BONE CHANGES IN THE SKULL IN DYSTROPHIA MYOTONICA

J. E. CAUGHEY, OTAGO, NEW ZEALAND

Associate Professor of Neurology, Department of Medicine, Otago Medical School

Dystrophia myotonica [myotonia atrophica] is a hereditary-familial disorder which is transmitted by male and female alike and by both normal and affected individuals. When the mutation first makes its appearance in a family, cataract alone is found. In subsequent generations, the cataract usually occurs at an earlier age and is associated with other features of the fully developed disease picture such as muscle wasting, myotonia, areflexia and certain endocrinological changes of which the most constant is gonadal atrophy. Recent endocrine studies by Caughey and Brown (1950) suggest that the endocrine lesion is primarily a failure of the androgenic function of the adrenal cortex and of the gonads. In the same study these authors reported the radiographic abnormalities encountered in the skull in patients with dystrophia myotonica. In a subsequent paper, Caughey (1952) reported briefly thirteen patients with dystrophia myotonica, all members of the so-called "dystrophic generation," who presented similar radiographic changes. This paper is presented in order to bring the radiological aspect of this disease entity to the notice of orthopaedic surgeons. Patients with dystrophia myotonica may seek advice from an orthopaedic surgeon on account of the muscular dystrophy with characteristic myotonia, muscle wasting and areflexia, or possibly on account of bony changes in the skull. In the latter instance the differential diagnosis from Paget's disease, secondary carcinomatosis and other disorders of bone has to be considered.

HISTORICAL BACKGROUND

Myotonia was originally described by Leyden in 1874, and in 1892 Thomsen recorded in detail the myotonia from which he himself suffered. The association of muscle atrophy with myotonia was described by Dana in 1888. In 1909 Steinert recorded the full clinical picture and first described changes in the mental status and some of the associated dystrophic features such as premature frontal baldness and gonadal atrophy. At the time these latter findings were regarded as being merely coincidental. In 1911 Greenfield recorded the constant association of cataract with the disorder and thereafter the other dystrophic manifestations came to be recognised as variable features of the clinical picture in the fully developed disorder as seen in the so-called "dystrophic generation."

Few authors have referred to the radiographic changes in these patients. Scharnke and Full (1920) reported a large frontal sinus in the presence of a normal pituitary fossa. Rouquès (1931) reported radiographic abnormalities in the skull of four patients with the fully developed disorder. In three there was distinct thickening of the calvarium, large frontal sinuses occurred in two, in two the pituitary fossa was small and in two it was bridged by calcification. Fagin (1946) reported hyperostosis frontalis in two patients, and Correia de Oliveira and Mosinger (1951) discussed hyperostosis frontalis interna associated with the disease.

CLINICAL MATERIAL

In the past five years in New Zealand we have had the opportunity of studying twenty-four patients with dystrophia myotonica, nineteen with the fully developed disorder and five with cataract alone. Through the courtesy of General Dart of the Armed Forces Institute of Pathology, Washington, the author has had access to the records of a further case, and he has received details of another patient with the fully developed disorder from Dr Paul Yakovlev of Massachusetts. Out of the twenty-one cases with the fully developed disorder fifteen have shown changes in the skull, and these are here recorded.

CASE REPORTS

Case 1—Myopathy, myotonia, bilateral cataract, premature frontal baldness, hypogonadism, hypothyroidism, small pituitary fossa and hyperostosis frontalis.

Man aged forty-five years. Unmarried. Pensioner. At twenty-seven years he noticed wasting of his arms, legs and neck muscles. This had progressed and for three years he had been unable to raise his head from the pillow or to stand alone. He developed difficulty in relaxing his grasp five years after the onset and about the same time he developed bilateral lenticular opacities which were successfully treated five years later. Seven years after the onset he had to give up farming on account of the increasing weakness. Frontal baldness developed in his early twenties. Body hair had become soft and scanty over the past ten years.

Family history—One brother, aged forty-one, has bilateral lenticular opacities but no other evidence of the disease. An aunt on the maternal side has cataracts.

Physical examination—A tall, middle-aged man with frontal baldness, myopathic facies and scanty eyebrows, body hair and beard (Fig. 1). Facial hair was soft and scanty on the chin and moustache area. Pubic hair was of a female type of distribution, axillary hair was normal. The skin of his fingers was shiny and dystrophic in appearance. He was unable to sit unaided and required assistance when walking. Facial muscles were wasted and weak and there was almost complete atrophy of both sternomastoid muscles.

FIG. 1

Case 1—Myopathic facies; atrophy of sternomastoid muscles; gynaecomastia following implant of testosterone.

There was wasting and weakness of all muscles of the forearms. The abdominal muscles were weak, and the lower limbs were wasted and weak in all movements. His gait was unsteady and "steppage" in type. When seen in 1936 there was myotonia of the grasp but, probably due to the excessive weakness, this is now slight. Mechanical myotonia was slight in the tongue, thenar and hypothenar eminences. All deep reflexes were lost. Sensory appreciation was normal. The testes were soft and very small. His mental state was good. The cardiovascular system was normal.

Investigations—The blood count was normal and the Kahn reaction negative. The cerebrospinal fluid was normal. Basal metabolic rate was -48 per cent and -34 per cent. The serum cholesterol was 360 milligrams/100 millilitres; total non-protein nitrogen 33 milligrams/100 millilitres; serum chlorides 556 milligrams/100 millilitres (as NaCl); serum calcium 10.7, 10.5, 9.1 milligrams/100 millilitres; serum phosphorus 4, 3.3 milligrams/100 millilitres; serum sodium 327 milligrams/100 millilitres; serum potassium 17 milligrams/100 millilitres; acid phosphatase 1.2 units; and alkaline phosphatase 22 K.A. units. The glucose tolerance test showed fasting blood sugar 98 milligrams/100 millilitres; subsequent levels were 125, 135, 139,

130 and 124 milligrams/100 millilitres at half-hourly intervals. Insulin tolerance test in 1947 was: fasting 100; 20 minutes 72, 30 minutes 41, 45 minutes 37, 60 minutes 77, 90 minutes 83, 120 minutes 98. The follicle-stimulating hormone test was positive to 96 mouse units. The test for adrenal cortical function (Cutler, Wilder, Power) gave an equivocal result. The 17-ketosteroid excretion was 1.3 and 1 milligram/100 millilitres in twenty-four hours. The electrocardiogram showed elevation of ST 1 and ST 2 and "slight ventricular myocardial damage seemed probable."

Radiographic findings—In the skull, the vault shape was normal and the calvarium thickened, with hyperostosis interna frontalis et parietalis. The sinuses were within normal limits. The pituitary fossa was small, with pneumatized dorsum sellae and the pineal body was calcified. The spine, pelvis and femora were normal.

Case 2—Myopathy, myotonia, bilateral cataract, frontal baldness, hypogonadism and small pituitary fossa.

Man aged forty-two years. Retired farmer. In 1941 he was aware of difficulty in relaxing his grasp, soon followed by weakness and wasting in his forearms, legs and neck muscles. The wasting and weakness have progressed and the myotonia has persisted. For four years there has been impairment of potentia and libido, with complete loss of potentia in the past six months, and he has become irritable and less reliable than previously.

Physical examination—A well-developed man with frontal baldness and myopathic facies. He had extensive body hair and normal facial hair. There was general wasting of his facial, temporal and sternomastoid muscles, the latter giving a rounded swan-like appearance to the neck. The deltoid muscles were hypertrophied but weak and there was severe wasting and weakness of his forearms and upper arms, the small muscles of the hands being unaffected. There was wasting of the legs and to a lesser extent of the thighs. All deep reflexes were absent. The grasp was myotonic and mechanical myotonia could be elicited from the tongue (Fig. 2), thenar, hypothenar and calf muscles. The visual acuity was reduced to six-twelfths in each eye, due to bilateral lenticular opacities. The testes were small and soft. The cardiovascular system was normal.

Investigations—The blood Kahn test was negative and a blood count normal. The serum calcium was 10.7 milligrams/100 millilitres; serum phosphorus 3.6 milligrams/100 millilitres; and serum cholesterol 180 milligrams/100 millilitres. The cerebrospinal fluid was normal. Basal metabolic rate was -12 per cent and -8 per cent. The electrocardiogram was normal. The glucose tolerance test was normal. Fasting blood sugar 80 milligrams/100 millilitres; subsequent levels: 115, 90, 75 and 70 milligrams/100 millilitres at half-hourly intervals. The insulin tolerance test was as follows: fasting 76 milligrams/100 millilitres; fasting 100, 20 minutes 80, 30 minutes 60, 45 minutes 66, 60 minutes 68, 90 minutes 102, 120 minutes 105, expressed as percentage of fasting value. Two 17-ketosteroid estimations were 2.5 and 4.5 milligrams excreted in twenty-four hours.

Radiographic findings—The chest was normal. Radiographs of the skull showed a normal vault. The frontal sinuses were extensive and the pituitary fossa was small. Femora and pelvis normal.

Case 3—Myotonia, myopathy, auricular flutter, hyperostosis frontalis, very small pituitary fossa.

Man aged twenty-six years. Unmarried. Panel beater. In 1945 he developed palpitation and breathlessness and was admitted to hospital where auricular flutter was diagnosed. For two years previously he had noticed difficulty in relaxing his grasp, and weakness of his wrists and legs. Frontal baldness began to develop at twenty-one years of age. Sexual functions were unimpaired.

Physical examination—A slightly built man, with frontal baldness. Body hair and secondary sex hair were normal. The facies was myopathic and the neck rounded and swan-like due to wasting of his sternomastoid muscles. The forearms were wasted and the extensors of the wrists weak. The deep reflexes of the arms were absent; the knee jerks were reduced. There was myotonia of the grasp and mechanical myotonia of the tongue, thenar and hypothenar eminences, and the calves. The testes were normal. The visual acuity was normal and there were no lenticular opacities. Cardiovascular system: Pulse 110; blood pressure 115/85; the electrocardiogram showed an irregular rhythm with a 4:1 to 7:1 flutter; the ST segment was normal.

Investigations—The blood count was normal, and the Kahn reaction negative. Serum calcium was 10.4 milligrams/100 millilitres; serum phosphorus 3.2 milligrams/100 millilitres; and serum cholesterol 210 milligrams/100 millilitres. Basal metabolic rate was +38 per cent and +27 per cent. Acid phosphatase: 2 units. The glucose tolerance test showed fasting blood sugar 83 milligrams/100 millilitres; subsequent levels: 140, 96, 72, 82 milligrams/100 millilitres at half-hourly intervals. The insulin tolerance test was normal. Two 17-ketosteroid estimations were 4.2 and 5.5 milligrams excreted in twenty-four hours.

Radiographic examination—The chest was normal. The bones of the skull were thickened, especially in the posterior parietal region. There was also a hyperostosis interna, commencing in the frontal region. The frontal sinuses were deep. The pituitary fossa was very small.

Case 4—Myotonia, muscular dystrophy, bilateral cataract.

Woman aged thirty-three years. Married. Twelve years ago she noticed difficulty in relaxing her grasp and six or seven years later she noticed weakness and wasting of her right leg. Soon the weakness and atrophy became apparent in the left leg, upper limbs and in the neck and face. She then had difficulty in holding her back straight and at times had a tendency to overbalance. For three years she noticed deterioration of her vision and eighteen months ago the vision in the

FIG. 2

Case 2—Mechanical myotonia of tongue after tapping with a percussion hammer.

right eye failed completely and a cataract was excised. The left eye subsequently failed and the cataract was removed. She has had three children. The first had a cleft palate and died of meningitis. The second had a cleft palate and hare-lip, and the third child is alive and well.

Physical examination—The facies was myopathic with wasting of all the facial musculature and the neck was swan-like due to complete wasting of the sternomastoids. There was wasting of the forearms with weakness more marked in the dorsiflexors of the wrists. The muscles of the legs were wasted and the dorsiflexors of the feet weak. The grip was myotonic and mechanical myotonia of the tongue, thenar and hypothenar eminences was present. All deep reflexes in the lower limbs were absent. There were bilateral lenticular opacities.

FIG. 3

Case 4—Thickened calvarium; hyperostosis frontalis et parietalis.

Radiographic examination (Fig. 3)—The skull vault shape was normal; the calvarium was markedly thickened throughout with marked hyperostosis frontalis interna and hyperostosis parietalis. The sinuses were within normal limits, with pneumatization of the dorsum sellae. The pituitary fossa was small.

Case 5—Muscle wasting, myotonia, thickened calvarium and hyperostosis frontalis; small pituitary fossa.

Man aged twenty-seven years. The onset of his illness was two years ago when he first noticed difficulty in relaxing his grasp and noted wasting and weakness of the neck muscles and wasting of the forearms and legs. Frontal baldness was apparent in the early twenties.

Examination—He had frontal baldness and a myopathic facies; also myotonia of the grip and mechanical myotonia of the tongue, thenar, hypothenar and plantar muscles. There were no lenticular opacities. There was wasting of the muscles of the face, neck, forearms and legs. The

reflexes were all present. There was no gonadal atrophy apparent.

Radiographic examination—The calvarium of the skull was thickened and there was hyperostosis interna frontalis. The sinuses were normal and the pituitary fossa small.

Case 6—Myotonia, myopathy, cataract, frontal baldness, calcification of falx cerebri.

Man aged thirty-two years. Returned soldier. While a prisoner of war in Germany in 1944 he noticed difficulty in relaxing his grip, soon followed by wasting and weakness of the right shoulder muscles. Wasting progressed to involve the muscles of the face, neck, forearms, shoulder girdles and legs. His vision had recently deteriorated. There had been no impairment of potentia or libido.

Physical examination—He had frontal baldness and a myopathic facies with early wasting of the facial musculature. The sternomastoid muscles were completely wasted and there was wasting of the left deltoid and pectoral muscles, the spinati and trapezii muscles. The lower limbs were normal. There was myotonia of the grip and mechanical myotonia of the tongue, the thenar and hypothenar eminences, the deltoids and flexors of the forearms. The knee jerks were diminished and the right ankle jerk was absent. The visual acuity was unimpaired but both lenses showed early cataract with a few striae radiating from the posterior pole of the right eye and a few minute opacities in the left lens.

Investigations—A blood count was normal and the Wassermann reaction negative. The cerebrospinal fluid was normal. Serum calcium was 10.8 milligrams/100 millilitres and serum cholesterol 180 milligrams/100 millilitres. Excretion of 17-ketosteroids was 4.8 milligrams in twenty-four hours. Insulin sensitivity: fasting 100, 20 minutes 63, 30 minutes 45, 45 minutes 60, 60 minutes 67, 90 minutes 74, 120 minutes 127, expressed as percentage of fasting glucose level of 106 milligrams/100 millilitres. Biopsy from the left deltoid muscle showed irregular changes in the muscle fibres with some hypertrophic and many wasted fibres and an increase in the fibrous tissue. There was loss of transverse striations and multiplication of the nuclei.

Radiographic examination—Skull: the calvarium was normal. There was a calcified falx cerebri. No definite hyperostosis frontalis was present. The pituitary fossa was normal to small. All sinuses were large. Pelvis, femora and chest normal.

Case 7—Complete picture of dystrophia myotonica, with myotonia, wasting, cataracts, failure of potentia and libido, left bundle branch block, pituitary fossa small.

Man aged forty-one years. Carpenter. When thirty-four years of age he noticed failure of potentia which proceeded to complete loss of potentia and libido. Four years later, his grasp became difficult to relax and he developed weakness of his arms and legs, difficulty in swallowing and his speech became slurred.

Physical examination—A bald, wasted man with a myopathic facies. His speech was somewhat slurred and thick. The sternomastoid muscles were completely wasted. There was wasting and weakness of all four limbs. Voluntary myotonia affected the grasp of both hands and mechanical myotonia was present. All deep reflexes were absent. Secondary sex hair was scanty. The testes were small and soft and the prostate gland was very small. Visual acuity was normal. Slit lamp examination revealed multiple punctate subcapsular opacities longer and more numerous at the periphery. The pulse was slow and regular. The heart was normal. There was reduplication of the second sound at the apex. The blood pressure was 100/55.

Investigations—A blood count was normal and a blood Kahn test was negative. The cerebrospinal fluid was normal. The 17-ketosteroid excretion was 1.7 milligrams in twenty-four hours and a gastric test meal revealed a low total acidity. The electrocardiogram revealed a left bundle-branch block.

Radiographic examination—Skull: the vault was normal with well marked venous lacunae. The frontal sinuses and sphenoids were extensive and deep, the latter extending into the posterior clinoid processes. The mandible was elongated. The pituitary fossa was small. Pelvis and femora normal.

Case 8—Myopathy, myotonia, bilateral cataract, small pituitary fossa and hyperostosis frontalis.

Woman aged fifty-one years. Since the age of thirty years she had noticed weakness of her neck muscles. In the past five years there had been progressive wasting and weakness of her forearms and legs, so that she had been bedridden for a year. At times she had noticed some difficulty in relaxing her grasp, but this was not troublesome. Her vision had not failed noticeably, but there had been loss of libido for several years.

Family history—There are two sons, the younger son aged twenty-eight years having the fully developed disease. The elder son is well. There is no history of cataract in the family.

Physical examination—A middle-aged woman with grey hair, no baldness, and a myopathic facies. Her speech was slurred. Her body hair and eyebrows were somewhat scanty but of normal female distribution. The skin was soft and of fine texture. There was some wasting of the facial muscles. The sternomastoid muscles were almost completely atrophied and were powerless. There was great weakness and wasting of the forearms and legs. Mechanical and voluntary myotonia was only slight. All deep reflexes were reduced with absent ankle jerks. There were bilateral polar cataracts. The mental status was normal and she was of average intelligence. The cardiovascular system was normal.

Investigations—Serum calcium 10.3 milligrams/100 millilitres and serum phosphorus 4 milligrams/100 millilitres; serum sodium 335 milligrams/100 millilitres; serum chlorides 556 milligrams/100 millilitres (as NaCl); serum cholesterol 310 milligrams/100 millilitres. Glucose tolerance curve: 71, 96, 131, 148, 129 milligrams/100 millilitres at half-hourly intervals. Insulin sensitivity: fasting 100, 20 minutes 71, 30 minutes 55, 45 minutes 70, 60 minutes 73, 90 minutes 105, 120 minutes 117, expressed as percentage of fasting blood sugar. Follicle-stimulating hormone was strongly positive for 96 mouse units. The 17-ketosteroid excretion was 1.8 milligrams in twenty-four hours. The water excretion for adrenal cortical function suggested impaired function. The volume of the night urine was 435 cubic centimetres and that of the largest day specimen 315 cubic centimetres, giving a ratio of 38. Basal metabolic rate was -4 per cent. Electrocardiogram showed low voltages throughout and a left bundle-branch block and probably a first degree of heart block.

Radiographic examination—Skull: the vault was normal in shape but possibly large in size due to thickening of all the membrane bones. There was extensive hyperostosis frontalis interna (Fig. 4). The thickening was somewhat patchy and resembled that of Paget's disease. The sinuses and mandible were normal. The pituitary fossa was very small with calcification near the floor. There was no pneumatization of the dorsum sellae. Chest, pelvis and femora normal.

Case 9—Myopathy, myotonia, cataract, hypogonadism, mental retardation, small pituitary fossa and hyperostosis frontalis.

Man aged twenty-eight years. Son of patient described in Case 8. At school was backward. On leaving school at thirteen years he was unable to hold any position. At seventeen he noticed difficulty in relaxing his grasp, soon followed by weakness and clumsiness of his arms, legs and

neck muscles. The weakness and wasting progressed slowly. For two years before our examination his vision had been deteriorating.

Physical examination—He was a dark, swarthy man of inferior intelligence. His facies was myopathic with a slow lingering smile. There was early recession of the hair in the frontal region, but his body hair was normal and of male distribution. His speech was slurred and indistinct. There was wasting of the sternomastoid muscles and of the muscles of the forearms and legs. There was marked myotonia of the grasp and, on percussion, of the tongue and small muscles of the hands. The knee and ankle jerks were absent. There was bilateral polar cataract. The testes were small and soft, but had normal sensation. The body dimensions were normal.

Investigations—The serum sodium was 332 milligrams and serum potassium 17.5 milligrams per 100 millilitres; the serum cholesterol 200 milligrams, serum calcium 9.9 milligrams and serum phosphorus 2.0 milligrams per 100 millilitres. The basal metabolic rate was +9 per cent. Glucose

FIG. 4

Case 8—Hyperostosis frontalis. Pituitary fossa small.

FIG. 5

Case 9—Hyperostosis frontalis et parietalis. Pituitary fossa small.

tolerance curve: 65, 120, 135, 130, 85 milligrams/100 millilitres at half-hourly intervals. Insulin sensitivity: fasting 100 (75), 20 minutes 80, 30 minutes 53, 45 minutes 80, 60 minutes 87, 90 minutes 75, 120 minutes 100, expressed as percentage of fasting blood sugar. The clinical response of the patient to insulin was normal. The 17-ketosteroid excretion was 1.2 milligrams in twenty-four hours. The water excretion test (Robinson, Power and Kepler 1941) produced 300 millilitres of night urine, and the greatest hourly volume of day urine after fluid was 210 millilitres, giving an index of 35. The excretion of follicle-stimulating hormone was positive to 96 mouse units. An electrocardiogram showed a P.R. interval of 0.17 seconds, and a very small R wave in leads V2 and V3 with the probability of myocardial damage.

Radiographic examination—The skull vault was normal in size (Fig. 5); all the membrane bones were thickened, with extensive hyperostosis frontalis interna and hyperostosis parietalis interna. The sclerosis was patchy, to some extent resembling Paget's disease. The sinuses were extensive and deep. The pituitary fossa was very small, and the dorsum sellae thick and partly pneumatized. The pineal body was possibly calcified. Pelvis and femora normal.

Case 10—Myopathy, myotonia, hypogonadism, mental retardation and small pituitary fossa.

Man aged thirty-three years. Grocer. He had always been a frail individual. At school he was backward. His occupational history was unsatisfactory, and for the last year he had been unemployed. He had first noticed difficulty in relaxing his grasp when thirteen years of age. At the age of fifteen he had noticed that his arm and leg muscles were becoming weaker and were wasting. The difficulty with his grip had become increasingly great. He had begun shaving at twenty-one years and at thirty-three shaved every third day. His vision had not deteriorated.

Physical examination—He was a thin, swarthy man with a disinterested look, and below the average in intelligence. The head hair was dark, very fine and scanty, and the eyebrows were scanty. The facial hair was scanty and confined to the moustache and chin areas. The axillary and pubic hair were also scanty, the latter being of female distribution. The hair on his legs was fine but of normal distribution. His skin was dry and atrophic, with numerous melanomata. The thyroid gland was not palpable. There was marked myotonia of the grip, and myotonia of the

tongue and thenar eminences on percussion. The facies was myopathic, and there was wasting of the sternomastoids and, to a lesser degree, of the limb muscles. The deep reflexes were normal. No cataracts were present. The prostate gland was small. The cardiovascular system was normal. *Investigations*—The blood Kahn test was negative. The serum sodium was 340 milligrams, serum potassium 16 milligrams and serum chloride 580 milligrams per 100 millilitres. The serum cholesterol was 280 milligrams and the serum calcium 10.1 milligrams per 100 millilitres. Glucose tolerance: 80, 160, 130, 130, 90 milligrams/100 millilitres at half-hourly intervals. Insulin sensitivity: fasting 100 (90), 20 minutes 72, 30 minutes 50, 45 minutes 78, 60 minutes 84, 90 minutes 89, 120 minutes 120, expressed as a percentage of fasting blood sugar. The clinical reaction to insulin was normal. The 17-ketosteroid excretion was 3.1 milligrams in twenty-four hours. The water excretion test (Robinson, Power and Kepler 1941) produced 360 millilitres of night urine, and the greatest hourly day urine after fluid was 270 millilitres, giving an index of 31. Excretion of follicle-stimulating

FIG. 6

Case 10—Skull small; mandible elongated. Pituitary fossa very small.

FIG. 7

Case 14—Thickening of the calvarium; hyperostosis frontalis. Pituitary fossa small and bridged over.

hormone was positive to 96 mouse units. An electrocardiogram showed some slurring of R in leads I and II, probably representative of myocardial damage.

Radiographic examination—The skull (Fig. 6) showed a small, globoid and microcephalic vault. The bones were thick but of normal density, with marked venous lacunae. The sinuses were extensive and deep, especially the sphenoids, which extended into the posterior clinoid processes. The mandible was elongated. The pituitary fossa was very small. The dorsum sellae was pneumatised.

Case 11—Myotonia, myopathy, cataract, hyperostosis interna frontalis, pituitary fossa small, mental defect.

Woman aged forty-five. Unmarried. She was committed to a mental hospital nine years ago on account of mental defect. Three years ago she first noticed difficulty in relaxing her grasp and a year ago first developed bilateral cataracts and noticed gradual wasting of the face, neck, forearm and leg muscles.

Examination—A slight, poorly nourished woman with a myopathic facies. Cataract in left eye and cataract recently removed from the right eye. The facial muscles were wasted and there was marked wasting of the sternomastoid muscles and wasting of the forearms and legs. There was well marked myotonia.

Radiographic examination—The skull showed marked hyperostosis interna frontalis. The floor of the anterior fossa was more vertical than usual and the pituitary fossa was small. The sphenoidal sinus was large and the antra natural. The jaw was prognathic.

Case 12—Bilateral cataract, myotonia, weakness of sternomastoids, thickened calvarium, hyperostosis frontalis, pituitary fossa small.

Married woman aged forty-seven years. Had developed bilateral cataract nine years previously. *Physical examination*—There was well marked myotonia of grasp and mechanical myotonia of the tongue and thenar and hypothenar eminences. The sternomastoid muscles were weak but there was no wasting of muscles apparent.

Radiographic examination—Skull: the calvarium was thickened and there was hyperostosis interna frontalis. The pituitary fossa was small. The sinuses were all normal.

Case 13—Myotonia, myopathy, calvarium thickened, hyperostosis frontalis, pituitary fossa small.

Woman aged forty-two. Unmarried. Cousin of previous patient (Case 12). For fifteen years she had noticed inability to relax her grasp. For fifteen months wasting and weakness of her legs. *Physical examination*—There was a myopathic facies and wasting of the sternomastoid muscles and of the muscles of the forearms and legs. There was myotonia of grasp and mechanical myotonia of the thenar and hypothenar eminences.

Radiographic examination—Skull: there is marked thickening of the calvarium, the average thickening being approximately $1\frac{1}{2}$ centimetres. The thickness is evenly distributed and involves all the bones of the vault. There is also hyperostosis interna frontalis. The pituitary fossa is small.

Case 14—Bilateral cataract, myopathy, gonadal atrophy, hyperostosis frontalis and small pituitary fossa.

Man aged fifty-two years. Admitted to hospital on account of weakness of his legs and inability to walk for five years. Since 1931 he stated that his legs kept "giving away." He had not worked since 1931 and for five years had been bedridden. His vision had been defective for years.

FIG. 8

Case 15—Wasting of sternomastoid muscles, forearms and legs. Jaw prognathic.

Physical examination—A pale man with a myopathic facies. Visual acuity was much reduced by bilateral cataract. There was marked wasting and weakness of the sternomastoid muscles and of the forearms and legs. All deep reflexes were lost. Cardiovascular system was normal. Blood pressure 155/100. There was no record of myotonia.

Family history—Two brothers suffer from similar disabilities.

Investigations—Kahn negative. Cholesterol 262 milligrams per cent. Creatinine 1.4 milligrams per cent. Creatine 4.6 milligrams per cent.

Radiographic examination—Skull: there was considerable thickening of all the bones of the vault, particularly in the frontal area where there is definite hyperostosis interna (Fig. 7). The pituitary fossa was small and almost bridged over.

Case 15—Myotonia, myopathy, hypogonadism, acromegaloid features, hyperostosis frontalis.

Man aged forty-three years. He was feeble-minded, with a mental age of seven years and intelligence quotient 44. His mother was said to be feeble-minded. Two siblings were both feeble-minded and with dystrophia myotonica. At seventeen patient was admitted to a farm colony in Connecticut on account of frequent falls and repeated fractures of the long bones.

Physical examination—The lower jaw was prognathic (Fig. 8). He had myotonia of the grip of both hands and mechanical myotonia of the adductor pollicis. There was gross muscle wasting of the temporal, masseter, sternomastoid, forearm and leg muscles. The knee jerks and ankle jerks were absent. There was testicular atrophy and gynaecomastia.

Post-mortem examination confirmed the clinical diagnosis of dystrophia myotonica. The skull showed severe hyperostosis frontalis interna. The inner table of the frontal bone was thickened by solid bony irregular smooth-surfaced excrescences symmetrically distributed on each side of the midline. In the area of endostosis the frontal sinuses extended deep into the frontal bone. The pituitary gland was large especially in transverse diameter which measured 24 millimetres. Its antero-posterior length was 13 millimetres, and weight 1.1 grammes. Both testicles were small and soft.

DISCUSSION

These fifteen patients (ten male and five female) had dystrophia myotonica with the fully developed disorder. In all there were radiographic abnormalities of the skull. There was thickening of the calvarium in eleven patients and hyperostosis interna occurred in eleven. This was more marked in the frontal region but occurred in the parietal region in five patients. In one the hyperostosis was more apparent in the parietal region. In eight patients the

frontal sinuses were extensive and deep, and in six there was extensive pneumatization of the sphenoidal bone.

The assessment of size of pituitary fossa is notably difficult and in the above reports it is classified as normal, small, or very small. "Small" indicates a sagittal diameter below 9 millimetres and/or a vertical diameter below 6 millimetres; "very small" indicates measurements below 6 millimetres and/or 4 millimetres respectively for the same diameters. With four exceptions the magnification distortion was known to be the same in the cases examined. In the series the pituitary fossa was small in eight cases, very small in five and normal to small in one. In one case no radiographs of the skull were available but post-mortem revealed a somewhat enlarged pituitary fossa.

The jaw was prognathic in three and in one it was sufficiently large to be classified as acromegaloid. In this patient post-mortem examination showed the pituitary fossa to be enlarged; the pituitary gland was small and it seemed likely that it must have been enlarged at one time and subsequently undergone atrophy. These acromegaloid features and the extensive sinuses suggest an overactivity of the anterior pituitary gland at some time in the course of the disorder in spite of the apparent paradox of the associated small pituitary fossae.

In one patient there was well marked calcification of the falx cerebri and this has since been observed in two other cases. In Case 1 a full check of other parts of the skeleton failed to reveal any abnormalities. In two others the chest radiographs were normal, and in five the pelvic bones and femora were normal.

It is evident that thickening of the calvarium, hyperostosis interna, a small pituitary fossa and extensive sinuses are some of the variable dystrophic features of dystrophia myotonica.

SUMMARY

Fourteen patients with dystrophia myotonica and a post-mortem report of another case are reported. All had radiological or other evidence of abnormalities of the skull. The most constant were a thickened calvarium, hyperostosis interna, small to very small pituitary fossa and extensive sinuses. It is believed that the high incidence of these changes cannot be coincidental and it is held that they should be accepted as some of the variable features of dystrophia myotonica.

For records and photograph of Case 14, I am greatly indebted to the Director of the Armed Forces Institute of Pathology, Washington, D.C., and for Case 15 I am indebted to Dr Paul Yakovlev and Dr Wadsworth of the Connecticut State Hospital. It is also a pleasure to thank other physicians who have given me access to their cases.

REFERENCES

- CAUGHEY, J. E., and BROWN, J. (1950): Dystrophia Myotonica: An Endocrine Study. *Quarterly Journal of Medicine*, **N.S. 19**, 303.
- CAUGHEY, J. E. (1952): Radiological Changes in the Skull in Dystrophia Myotonica. *British Medical Journal*, **1**, 137.
- CORREIA DE OLIVEIRA, and MOSINGER, M. (1951): Dystrophie de Steinert-Batten associée à une hyperostose frontale interne de Morgagni-Stewart-Morel. (1951): IVe Congrès Neurologique International, Paris, 1949. Paris: Masson et Cie, **2**, 115; **3**, 409.
- DANA, C. L. (1888): An Atypical Case of Thomsen's Disease (Myotonia Congenita). *Medical Record*, **33**, 433.
- FAGIN, I. D. (1946): Dystrophia Myotonica. *Journal of the Michigan State Medical Society*, **45**, 500.
- GREENFIELD, J. G. (1911): Notes on a Family of "Myotonia Atrophica" and Early Cataract, with a Report of an Additional Case of "Myotonia Atrophica." *Review of Neurology and Psychiatry*, **9**, 169.
- LEYDEN, E. (1874): *Klinik der Rückenmarkskrankheiten*, **1**. Berlin: A. Hirschwald.
- ROUQUÈS, L. (1931): La myotonie atrophique. Paris: Amédée Legrand, 39.
- SCHARNKE and FULL (1920) (quoted by Rouquès, L., 1931).
- STEINERT, H. (1909): Myopathologische Beiträge. *Deutsche Zeitschrift für Nervenheilkunde*, **37**, 58.
- THOMSEN, J. (1892): Nachträgliche Bemerkungen über Myotonia congenita (Strümpell), Thomsen'sche Krankheit (Westphal). *Archiv für Psychiatrie und Nervenkrankheiten*, **24**, 918.