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OSTEOSCLEROSIS FRAGILIS GENERALISATA

MARMORKNOCHEN: ALBERS-SCHÖNBERG DISEASE *

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A patient who entered the hospital with a fracture of the right leg, the result of a rather trivial injury, giving a history of previous fractures, likewise following slight trauma, was found, on roentgen-ray examination, to have a pathologic fracture as the result of a rather obscure bone condition which has been termed osteosclerosis fragilis generalisata, Marmorknochen (marble bone), or Albers-Schönberg disease. Inasmuch as only nine other cases of this disease have been reported, all of which have been in the foreign literature, none in the English language, the history of this case is given, together with the roentgen-ray study of the entire skeleton and a review of the literature of this subject to date.

REPORT OF CASE

History.—W. S., a schoolboy, aged 11 years, born in this country, was admitted to my service at the Cook County Hospital, April 20, 1922. He was brought to the hospital by his mother, who stated that, on April 18, 1922, he sustained an injury of the right leg. A playmate who was swinging him around became dizzy and fell with the patient, stepping on his right leg above the ankle. The patient had to be carried home, where he stayed in bed. He entered the hospital because of pain, tenderness and very slight swelling of the lower part of the right leg and inability to use it.

He sustained a fracture of both bones of the left leg in July, 1920, when he fell out of a window, about 4 feet high, striking the middle of the left leg on a step. No physician was called at the time but a firm bandage was applied. He was unable to walk on the leg for three weeks. A fracture of the left femur occurred in November, 1920, when another boy pushed him against a fire hydrant. He was treated in St. Elizabeth's Hospital at that time. The tonsils and adenoids were removed in 1918. He had a mild attack of appendicitis in 1917. He had had pneumonia seven times—at 4 months, 14 months, 3 years, 4 years, 6 years, and 10 years of age. With the last attack, he had an associated otitis media on the right side, at which time an "abscess was lanced." His hearing in the right ear at the time of examination was not so good as in the left.

He was essentially normal. His birth had been normal (a precipitate 10 pound baby). He was breast fed, his feedings being supplemented by cow's

* The author is indebted to Dr. Arthur R. Metz for the roentgenographic examination and the notes on it.

milk after three months and up to sixteen months, when he was taken off both the breast and the bottle. He usually stood high in his school work. He was in the high fifth grade.

His father and mother were both living and well. Two brothers were living and well. One brother had had "heart trouble." One brother died of pneumonia at 16 months. This brother was paralyzed on one side for a month, at 3 months of age.

Fig. 1.—Left, anterior view of patient (W. S.), aged 11, with generalized osteosclerosis fragilis; right, lateral view of patient.

Physical Examination.—The patient was fairly well nourished, 3 feet 7½ inches tall (110 cm.) and weighed 49 pounds (22 kg.). There was loss of function of the right leg, with extreme pain and tenderness to touch over the lower third, with slight swelling but no deformity.

His head was large and had a long anteroposterior diameter. His eyes were brown and reacted well to light and on accommodation. The ears were negative externally, but there was an old otitis media on the right side. The septum

of the nose was deflected to the right. Many of the teeth were carious. The tongue was negative and the tonsils had been removed. The hard palate was extremely high. The cervical glands were palpable. The chest was symmetrical, except for a very slight scoliosis to the right in the middorsal region. A very slight suggestion of a Harrison's groove was present. The excursion and expansion of the lungs were good, and there was no area of dulness or râles. The apex beat was within the nipple line, 5 cm. to the left of the median line. There was no enlargement or murmurs. In the abdomen, there were no palpable tumors or areas of tenderness. The limbs were practically negative except for the pathologic condition noted above, and that the radial epiphyses were noticeably enlarged.

Laboratory Findings.—The blood pressure was: systolic, 128, and diastolic, 85. Hemoglobin was 86; erythrocytes, 4,992,000; color index, 86; leukocytes, 11,000. The urinary findings were negative. The specific gravity was 1.014, and the reaction acid. There was no albumin, sugar, acetone, diacetic acid, blood, cells or casts. The spinal fluid was clear and of normal pressure and gave a negative Wassermann reaction. The blood Wassermann reaction was also negative. The blood chemistry was: total nitrogen, 34.30 (normal, 26.50); urea nitrogen, 21.48 (normal, 10); urea, 45.96 (normal, 21.40); uric acid, 1.95 (normal, 1.80); creatinin, 1.54 (normal, 1.35); sugar, 93 (normal, 100).

A blood Wassermann test on the mother gave a negative result.

July 10, 1922, an examination of the basal metabolic rate showed 52.5 calories, which is normal for a boy weighing 46 pounds, 44 inches high and 11 years old.

Roentgen-Ray Examination.—This revealed a fracture of the right tibia at the juncture of the middle and lower thirds, without displacement of fragments, together with other pathologic conditions of the bone. A posterior molded splint was applied and the fracture showed union without much callus, the splint not being removed until June 21, 1922.

Course.—About June 8, 1922, the patient developed severe pain and tenderness over the left scapula, associated later with redness, heat and fluctuation. The white blood count was 27,900; temperature, 99.4 F. Aspiration of pus revealed gram-positive cocci in staphylococcus formation. Cultures of pus revealed hemolytic colonies. Incision revealed a thick yellow pus.

Diagnosis.—Pathologic fracture of the right tibia associated with osteosclerosis fragilis generalisata; old otitis media on the right side; probably old rickets; slight scoliosis of the middorsal spine; periostitis (?) of the left scapula.

Roentgen-Ray Examination.—Roentgenographic examination of the entire skeleton revealed a generalized disturbance of the bony structure, characterized by a marked, irregularly increased density of some portions of the bones, with thinning and rarefaction in other areas. In the long bones, the tendency was toward a marked narrowing of the medullary canals in the middle third, due to a thickening of the cortex, with the ends of the shaft presenting an expanded appearance, with a thinning of the cortex and a coarsely mottled effect due to increased density in the marrow cavity. The small bones, such as the vertebrae, carpals, and tarsals, presented a generalized increased density, with absence of bone structure. The epiphyseal lines were all present and were normal in width, but had slightly irregular margins. There was a general increase of density of the epiphyses, with absence of bony structure, but they appeared normal in size and outline. A detailed description of the bony changes is presented in the six roentgenograms, which altogether include the entire

skeleton; the bones of the hands, forearms and lower humeri are reproduced in Figure 2; feet, Figure 3; femurs and pelvis, Figure 4; legs, Figure 5; trunk, Figure 6; head, Figure 7.

In the examination of the hands, forearms and lower humeri (Fig. 2), the following pathologic findings were noted: The structural contour of the phalanges was preserved, though the phalanges themselves were thickened. The

Fig. 2.—General marble-like picture of the bones of the hands, forearms and arms; transverse, parallel, disklike bands in the phalanges and metacarpals; fracture of the distal epiphysis of left radius.

medullary portion was changed to compact bony tissue at the distal ends of all phalanges. This occurred in such a manner that it left a triangular area of lesser density at the proximal end of each phalanx, with the base of the triangle at the proximal end of each phalanx and the apex pointing toward the distal end. At the apexes of these triangles, small isolated areas of calcification were noted, especially in the proximal phalanges. At the base of these triangles,

parallel, transverse bands of lime deposits were noted. These were especially marked in the thumbs. Parallel hairlike lines also ran from the base of this triangle toward the apex. The proximal ends of the bodies of the phalanges at the base of the triangle described were structureless and of marble-like density, as were also the centers of ossification for the proximal ends of the bone, a well defined line separating the former from the latter.

The metacarpals showed similar changes, the greater portion of the bones presenting a marble-like density. The distal extremities of each of the second, third, fourth and fifth bones, corresponding to the distal center of ossification, showed great density. Similarly, the proximal, or epiphyseal, portion of the

Fig. 3.—General marble-like picture of the bones of the feet; parallel lines of calcification running in superimposed disklike fashion at the base of the first metatarsals; peripheral and central calcification of the cuboid bone, with an area of lesser density between.

first metacarpal showed great density. A triangular area of lesser density, with its base at the distal end of the bodies of the metacarpals, was noted in the metacarpal bones corresponding to the fingers. The base of the triangle of light area in the metacarpal corresponding to the thumb was toward the proximal end of the body of the bone and presented well defined, disklike, parallel, transverse bands of calcification. There was a trace of a distal epiphyseal line in each of the first metacarpals.

The carpal bones presented a compact, structureless mass of marble-like density.

The epiphyses of the radius showed the same marble-like density and a well defined epiphyseal line in the upper portion, not so well defined in the lower. The lower epiphysis of the left radius was definitely shown to be fractured, although the patient made no complaint of this.

The diaphysis of each radius was curved slightly toward the radial side, and was very dense, the medullary canal being almost obliterated in pro-

Fig. 4.—Hour-glass-like narrowing of the medullary canal due to thickening of the cortex in the middle third of the femur, and transverse layers of increased density in the expanded distal portion of the medullary canal; increased density of the pelvis.

portion to the thickening of the corticalis. Each ulna presented a picture similar to that of the radius. There was more or less clubbing of the upper ends of both bones of the forearm. Peri-articular calcification of the elbow joint was noted in the area between the head of the radius and the capitellum. The lower end of each humerus, although preserving its normal contour, showed

the same marble-like density, the medullary canal being very narrow, with a corresponding thickening of the compact substance.

The examination of the feet (Fig. 3) revealed a picture quite similar to that noted in the hands. The disklike, parallel, transverse shadows at the proximal ends of the first metatarsals were particularly well defined. The tarsal bones, with the exception of the cuboid, showed the same compact,

Fig. 5.—Pathologic oblique fracture through the distal third of right tibia; outward bowing of the shafts of the tibia and fibula; increased density of the long bones; marked increase in density of the epiphyses.

structureless, dense, marble-like condition noted in the carpal bones. The cuboid showed a peripheral shadow which, toward the inside, gave place to a lighter area, which again showed a greater density in its center. There was no calcification of the tendon of Achilles at its insertion, as noted by Schulze in his case.

The femurs (Fig. 4) were symmetrically involved, with a marked increased density of the proximal and distal thirds, with an hour-glass-like narrowing of the medullary canal in the middle third, due to a thickening of the cortex. Toward each end, the cortex was gradually thinned and the medullary canal correspondingly expanded. This was most marked in the distal portion. In this expanded medullary canal, there were seven irregular, transverse layers

Fig. 6.—Scoliosis of the dorsal spine; ribs larger and denser than normally with the absence of bony structure; increased density of scapulas, most pronounced about the head and coracoid process; humeri similar to femurs.

of increased density, about 1 cm. in width, which may have represented periods of growth. There was an absence of normal bone structure. The epiphyseal lines appeared normal. The distal epiphyses were markedly increased in density, with absence of bone structure. The proximal third presented a more uniformly increased density than the distal, with absence of the transverse layer formation, and a less marked thinning of the cortex. The epiphyses of

the head and great trochanter presented the marked dense appearance, with absence of bony structure. There was no bowing or evidence of injury and the margins were smooth in outline.

The pelvis was normal in size and shape, presenting a marked increase in density. The margin of the crests of the ilia was irregular in outline. In the central portion of each wing, there was a circular area, 3 cm. in diameter, which was less dense and appeared like normal bone about which were concentric layers of increased density which suggested periods of growth.

Fig. 7.—Skull showing a definite increase in density about the base of the middle and frontal fossae; posterior and anterior clinoid processes enlarged, increased in density; the posterior, a clublike prominence.

The tibiae (Fig. 5) were similar in appearance, except for an oblique fracture extending for a distance of 8 cm. through the distal third of the right. The fragments were in good position and there was evidence of callus formation. There was definite bowing outward of the shaft. The middle third was similar in appearance to the femurs. The proximal third presented a similar appearance to that of the distal third of the femur, having the indistinct transverse layers of increased density, of which five could be identified. In

the distal third, the density was irregular and presented no suggestion of layer formation. The epiphyses were markedly increased in density, with absence of bony structure.

The fibulas presented the same general characteristics as the femurs and tibias. There was a slight scoliosis of the spine (Fig. 6), and the bodies of all the vertebrae showed a marked increase in density. The ribs were larger and denser than normal, with absence of bony structure. There were the same general changes in the clavicles that were common to the other long bones. The scapulae showed increased density, which was most pronounced about the head and coracoid process. The humeri were symmetrically involved, the proximal two-thirds having an appearance similar to that of the distal portion of the femur, while the distal third showed less change.

The skull (Fig. 7) showed a definite increase in density about the base of the middle and anterior fossae. The anterior and posterior clinoid processes were larger and more dense than normally, the posterior appearing as a clublike bony prominence. The fossa for the pituitary gland was 8 mm. in diameter. The area of the sphenoidal sinus showed a uniformly increased density, leaving no evidence of a cavity. The mastoid areas were similar in appearance, with an increased density and no evidence of mastoid cells. The coronal and lamboid structures were very distinct and appeared normal, as did also the grooves of the meningeal arteries. The vault appeared normal, having a good bony structure, and it was the only part of the skeleton that did appear normal.

These changes showed that there had been a generalized disturbance in the bone forming elements, in which there was an increased bone production, together with a thinning out of the structure in other parts, leaving the bone rather fragile, as is demonstrated by the oblique fracture of the right tibia, which was the result of a very minor injury. If the layer formations which could be demonstrated are interpreted as periods of growth, each of a year's duration, we may conclude that the process had been going on for about seven years.

LITERATURE

In 1904, Albers-Schönberg¹ presented roentgenograms of a rare bone disease which hitherto had been undescribed. A man, aged 26, fell into a shallow rut and fractured the femur. Roentgen-ray examination revealed that the bony structure was not recognizable. The bones gave deep, black shadows; the medullary cavity was lacking; the corticalis was diffused. Examination of the entire bony structure revealed a fracture of the other thigh and one of the olecranon. Of the origin of these the patient knew nothing.

Besides the deep, dark bone shadows, there were several transverse rings visible on the shorter bones of the extremities, as well as on the ribs. The whole picture suggested an unusually pronounced calcification of the whole skeleton.

In 1907, Albers-Schönberg² enlarged on the earlier report (1904) of his patient, who now enjoyed perfect health, and worked as a

1. Albers-Schönberg: Röntgenbilder einer seltenen Knochenerkrankung, München. med Wchnschr. **51**:365, 1904.

2. Albers-Schönberg: Eine bisher nicht beschriebene Allgemeinerkrankung des Skeletts im Röntgenbilde, Fortschr. a. d. Geb. d. Röntgenstrahlen **11**:261, 1907.

merchant without any trouble. Symptoms given in the first description were still unchanged. He adds the picture of the condition of the skull, which is peculiar in the region of the sella turcica. The posterior clinoid process consisted of a club-shaped solid bony prominence, which apparently indented the region of the sella. The crista galli also showed the same changes. The other bones showed a marble-like character.

In conclusion, Albers-Schönberg emphasized besides the marble-like changes of the bones, the especially characteristic appearance of parallel bands of lime in the diaphyses of the bones of the hand, of the feet, of the fibula and on the ribs. He emphasized the fact that these were the result of especially dense lime deposits. The etiology of this condition is not known.

In 1913, Schmidt³ reported a case. He wished to introduce the name of "lime gout" because of the similarity between the process in extensive lime deposit due to metabolic disturbances, and the genuine uric acid gout.

The case reported by Schmidt was that of congenital osteosclerosis, in which the long pipe bones were less affected than the vertebrae, the base of the skull and the sternum. The child was well developed, and died thirty hours after birth. The blood was that of a normal cadaver. The bone marrow showed a physiologic cell synthesis without signs of a fibrous change or a leukemic or pseudoleukemic disease. There was also enlargement of the hypophysis.

In 1914, Sieck⁴ reported three cases of a rare disease of the skeleton.

CASE 1.—A girl, aged 15, undeveloped for her years, had been apparently well in early youth. Her growth was impeded when 5 years old by a slight fracture of the femur. In the course of the years, she had fourteen other fractures. There was gradual increase in defect of eye-sight. During the last two years, suppuration of the lower jaw had occurred, causing almost all the teeth to fall out. Ophthalmoscopically, considerable optic nerve atrophy was revealed. Roentgen-ray examination revealed complete, structureless skull bones. The sella turcica was narrowed. The clinoid process projected greatly. The femur, tibia and fibula of both sides showed club-shaped thickenings. In the lower half of the tibia, parallel to the middle of the diaphyses, were convex streaks. The epiphyses, as well as the diaphyses, were without structure and only in the lower third of the leg (below the knee) could the corticalis and medullary space still be distinguished. In the upper extremities were different, deformed, healed fractures. The upper half of the humerus was thickened like a club, and the lower half showed transverse striations, like the tibia, with the concavities toward the diaphyses.

3. Schmidt, M. B.: Kalkmetastase und Kalkgicht, Deutsch. med. Wchnschr. **39**:59, 1913.

4. Sieck: Ueber drei Fälle einer seltenen Skeletterkrankung (Marmor-knochen nach Albers-Schönberg), Festschrift zur Feier des 25 jährigen Bestehens des Eppendorfer Krankenhauses, 1914.

CASE 2.—A boy, aged $3\frac{1}{2}$ years, with hydrocephalus, great decrease in vision, and beginning optic nerve atrophy, presented a perceptibly enlarged posterior clinoid process. The base of the skull and the skeleton of the face were thickened and structureless. The humerus in its upper end was club-shaped. The metacarpals and phalanges were thickened. The talus, calcaneus and cuboid showed, in the roentgenogram, a peripheral shadow which, toward the inside, gave place to a lighter area so as to show again a thickening in the center.

CASE 3.—A girl, aged $2\frac{1}{2}$ years, with hydrocephalus and optic nerve atrophy, presented a narrowed sella turcica, but not so pronounced as in Case 2. The posterior clinoid process, however, was plainly enlarged. The bones of the skull and extremities were of the same structureless nature as in the preceding case. This patient and the patient in Case 2 were brother and sister.

Sieck believes that the fine parallel streaks in the diaphyses are zones of growth.

In 1915, Reiche⁵ described a case of osteosclerosis and anemia.

The patient was a man, 37 years old, mentally active. He was delicately built and looked pale. He was married and had no children. He had an excessive appetite, and required a great deal of sleep. Roentgenograms revealed thickening of the bones. In the left groin was a tumor the size of a child's fist, which was sensitive to pressure. The liver projected about one and one-half finger breaths over the right costal arch.

The condition of the blood was as follows: The hemoglobin content was permanently decreased and varied between 30 and 36. Microscopically, the red blood corpuscles varied greatly in size. Erythrocytes were seen in some of the preparations. Blood platelets were present in abundance. The number of polymorphonuclear leukocytes was permanently decreased, which multiplied the number of lymphocytes.

Reiche concludes that no peculiarity in the blood picture exists in cases of osteosclerotic anemia, and that so far roentgenography is the best procedure to determine the characteristic marble-like density of the bones.

In 1917, Pick⁶ called attention to the fact that it could not be proved macroscopically that the changes in the bone were responsible for the appearance of the lime deposits, and that they reminded one of the picture of classical lime metabolism. Schulze⁷ found double the normal lime value of the blood in his case; and, in considering the progressive exhaustion of the bone substance and the enrichment of the blood with lime salts, he suggests that this follows a low grade of activity of the osteoblasts, and the lime is incompletely utilized in forming new bone substance.

5. Reiche, F.: Osteosklerose und Anämie, München. med. Wchnschr. **62**: 944 (July 13) 1915.

6. Pick, L.: Die indikatorische Bedeutung der Kalkmetastase für den Knochenabbau, Berlin klin. Wchnschr. **54**:797, 1917.

7. Schulze, Fritz: Das Wesen des Krankheitsbildes der "Marmorknochen (Albers-Schönberg)," Arch. f. klin. Chir. **118**:411, 1921.

In 1920 Laurell and Wallgren⁸ described a disease of the skeleton originally observed in a boy of 12. The skeleton showed general fragility, with a marble-like appearance.

Ernst E., aged 12 years, was the third of five children. The other children were healthy, without any sign of rickets or other bone disease. The family history was negative. At one-half year, he had not developed much since birth. He was pale and irritable and cried all day long. The head seemed to grow, although the body did not. Up to the age of 5 or 6 years, the skull circumference increased very noticeably. At about 1 year of age, his mother noticed that he had nystagmus. After his second year, it was discovered that his vision was defective. At 2½ years he could walk and talk quite well. At the age of 1 year his first teeth appeared, and the rest came in slowly and irregularly. At 3 years of age, his parents consulted a physician who diagnosed his case as rickets and hydrocephalus and prescribed cod liver oil. No great improvement followed. In 1915, when the boy was 8 years old, he fell backward down the stairs and fractured the right femur, for which he was treated for eight weeks at the hospital and was then discharged with good callus formation. The next year he broke his left leg. This fracture also healed. In the following year he suffered still another fracture of the left leg. In 1918, the right femur was fractured; this healed after six weeks. In July, 1919, without known injury or accident, the right femur was again fractured. He was sent to the hospital, the fracture healed, and he was then transferred to the children's ward.

Roentgen-ray examination revealed old fractures in other parts of the skeleton. On admission, the boy seemed in good general condition, with poor musculature. He was 122 cm. tall and weighed 23.3 kg. He was afebrile; the pulse was 100. His head was large in proportion to the rest of his body. It measured 57.5 cm. in circumference. When he looked to the side, a slow nystagmus was present. When he looked toward the left, this was especially marked. The pupils were wide and reacted normally to light. Vision was limited. There was a bilateral choked disk in the atrophic state, moderate bilateral rhinitis, poor teeth and stomatitis. The tonsils were small and smooth. There was marked lordosis of the lumbar spinal column when he stood. The thorax was deformed, with a deep depression along the insertion of the diaphragm, and a corresponding bulging forward of the edges of the thorax. The abdomen was slightly distended but not painful. The skin and tendon reflexes were active. The Babinski sign on the right was negative; on the left, uncertain. The lungs were normal except for a slight basal bronchitis. The heart sounds were distinct. The blood pressure was 100. The spleen was palpable. The liver was not enlarged. The sexual organs were normal. The Wassermann reaction was negative; the Ross-Jones reaction was negative. Detailed roentgen-ray findings are given.

Examination revealed the fact that the thyroid was nonpalpable. All osseous structures showed an enormous deposition of lime, especially in the cranium and trunk. There was a history of hydrocephalus. The long bones showed condensed lime rings and lateral bands. Experiments were made with the view of determining a possible retention of lime, but the result was nega-

8. Laurell and Wallgren: Untersuchungen über einen Fall einer eigenartigen Skeletterkrankung (Osteosclerosis fragilis generalisata), Upsala Läkaref. Förh. 25:309 (Nov. 8) 1920.

tive. The diagnosis, founded on history and feeding experiments, was: initial rachitis, complicated by hydrocephalus and a fundamental disturbance of the glands of internal secretion: thyroid, hypophysis and perhaps others, resulting in lime condensation, and some secondary symptoms (serous meningitis, atrophy of the optic nerve, anemia).

Four similar cases are known. Eight roentgenograms show the pathologic structure.

In 1921, Schultz⁷ discussed the nature of the disease of marble bones (Albers-Schönberg) and reported a case.

Hugh S., aged 11 years, of healthy family, mentally well developed, had always been well. In 1914 he had scarlet fever. Ever since that time he had been sickly. He was sent to the hospital for disease of the lungs. There was no improvement. There was slowly increasing stiffness of the vertebral column and visible emaciation.

At the time of examination the vertebral column showed a right scoliosis of the upper thoracic vertebrae. The patient was confined to bed. The teeth were decidedly rachitic. Calcification of the ligament of the patella and the Achilles tendon at insertion showed in the roentgenograms, also calcification of the posterior longitudinal ligament of the vertebral column and the plantar ligament was noted.

The ossification of the vessels appeared as a secondary condition, compared with the changes in the entire skeleton. With the exception of the metaphyseal regions, the corticalis and medullary space had disappeared in all the long pipe bones. The bones were changed into a compact, structureless, bony mass. These changes also appeared in the short bones, such as the vertebrae and bones of the feet. The axes of the femur, fibula, tibia and forearms showed indistinct curvature. The head of the humerus showed club-shaped thickenings. The head of the left femur stood in coxa-valga position.

Necropsy revealed that the degree of thickness of the bone substance was increased, inasmuch as there were lime deposits in the marrow spaces, which in places completely filled the marrow space, with the exception of very small blood vessel canaliculi. This lime deposit rested partly on the wall of the arteries but was independent of the condition of the medullary tissue. Bone changes were found in the whole skeleton. The posterior clinoid process and the sella turcica showed clublike thickenings, which authorities believe cause a decrease in function of the hypophysis.

Worthy of notice was the considerable narrowness of all the foramina of the base of the skull. This narrowing seemed to justify the conclusion that the optic nerve atrophy, which is so often noticed, might be due to bony pressure upon the optic nerve. Schulze believes that the slow bone formation is responsible for the increase in the lime content in the blood and can be considered as a final result of defects in the lime metabolism.

In this disease, according to Virchow,⁹ the normal excretion of lime

9. Virchow: Die Kalkmetastase, Virchows Arch. f. path. Anat. **81**:618, 1856; *ibid.* **81**:103, 1855.

salts is reduced because of inflamed or diseased kidneys, an accumulation of these salts in the blood occurring as a consequence. It has been shown, however, that marked disturbances in lime metabolism are possible even when the kidneys are not diseased. The kidneys in the case observed by Virchow presented a hyaline degeneration of the glomeruli due to an obliterating endarteritis and calcification. The process which at first seemed dependent on an excess of lime salts in the blood caused extensive calcification of the vessels.

According to Reiche, the osteosclerosis in his case was caused by myelogenous leukemia or pseudoleukemia, but this is not very probable. On the contrary, there exists a similarity between this condition and rachitis, as is shown by the condition of the proliferative cartilage zone.

Microscopically, the formation of the periosteal new bone is very slight. The bone very often appears to be incomplete because of the imperfect bone corpuscles. The cambium layer of the periosteum is distinctly recognizable, but shows flat, spindle-like cells, without any very active zones of proliferation.

According to Lorey,¹⁰ cited by Schulze, the three children reported by Sieck died with symptoms of anemia due to maxillary necrosis, with protracted suppuration. Lorey reports the findings in a brother of the girls in whom he could observe great thickening of the skeletal system, so that no separation between corticalis and spongiosa was possible.

Especially noticeable was the even thickening of the calcaneus and talus, which did not show a light place in the center, as in the two sisters. The streaks running transversely, which in the other cases were very plain, were not visible in this case. There was increased intraspinal pressure, and optic atrophy in a few weeks caused blindness. The child died at the age of 5 months, after a severe anemia and necrosis of the maxilla with suppuration. Necropsy was not performed.

10. Lorey: Ueber eine sehr seltene Allgemeinerkrankung des Skeletts (Marmorskelett), Verhandl. der deutsch. Röntgen-Gesellsch., cited by Schulze: Arch. f. klin. Chir. **118**:413, 1921.