate 29A Case 5047 – Female, Age 71
General Disturbance of Trabecular
Calcification and Pattern (See plate 26)

Plate 29C Case 5215, – Female, Age 74
Generalized Increased Density

Plate 29B Case 5048 – Female, Age 58
(See plate 27)

Plate 29D Case 5281 – Female, Age 63

Plate 29 A, B, C and D

Plate 30A

Plate 30B

Plate 30C

Plate 30D

Plate 30A

Case 5284 – Female, Age 61

Plate 30B

Case 5199 – Female, Age 59

Plate 30C

Case 5155 – Female, Age 62

Plate 30D

Case 5037 – Female, Age 61

Plate 30 A, B, C and D

FILM PLATES and PRINTING

This book was printed by Alma Offset Company, Inc., Trenton, New Jersey. The X-ray plates were produced from mechanicals prepared by the graphic art staff of the New Jersey State Department of Health by the following procedure:

1. Continuous tone negatives were made from the original X-rays.
2. Pertinent sections of the continuous tone negatives were cut up and placed in reverse position on clear acetate.
3. Velox prints were made from these layouts. The velox prints were retouched by airbrush to unify the backgrounds.
4. Bourges Kleercote acetate placed over step 3 was ruled with Pelikan Ink and varityped (12 Pt. School Book) captions were glued in position.
5. 133-line negatives were made with and without the surprinting from the mechanicals as prepared in step 4.

Text pages are 12 Pt. Century Expanded set by Trentypo, Inc., Trenton, New Jersey. The cover is Warren's Lusterkote and the inside pages are Mead's 80# Black and White.

The original X-ray films in this report were taken by the following:

	Plate Number
Theodor Blum, M.D., D.D.S.	1A, 1B
Robert Bonda, D.D.S.	26, 27, 28, 29, 30
Carye-Belle Henle, M.D.	4, 5, 6, 7B, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25
Harrison Martland, M.D.	2
Vincent Whelan, M.D.	3, 7A